West African Journal of Life Sciences. Available online at ***http://www.wajls.com*** *ISSN (Print):2992-5150. eISSN:3122-0916*
Volume 3; Issue 1: pages xxxx

Full Length Research

Gastroprotective Effects of Hydro-Ethanol Extract of *Rinorea Subintegrifolia* Root in Wistar Rats

Okonudo, P.O[1*] and Otoikhilia, C.O[2]

[1,2]Department of Human Physiology, Faculty of Basic Medical Sciences, Edo State University Uzairue, Edo State, Nigeria.

***Corresponding Author's Email**: okonudo.peter@edouniversity.edu.ng Tel +2348134577756

ABSTRACT

Rinorea Subintegrifolia ***(iyókhẹ́zẹ),*** a shrub of the lowland rain forest is believed to have antiulcer properties. Thus, this study evaluated the gastroprotective effects of hydro-ethanol root extract of *Rinorea Subintegrifolia* (HRRS) in Wistar rats. The gastroprotective effects of HRRS was studied in pyloric ligature-induced and ethanol-induced gastric ulcer models. Twenty-five male Wistar rats were used for both models. In the pyloric ligature-induced gastric ulcer model, fifteen Wistar rats were used and were randomly divided into three groups, each comprising five rats. Group A received 5 ml/kg of normal saline (control), Group B was pretreated with 30 mg/kg of Ranitidine, and Group C received 250 mg/kg of HRRS pretreatment. The extracts were administered for 14 days, after which the animals underwent a 24-hour fasting period. Pyloric ligation was then performed, and the stomachs were collected for gastric ulcer evaluation while the stomach content was used to determine gastric juice volume, gastric juice pH and total acidity. In the ethanol-induced ulcer model, ten rats were divided into two groups of five rats each. Group A received 5 ml/kg of normal saline (control), while group B was given 250 mg/kg of HRRS. Following 14 days of pretreatment, gastric ulcers were induced and the stomachs excised for evaluation. Results of the qualitative analysis of HRRS showed the presence of flavonoids, tannins, terpenoids, saponins and steroids. The results showed that HRRS significantly reduced ulcer indices in pyloric ligated ulcer model (3.80 vs 12.5) when compared with control (P<0.05). HRRS significantly reduced gastric juice secretion (0.74 mL vs 1.26mL) and total acidity (5.84mEq/L vs 12.33mEq/L) but pH of gastric juice was significantly increased (4.82 vs 2.55) (P<0.05). Histological assessment showed that HRRS protected against gastric ulceration when compared with control. In conclusion, HRRS protect against gastric ulcers. Reduction in gastric juice secretion, decreased total gastric acidity and increasing pH level are mechanisms underlying the gastroprotection exhibited by HRRS.

Received Nov. 30, 2025

Received in Revised form Jan. 12, 2026

Accepted Jan. 13, 2026

Available Online

W. Afr. J. Life Sci. 3 (1):xxxx

Keywords: Antiulcer, gastric juice, gastroprotection, gastric ulceration, hydro-ethanol extract, pyloric ligation, *Rinorea Subintegrifolia.*

INTRODUCTION

Medicinal plants have long been integral to the treatment of various ailments in African traditional medicine and other cultural healing systems globally. Their use dates back thousands of years for purposes such as preventing epidemics, preserving food, and treating disorders including ulcers (El-Allaoui, 2024). As far back as 1993, the World Health Organization (WHO) estimated that about 80% of the global population relied on traditional medicines, primarily plant-based (WHO, 1993). Also in 2019, the WHO global report on traditional and complementary medicine estimated that approximately 87% of Africa's population uses traditional medicines (WHO, 2019), highlighting the immense reliance on herbal remedies.

This widespread use is driven by the affordability, accessibility, and perceived safety of herbal medicines compared to synthetic drugs. Traditional herbal medicines are commonly prescribed by local practitioners and valued for their fewer side effects and greater acceptance in treating conditions like peptic ulcers (Pahadiya et al., 2018). Consequently, pharmaceutical industries have shown increasing interest in developing herbal healthcare formulations, cosmetics, and nutritional supplements to meet the growing demand for plant-based therapies (Ugwu et al., 2024).

Peptic ulcer, a common gastrointestinal disorder, occurs when aggressive factors such as acid, pepsin, and *Helicobacter pylori* surpass mucosal defense mechanisms including bicarbonate secretion, mucus production, prostaglandins, and cellular resistance (Aiyeola & Oluwole 2023). Gastric ulcers form when hydrochloric acid (HCl) erodes the stomach lining, leading to pain, bleeding, or anemia

(Christina et al. 2025). The lifetime risk of developing peptic ulcer disease is estimated at 5–10%, with annual incidence rates between 0.1–0.3% (Abdullah, 2019; Christina et al. 2025).

