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Review Article

CURRENT PERSPECTIVES ON GASTRIC ULCER DISEASE: ETIOLOGY, DIAGNOSIS, CONVENTIONAL THERAPY AND HERBAL THERAPEUTICS

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ABSTRACT

Gastric ulcer is one of the most prevalent gastrointestinal disorders worldwide and remains a significant health concern due to its high incidence, recurrence, and potential complications such as bleeding, perforation, and gastric cancer. The disease develops as a result of an imbalance between aggressive factors, including gastric acid, pepsin, *Helicobacter pylori* infection, non-steroidal anti-inflammatory drugs (NSAIDs), alcohol consumption, smoking, and stress, and the defensive mechanisms of the gastric mucosa. Although conventional therapies such as proton pump inhibitors, H_2-receptor antagonists, antacids, and antibiotics are effective, their long-term use is often associated with adverse effects, relapse, drug interactions, and increasing antimicrobial resistance. Consequently, there is growing interest in the exploration of medicinal plants as safer and more effective alternatives for the prevention and treatment of gastric ulcers. Medicinal plants contain a wide range of bioactive phytoconstituents, including flavonoids, phenolics, tannins, alkaloids, terpenoids, and glycosides, which exhibit gastroprotective, antioxidant, anti-inflammatory, antimicrobial, and cytoprotective properties. This review summarizes the anatomy and physiology of the gastrointestinal tract, etiology and pathogenesis of gastric ulcer disease, diagnostic approaches, conventional treatment strategies, and the therapeutic potential of medicinal plants traditionally used in ulcer management. The review also highlights the mechanisms by which medicinal plants promote ulcer healing, including enhancement of mucosal defense, reduction of gastric acidity, scavenging of free radicals, inhibition of inflammatory mediators, and acceleration of tissue regeneration. The available evidence suggests that medicinal plants represent promising candidates for the development of novel gastroprotective agents; however, further phytochemical investigations, mechanistic studies, and well-designed clinical trials are required to establish their safety, efficacy, and therapeutic applicability.

Keywords: Gastric Ulcer, Gastroprotection, Medicinal Plants, *Helicobacter pylori*, NSAIDs, Phytochemicals, Anti-ulcer Activity, Traditional Medicine, Gastric Mucosa, Natural Products.

INTRODUCTION

The most concerning gastrointestinal (GI) symptom in the world is gastric ulceration (GU).The most common gastro- intestinal ailment is a stomach ulcer and around 10% of people worldwide suffer from gastric ulcer disease (Hady *et al*., 2019). It is a typical gastroduodenal disease, commonly marked by

gastric mucosa lesions and often caused by an imbalance between protective and aggressive factors. In case of gastric rupture and hemorrhage, it can be fatal; however, chronic gastric mucosal inflammation may destroy the glands and cause metaplasia, which may further contribute to gastric cancer (Zheng *et al*., 2024).

It is typically characterized by persistent, recurring epigastric pain that is fought off by the gastrointestinal system's endogenous offensive and aggressive forces combined (Aman *et al*., 2021). Endogenous aggressive factors include HCL and pepsin overproduction and an H pylori infection. Mixed endogenous offensive factors include imbalance of mucin, antioxidants, bicarbonate, nitric oxide, prostaglandins, and growth factors levels in mucus layer of GI. Among the myriad causes, the use of nonsteroidal anti-inflammatory drugs (NSAIDs) is an important risk factor due to the inhibition of the cyclooxygenase (COX) enzyme, thus compromising the protective mucosal lining of the stomach (Laucirica *et al*., 2023; Kamada *et al*., 2021).

Gastro protectants like sucralfate, proton-pump inhibitors (PPIs) like omeprazole, histamine, type-2 receptor antagonists like famotidine, antibiotics like clarithromycin in the event of an H. pylori infection, and antacids are frequently used to treat gastric ulcers (Mahmoud *et al*., 2023; Chang *et al*., 2022). Nevertheless, these therapies may entail, in particular, side effects after longer-terms like vitamin B12 deficiency, hypomagnesemia, higher fracture risk with PPIs. Also, arrhythmia, increased resistance to antibiotics in H. pylori infection, relapse incidences, drug interactions, and in some cases, increased risk of carcinogenesis (Liao *et al*., 2009).

Gastro intestinal tract

Cross-section of the alimentary tube has four layers the mucosa, submucosa, external muscle layer, and serosa. Each layer has a specific structure, and its functions (Liao *et al*., 2009).

A] Mucosa: The mucosa of the alimentary tube is made up of smooth muscle, areolar connective tissue, and epithelial tissue. The stomach and intestines have simple columnar epithelium, while the esophagus has stratified squamous epithelium (Wilding, 2000).

B] Submucosa: Blood vessels, lymphatic vessels, and areolar connective tissue make up the submucosa. The enteric nervous system, which controls gut function, is made up of millions of nerves. Mucosal secretions are regulated by Meissner's plexus, where sympathetic impulses reduce secretion and parasympathetic impulses increase it. Motor neurons control blood flow, but sensory neurons perceive pain (Day *et al*., 2008).

C] Serosa: The outermost layer, made of fibrous connective tissue, is called the serosa. The mesentery, also known as the visceral peritoneum, is a kind of serous membrane that lies beneath the diaphragm. The parietal peritoneum, sometimes referred to as just the peritoneum, covers the abdominal cavity (Odze *et al*., 2022).

D] Oesophagus: Food is transported from the throat to the stomach by the muscular tube known as the esophagus, but no digestion takes place during this process. The lower esophageal sphincter, also known as the cardiac sphincter, is a ring of muscle at the place where it joins the stomach that helps prevent the reflux of stomach acid.

Acid can ascend into the esophagus if this muscle doesn't seal correctly, resulting in heartburn or GERD (gastroesophageal reflux disease), a burning feeling (El-Serag *et al*., 2014).

Etiology

The two most common causes of stomach ulcers are Helicobacter pylori infections and the loss of gastric prostaglandins brought on by non-steroidal anti-inflammatory drug use. Gastric outlet blockage, gastric infiltrative illnesses such cancer, cigarette smoking, Crohn's disease, chemotherapy, radiation, viral infections like CMV, and hypergastrinemia (Zollinger-Ellison syndrome) are less typical causes (Serena *et al*., 2018). All of these causes have one thing in common: they encourage the mucosal barrier to deteriorate and expose the stomach mucosa to the harmful effects of acid. Peptic ulcers appear to be genuinely idiopathic in a tiny but growing percentage of cases (Lau *et al*., 2011).

A] Role of Helicobacter pylori

- The bacterium described colonizes 45-50% of the stomach worldwide, often acquired in childhood, especially in low-income, crowded environments. It triggers an inflammatory response, causing gastritis and increased acid production due to disrupted somatostatin regulation. Gastric ulcers develop when the bacteria remain in the antrum, while parietal cells in the gastric body maintain acid production. Symptoms vary based on bacterial virulence and host factors, with the cag-A gene being a key virulence factor that enhances mucosal damage (Alberto *et al*., 2018).
- Duodenal ulcers are linked to H. pylori-induced antrum-predominant gastritis, characterized by reduced somatostatin, increased gastrin levels, and elevated acid production. The development of gastric metaplasia in the duodenum facilitates bacterial colonization, leading to duodenitis and epithelial damage (Wilson, 1962). In contrast, gastric ulcers are associated with corpus gastritis, which contributes to epithelial injury. Eradicating the infection promotes ulcer healing, restores normal acid secretion, and prevents recurrence (Habeeb *et al*., 2016).
- Whereas the humoral immune system has minimal effect on protective immunity, the host immunological response is crucial in the development of ulcers caused by H. pylori. H. pylori causes a particular immune response that changes host immunity and increases inflammation rather than curing the illness (Chakravorty *et al*., 2006). Intracellular peptidoglycan most likely triggers the innate immune response, and H. pylori can avoid macrophage phagocytosis by an unidentified mechanism. T cells that produce IL-10 are crucial for controlling inflammation, which keeps the bacteria in the stomach lining. Some stable cytokine gene variants affect cytokine levels and prevent acid secretion, especially interleukin-1β. Although the risk of stomach cancer is associated with certain polymorphisms, it is unclear how they

relate to peptic ulcers (Robinson *et al*., 2007).

B] Role of NSAID's

NSAID medications are a leading cause of gastric ulcers, with users facing a fourfold increased risk compared to non-users. These drugs contribute to ulcer formation through multiple mechanisms. As weak acids, NSAIDs become trapped in epithelial cells upon exposure to gastric acid, increasing cellular permeability and causing direct injury. Their primary ulcerogenic effect, however, stems from inhibiting the cyclooxygenase-1 (COX-1) enzyme, which normally promotes prostaglandin synthesis.

Prostaglandins support gastric defense by stimulating bicarbonate secretion, mucus production, mucosal blood flow, and epithelial repair. By suppressing these protective mechanisms, NSAIDs make the gastric lining more susceptible to damage from acid and pepsin. The most significant harm results from reduced gastric blood flow, leading to mild ischemia. While the specific causes of gastric ulcers vary, they all ultimately compromise the integrity of the gastric mucosa (Chan, 2010).

Smoking is considered a risk factor for peptic ulcers, as smokers are twice as likely to develop the condition. The slower healing of ulcers in smokers is linked to factors such as higher levels of free radicals in tissues, changes in blood flow, and reduced circulation (Cho and Ko, 2000).

Additionally, stress contributes to ulcer formation by affecting behavioral and psychological conditions, increasing susceptibility to gastric ulcers through hormonal changes, elevated gastric acid secretion, and a greater likelihood of alcohol consumption and smoking. Alcohol and coffee also play a role in ulcer development by weakening the mucus barrier and stimulating acid secretion. Furthermore, genetic factors can increase the risk, particularly among individuals with a family history of peptic ulcers (Joseph *et al*., 2003).

Physiological factors in gastric ulcer

Gastric ulcers are typically associated with chemical or H. pylori gastritis, which damages the epithelium. People with gastric ulcers usually produce less stomach acid than those with duodenal ulcers and even less than healthy individuals (Malik *et al*., 2022).

- Back-diffusion of acid into the mucosa,
- Decreased parietal cell mass,
- Abnormalities of the parietal cells themselves

A small number of gastric ulcer patients exhibit acid hypersecretion, with ulcers typically near the pylorus, resembling duodenal ulcers. In Zollinger-Ellison syndrome, excessive acid production leads to severe duodenal and even jejunal ulcers but rarely causes gastric ulcers (Kumar *et al*., 2014).

Mechanism of gastric inflammation

Inflammation involves response of living tissues towards harmful stimulifor example damaged cells, allergens, pathogens, irritants (Jaroenlapnopparat *et al*., 2022). It is a protective action taken by body which involves cellsof immunity, blood vessels, and other molecular regulators. The major anti-inflammatory activity to these stimuli is to protect cells from injury and regulation of protective tissue repair (Miliani *et al*., 2006; Nicholson, 2016). Inflammation is a matrix interaction which

can cause cell proliferation, migration, and differentiation. From study on animal and cell cultures the role of MMP-9 (metallo-matrix proteinases-9) has been evaluated in the formation of gastric ulcer/ulcers. Gastric ulcer can be obtained by non-steroidal anti inflammatory drugs, ethanol treatment, stress and by infection of Helicobacter pylori. Studies shows MMP-9 and MMP-2 (metallo-matrix proteinases-2) are playing important role in gastric ulceration involving mucosal inflammations which is important factors in facilitating lymphocyte infiltration in gastric tissues (Marshall *et al*., 2018; Swarnakar, 2016).

Diagnosis

H. pylori infection can be diagnosed through invasive methods (endoscopic biopsy with rapid urease testing, histology, culture, or PCR) or non-invasive methods (serology, urea breath test, or stool antigen detection) (Talley *et al*., 2005).

The choice of test depends on the clinical situation. If peptic ulcer disease is suspected, patients should be assessed for alarm symptoms:

- Bleeding (anemia, hematemesis, melena, hemo-positive stool)
- Obstruction (vomiting)
- Cancer risk (anorexia, weight loss)
- Complications (pain radiating to the back suggests penetration; severe, spreading pain suggests perforation)

Non-Invasive Methods

- Serology: Detects antibodies in blood, urine, or saliva, but has lower accuracy. ELISA and Western Blot are commonly used, but serology is not suitable for post-eradication monitoring (Gisbert JP, Abraira, 2006; Dore *et al*., 2016).
- Urea Breath Test (13C-UBT): Highly accurate but requires special equipment. Some conditions may lead to false positives or negatives (Pilotto *et al*., 2000).
- Stool Antigen Test (HpSA): Detects bacterial antigens in stool but may have lower sensitivity in elderly patients due to digestion factors (Perna *et al*., 2005).

Invasive Methods

- Endoscopy & Biopsy: The gold standard for diagnosis, allowing direct visualization, biopsy, and histological examination (Tian *et al*., 2012).
- Rapid Urease Test (RUT): Detects bacterial urease activity in biopsy samples. Provides fast results but requires a sufficient bacterial load (Rogge *et al*., 1995; Uotani and Graham, 2015).
- Histology: Identifies H. pylori, gastric inflammation, and atrophy. Biopsies from multiple locations improve detection accuracy (Zimaity *et al*., 2013).
- Culture: Useful for antibiotic resistance testing but not a preferred diagnostic method due to technical challenges (Miftahussurur and Yamaoka, 2016).
- Molecular Methods (PCR, FISH): Detects bacterial DNA and resistance mutations. PCR is particularly useful for rapid antibiotic susceptibility testing (Xuan *et al*., 2016).

Treatment of Ulcer Disease

Drugs for the treatment of ulcer

1. Reduction of gastric acid secretion

- **H2 antihistamines:** Cimetidine, Ranitidine, Famotidine, Roxatidine (Malfertheiner *et al*., 2009).
- **Proton pump inhibitors:** Omeprazole, Esomeprazole, Lansoprazole, Pantoprazole, Rabeprazole, Dexrabeprazole (Mcguigan, 1983; Fellenius *et al*., 1982).
- **Anticholinergic drugs:** Pirenzepine, Propantheline, Oxy-phenonium (Lind *et al*., 1983).
- **Prostaglandin analogue:** Misoprostol (Londong *et al*., 1983).

2. Neutralization of gastric acid (Antacids)

- **Systemic:** Sodium bicarbonate, Sodium citrate.
- **Non-systemic:** Magnesium hydroxide, Magnesium trisilicate, Aluminium hydroxide gel, Magaldrate, Calcium-carbonate (Goel and Bhawani, 2008).

3. Ulcer Protectives

- Sucralfate, Colloidal bismuth sub citrate (CBS) (Ito and Lacy, 1985).

4. Anti-H. pylori drugs

- Amoxicillin, Clarithromycin, Metronidazole, Tinidazole, Tetracycline (Brogden *et al*., 1976; Wilson, 1981).

Surgical treatment

Surgery is recommended for patients who cannot tolerate medications, fail to adhere to treatment regimens, or are at high risk for complications (such as transplant recipients, those reliant on steroids or NSAIDs, individuals with large gastric or duodenal ulcers, or those whose ulcers do not heal despite proper treatment). It should also be considered for patients who relapse during maintenance therapy or require multiple medication courses.

Surgical options for duodenal ulcers include truncal vagotomy with drainage (via pyloroplasty or gastrojejunostomy), selective vagotomy (preserving the hepatic and celiac branches) with drainage, highly selective vagotomy (which divides only gastric branches while preserving the Latarjet nerve to the pylorus), or partial gastrectomy. For gastric ulcers, surgery typically involves partial gastrectomy. However, procedures other than highly selective vagotomy may lead to complications such as post-procedure dumping syndrome and diarrhea (Rane *et al*., 2014).

Traditional uses of some plants as hepatoprotective and anti-ulcer activities

Medicinal plants constitute a viable alternative for the development of phytopharmaceuticals with hepatoprotective activity in order to solve some of these health problems. In Mexico, the use of herbal remedies is an ancestral practice, but even though the information about the plant's attributed properties is transmitted from generation to generation, for the most part there is no research supporting the information.

It has been established that just 20% of the plants used in traditional medicine have been biologically and scientifically assessed. The use of medicinal plants has been employed by socially and economically disfavored groups, in addition to the part of the population with cultural and economic resources who generate an increase in the consumption of medical plants.

The pathophysiology of gastric ulcers, the most prevalent GIT condition, includes multiple functional reasons. Several plants and herbs have been used in traditional Indian medicine to heal stomach ulcers and other gastrointestinal ailments. The most common condition affecting the GI tract is peptic ulcer. An excoriated portion of the duodenum or stomach mucosa brought on by the action of the gastric juice is known as a peptic ulcer. The jejunum, distal duodenum, and lower oesophagus could be impacted. One of our ongoing programs, which tests extracts, fractions, and isolated chemicals from indigenous medicinal plants for anti-ulcer activity, is interested in the plant's efficacy in treating gastrointestinal ulcers. The anti-ulcer properties most likely work by increasing intragastric mucous secretion and decreasing gastric acid secretion. Antiulcer medications can also be found in plants. In the 1960s, a medication known as carbenoxolone was used to treat peptic ulcers in a modern manner. One of the most significant aspects of people's culture and traditions is the use of plant-based medications. The majority of people on the planet now rely on plant-based medications for their basic medical needs.

Table 1: Medicinal Plants with Reported Hepatoprotective and Anti-Ulcer Activities

S. No.	Botanical Name	Common Name	Family	Parts Used	Hepatic/Ulcer-Related Properties
1	*Aegle marmelos*	Bel	Rutaceae	Fruit, Leaves	Used in gastrointestinal disorders, gastric ulcer management, and liver ailments such as jaundice.
2	*Azadirachta indica*	Neem	Meliaceae	Leaves, Bark	Effective against intestinal ulcers, gastric disorders, and liver-related conditions.
3	*Butea monosperma*	Palas	Fabaceae	Bark, Root	Traditionally used for dyspepsia, diarrhea, and gastric ulcers.
4	*Cuscuta reflexa*	Amarbel	Convolvulaceae	Whole Plant	Used in jaundice, liver dysfunction, inflammation, and wound healing.
5	*Curcuma longa*	Haldi	Zingiberaceae	Rhizome	Exhibits gastroprotective, anti-inflammatory, antioxidant, and hepatoprotective activities.
6	*Dalbergia sissoo*	Shisham	Fabaceae	Leaves	Traditionally used for gastric irritation, ulcers, and digestive disorders.
7	*Emblica officinalis*	Amla	Euphorbiaceae	Fruit	Possesses antioxidant, anti-ulcer, hepatoprotective, and

					gastroprotective properties.
8	*Mentha spicata*	Pudina	Lamiaceae	Leaves	Promotes digestion and helps alleviate gastric discomfort and dyspepsia.
9	*Ocimum sanctum*	Tulsi	Lamiaceae	Leaves	Effective against gastrointestinal disorders, gastric ulceration, and oxidative stress-induced liver damage.
10	*Syzygium cumini*	Jamun	Myrtaceae	Fruit, Seed	Traditionally used for stomach disorders and exhibits hepatoprotective potential.
11	*Zingiber officinale*	Adrak	Zingiberaceae	Rhizome	Shows anti-ulcer, gastroprotective, anti-inflammatory, and digestive stimulant activities.
12	*Santalum album*	Chandan	Santalaceae	Heartwood	Traditionally used in jaundice and liver-related disorders.

CONCLUSION

Medicinal plants represent an important source of natural therapeutic agents for the management of gastric ulcers and liver disorders. Their gastroprotective, anti-ulcer, antioxidant, anti-inflammatory, and hepatoprotective activities are mainly attributed to bioactive compounds such as flavonoids, phenolics, tannins, and alkaloids. Plants including *Aegle marmelos, Curcuma longa, Emblica officinalis, Ocimum sanctum,* and *Zingiber officinale* have shown significant potential in protecting the gastric mucosa and liver tissues. Although current findings support their traditional use, further phytochemical, pharmacological, and clinical studies are necessary to establish their safety, efficacy, and mechanisms of action. These medicinal plants hold promise for the development of safe, effective, and affordable herbal therapies for gastric and hepatic diseases.

DECLARATION OF INTEREST

The authors declare no conflicts of interests. The authors alone are responsible for the content and writing of this article.

REFERENCES

- Abd El Hady, W. E., Mohamed, E. A., Soliman, O. A., & El-Sabbagh, H. M. (2019). In vitro–in vivo evaluation of chitosan-PLGA nanoparticles for potentiated gastric retention and anti-ulcer activity of diosmin. *International Journal of Nanomedicine, 14*, 7191–7213.
- Du, K., Zheng, C., Kuang, Z., Sun, Y., Wang, Y., Li, S., & Meng, D. (2024). Gastroprotective effect of eupatilin, a polymethoxyflavone from *Artemisia argyi* H. Lév. & Vaniot, in ethanol-induced gastric mucosal injury via NF-κB signaling pathway. *Journal of Ethnopharmacology, 318*, 116986.
- Aman, R. M., Zaghloul, R. A., & El-Dahhan, M. S. (2021). Formulation,

optimization and characterization of allantoin-loaded chitosan nanoparticles to alleviate ethanol-induced gastric ulcer: In-vitro and in-vivo studies. *Scientific Reports, 11*(1), 2216.

- Laucirica, I., Iglesias, P. G., & Calvet, X. (2023). Úlcera péptica. *Medicina Clínica, 161*(6), 260–266.
- Kamada, T., Satoh, K., Itoh, T., Ito, M., Iwamoto, J., Okimoto, T., Kanno, T., Sugimoto, M., Chiba, T., Nomura, S., & Mieda, M. (2021). Evidence-based clinical practice guidelines for peptic ulcer disease 2020. *Journal of Gastroenterology, 56*(4), 303–322.
- Mahmoud, M. F., Abdo, W., Nabil, M., Drissi, B., El-Shazly, A. M., Abdelfattah, M. A., & Sobeh, M. (2023). Apple (*Malus domestica* Borkh) leaves attenuate indomethacin-induced gastric ulcer in rats. *Biomedicine & Pharmacotherapy, 160*, 114331.
- He, Y., Li, L., Chang, H., Cai, B., Gao, H., Chen, G., Hou, W., Jappar, Z., & Yan, Y. (2022). Research progress on extraction, purification, structure and biological activity of *Dendrobium officinale* polysaccharides. *Frontiers in Nutrition, 9*, 965073.
- Liao, D. H., Zhao, J. B., & Gregersen, H. (2009). Gastrointestinal tract modelling in health and disease. *World Journal of Gastroenterology, 15*(2), 169–178.
- Wilding, I. R. (2000). Site-specific drug delivery in the gastrointestinal tract. *Critical Reviews in Therapeutic Drug Carrier Systems, 17*(6), 557–620.
- Day, D. W., Jass, J. R., Price, A. B., Shepherd, N. A., Sloan, J. M., & Talbot, I. C. (2008). *Morson and Dawson's gastrointestinal pathology* (4th ed.). Wiley-Blackwell.
- Odze, R. D., & Goldblum, J. R. (2022). *Odze and Goldblum surgical pathology of the GI tract, liver, biliary tract and pancreas* (4th ed.). Elsevier.
- El-Serag, H. B., Sweet, S., Winchester, C. C., & Dent, J. (2014). Update on the epidemiology of gastro-oesophageal reflux disease: A systematic review. *Gut, 63*(6), 871–880.
- Serena, S., Michele, R., Chiara, M., Gioacchino, L., Lorella, F., Tiziana, M., et al. (2018). Relationship between *Helicobacter pylori* infection and GERD. *Acta Bio-Medica, 89*(Suppl. 8), 40–43.
- Lau, J. Y., Sung, J., Hill, C., Henderson, C., Howden, C. W., & Metz, D. C. (2011). Systematic review of the epidemiology of complicated peptic ulcer disease: Incidence, recurrence, risk factors and mortality. *Digestion, 84*(2), 102–113.
- Alberto, B., Chiara, M., Alessandra, V., Ginevra, C., Antonio, N., Mario, C., et al. (2018). A noninvasive method for the diagnosis of upper GI diseases. *Acta Bio-Medica, 89*(Suppl. 8), 44–48.
- Wilson, E. B. (1962). Note on the epidemiology of peptic ulcer. *Proceedings of the National Academy of Sciences, 48*(11), 1924–1927.

- Habeeb, A., Tiwari, S. K., Bardia, A., Khan, S., Vishwakarma, S. K., Habeeb, S., et al. (2016). *Peptic ulcer disease: Descriptive epidemiology, risk factors, management and prevention*. IntechOpen.
- Chakravorty, M., Ghosh, A., Choudhury, A., Santra, A., Hembrum, J., & Roychoudhury, S. (2006). Interaction between IL1B gene promoter polymorphisms in determining susceptibility to *Helicobacter pylori*-associated duodenal ulcer. *Human Mutation, 27*(5), 411–419.
- Robinson, K., Argent, R. H., & Atherton, J. C. (2007). The inflammatory and immune response to *Helicobacter pylori* infection. *Best Practice & Research Clinical Gastroenterology, 21*(2), 237–259.
- Ng, S. C., & Chan, F. K. L. (2010). NSAID-induced gastrointestinal and cardiovascular injury. *Current Opinion in Gastroenterology, 26*(6), 611–617.
- Ko, J. K. S., & Cho, C. H. (2000). Alcohol drinking and cigarette smoking: A partner for gastric ulceration. *Chinese Medical Journal, 63*(12), 845–854.
- Joseph, I. M., Zavros, Y., Merchant, J. L., & Kirschner, D. (2003). A model for integrative study of human gastric acid secretion. *Journal of Applied Physiology, 94*(4), 1602–1618.
- Malik, T., Gnanapandithan, K., & Singh, K. (2022). Peptic ulcer disease. In *StatPearls*. StatPearls Publishing.
- Kumar, V., Abbas, A. K., Fausto, N., & Aster, J. C. (2014). *Robbins and Cotran pathologic basis of disease* (9th ed.). Elsevier.
- Jaroenlapnopparat, A., Bhatia, K., & Coban, S. (2022). Inflammation and gastric cancer. *Diseases, 10*(3), 35.
- Miliani, F. L., Nielsen, H. O., Andersen, S. P., & Girardin, S. E. (2006). Chronic inflammation: Importance of Nod2 and Nalp3 in interleukin-1β generation. *Clinical and Experimental Immunology, 147*(2), 227–235.
- Nicholson, L. B. (2016). The immune system. *Essays in Biochemistry, 60*(3), 275–301.
- Marshall, J. S., Warrington, R., Watson, W., & Kim, H. L. (2018). An introduction to immunology and immunopathology. *Allergy, Asthma & Clinical Immunology, 14*(Suppl. 2), 49.
- Swarnakar, S. (2016). Cell biology newsletter. *Indian Society of Cell Biology, 35*(2). ISSN 2349-8307.
- Talley, N. J., Vakil, N. B., & Moayyedi, P. (2005). American Gastroenterological Association technical review on the evaluation of dyspepsia. *Gastroenterology, 129*(5), 1756–1780.
- Gisbert, J. P., & Abraira, V. (2006). Accuracy of *Helicobacter pylori* diagnostic tests in patients with bleeding peptic ulcer: A systematic review and meta-analysis. *The American Journal of Gastroenterology, 101*(4), 848–863.

- Dore, M. P., Pes, G. M., Bassotti, G., & Usai-Satta, P. (2016). Dyspepsia: When and how to test for *Helicobacter pylori* infection. *Gastroenterology Research and Practice, 2016*, 8463614.
- Pilotto, A., Rassu, M., Leandro, G., Franceschi, M., & Di Mario, F. (2000). Prevalence of *Helicobacter pylori* resistance to antibiotics in Northeast Italy: A multicentre study. *Digestive and Liver Disease, 32*(9), 763–768.
- Perna, F., Ricci, C., Gatta, L., Bernabucci, V., Cavina, M., Miglioli, M., et al. (2005). Diagnostic accuracy of a new rapid urease test (Pronto Dry), before and after treatment of *Helicobacter pylori* infection. *Minerva Gastroenterologica e Dietologica, 51*(3), 247–254.
- Tian, X. Y., Zhu, H., Zhao, J., She, Q., & Zhang, G. X. (2012). Diagnostic performance of urea breath test, rapid urease test, and histology for *Helicobacter pylori* infection in patients with partial gastrectomy: A meta-analysis. *Journal of Clinical Gastroenterology, 46*(4), 285–292.
- Rogge, J. D., Mahoney, S. J., Wagner, D. R., Carrico, R. J., Boguslaski, R. C., Genta, R. M., et al. (1995). Evaluation of a new urease reagent strip for detection of *Helicobacter pylori* in gastric biopsy specimens. *American Journal of Gastroenterology, 90*(11), 1965–1967.
- Uotani, T., & Graham, D. Y. (2015). Diagnosis of *Helicobacter pylori* using the rapid urease test. *Annals of Translational Medicine, 3*(1), 9.
- El-Zimaity, H., Serra, S., Szentgyorgyi, E., Vajpeyi, R., & Samani, A. (2013). Gastric biopsies: The gap between evidence-based medicine and daily practice in the management of gastric *Helicobacter pylori* infection. *Canadian Journal of Gastroenterology, 27*(10), e25–e30.
- Miftahussurur, M., & Yamaoka, Y. (2016). Diagnostic methods of *Helicobacter pylori* infection for epidemiological studies: Critical importance of indirect test validation. *BioMed Research International, 2016*, 4819423.
- Xuan, S. H., Wu, L. P., Zhou, Y. G., & Xiao, M. B. (2016). Detection of clarithromycin-resistant *Helicobacter pylori* in clinical specimens by molecular methods: A review. *Journal of Global Antimicrobial Resistance, 4*, 35–41.
- Malfertheiner, P., Chan, F. K. L., & McColl, K. E. L. (2009). Peptic ulcer disease. *The Lancet, 374*(9699), 1449–1461.
- McGuigan, J. E. (1983). Side effects of histamine2-receptor antagonists. *Clinics in Gastroenterology, 12*(3), 819–838.
- Fellenius, E., Elander, B., Wallmark, B., Helander, H., & Berglindh, T. (1982). Inhibition of acid secretion in isolated gastric glands by substituted benzimidazoles. *American Journal of Physiology-Gastrointestinal and Liver Physiology, 243*(6), G505–G510.

- Lind, T., Cederberg, C., Ekenved, G., Haglund, U., & Olbe, L. (1983). Effect of omeprazole on pentagastrin-stimulated acid secretion in man. *Gut, 24*(4), 270–276.
- Londong, W., Londong, V., Cederberg, C., & Steffen, H. (1983). Dose-response study of omeprazole on meal-stimulated gastric acid secretion and gastrin release. *Gastroenterology, 85*(6), 1373–1378.
- Goel, R., & Bhawani, G. (2008). *Drugs acting on gastrointestinal system*. Pragati Prakashan.
- Ito, S., & Lacy, E. R. (1985). Morphology of rat gastric mucosal damage, defense, and restitution in the presence of luminal ethanol. *Gastroenterology, 88*(1), 250–260.
- Brogden, R. N., Pinder, R. M., Sawyer, P. R., Speight, T. M., & Avery, G. S. (1976). Tri-potassium di-citrato bismuthate: A report of its pharmacological properties and therapeutic efficacy in peptic ulcer. *Drugs, 12*(5), 401–411.
- Nagashima, R. (1981). Mechanisms of action of sucralfate. *Journal of Clinical Gastroenterology, 3*(Suppl. 2), 117–127.
- Rane, M. H., Sahu, N. K., Ajgoankar, S. S., Teli, N. C., & Verma, D. R. (2014). A holistic approach on review of *Solanum virginianum* L. *Research and Reviews in Pharmacy and Pharmaceutical Sciences, 3*(1), 1–4.