Conventional treatments aim to reduce gastric acid secretion and enhance mucosal protection, primarily using proton pump inhibitors (PPIs) and H_2 receptor antagonists (Lanas & Chan, 2017, Khodake & Bhargav, 2025). However, these drugs may lead to relapses, adverse effects, and drug interactions. As a result, herbal remedies are gaining popularity due to their effectiveness and safety profile (Coana et al. 2025). Moreover, plants are cost-effective, readily available, and remain promising sources of novel therapeutics Coana et al. 2025).

Rinorea Subintegrifolia, locally known as *íyókhẹ́zẹ* in Edo State, Nigeria, is a shrub predominantly found in the Tropical regions of West Africa, including Guinea, Cameroon, Ivory Coast, Liberia, Tanzania, and Nigeria (Montaut et al.,2016). It grows in lowland rainforests and can reach a height of 2–4 meters. It is traditionally used to treat stomach disorders and menstrual pain. The plant bears greenish-white to cream-yellow flowers. Its roots, stems, and leaves are believed to possess medicinal properties, offering relief from ailments like rheumatism, arthritis, venereal and eye diseases (Tulassay & Herszényi, 2010).

Though research is limited, phytochemical screening of *Rinorea Subintegrifolia* stem bark extract and fractions revealed the presence of various bioactive compounds,

including alkaloids, phenols, flavonoids, saponins, anthocyanins, anthraquinones, sterols, lipids, cardiac glycosides, tannins, phlobatannins, and essential oils (Montaut et al*.,* 2016). Additionally, anecdotal evidence from Edo State suggests its effectiveness in treating peptic ulcers, though this remains largely undocumented. Studies on the therapeutic potential of *Rinorea Subintegrifolia* are scarce and focusses more on phytochemicals with no study on its gastroprotective effects and its effects on gastric acid secretion. Thus, this study was carried out to address this gap

MATERIALS AND METHOD

Procurement of Experimental Animals. Male Wistar rats weighing between 140-180g were used in this study. The animals were purchased from the Department of Physiology Animal House, College of Health Sciences, Abia State University Uturu, Abia state, Nigeria and were housed in the animal house of the Department of Physiology, Edo State University where the experiment was carried out.

Drugs/Chemicals

Ethanol and NaOH were obtained from Sigma Chemicals (Perth,WesternAustralia), Ranitidine (Zantac-GSK) was obtained from a local pharmarcy. All chemicals used in buffers and other solutions were of analytical grade.

Collection and Preparation of Plant Material

Whole plants of *Rinorea subintegrifolia* including the roots were collected from Ibhiolulu in Edo state, Nigeria. The roots were taken to the Department of Botany, Ambrose Alli University Ekpoma, Edo state, where they were identified and authenticated by a Botanist at the University Herbarium. The roots were cut into pieces, washed and air dried and thereafter grinded into powder and stored for further use.

Extraction Procedure

Three hundred and thirty-five grams (335g) of coarsely powdered root material of *Rinorea Subintegrifolia* was extracted with 60% ethanol using soxhlet apparatus. The extraction was carried out until the extractive becomes colorless. The extract was filtered through a cotton plug, followed by Whatman filter paper (no.1). The extract was evaporated under reduced pressure using rotary vacuum evaporator. The filterate was concentrated using rotary evaporator and was further dried in the oven set at 40°C for 24hours giving a yield of 10.44% of a sticky gel like product.

For aqueous extraction, three hundred grammes (300 g) of the powdered root material was soaked in 1500 ml of distilled water for 72 hours with the solution thoroughly stirred twice daily. The extract was filtered with WHATMAN No 1 filter paper. The filtrate was dried using an oven, set at 40°C and then reconstituted before use for the phytochemical analysis.

Qualitative Phytochemical Screening

The extract obtained from *Rinorea Subintegrifolia* plant was subjected to phytochemical screening using standard procedures as described by Trease and Evans, 1989, and Vinay et al*.,* 2014.

Experimental Design

The Pylorus-ligated gastric ulcer model as described by Gilbert et al., 2006 was used to investigate if the ethanol root extract of *Rinorea Subintegrifolia* (HRRS has

neutralizing properties and or antisecretory effects. Eighteen male rats were used in this study and were divided into 3 groups of 6 rats each. Group 1 served as control and was given normal saline (5ml/kg), group 2 received ranitidine (30mg/kg) and group 3 received 250mg/kg of HRRS. The treatment lasted for a period of fourteen days.

The rats were then fasted for 24 hours but had free access to drinking water. After fasting, rats were anesthetized, the abdomen was incised, and the pylorus was ligated and the abdominal incision was closed. Four hours after the ligation, the animals were sacrificed using cervical dislocation and, the abdomen was opened and another ligature was placed around the esophagus in close proximity to the diaphragm. The stomachs were removed, and the gastric content was collected for determination of the gastric juice volume, pH and total acidity.

Gastric Ulcer Determination

The stomach was opened along the greater curvature and ulcers produced were graded according to the method by Kulkarni, 2002. The ulcer index for each rat was taken as the mean ulcer score using the following severity scores and multiplying the scores by the number of ulcers developed in each rat: 0.0 = normal colored stomach, 0.5 = red coloration, 1.0 = spot ulcers, 1.5 = hemorrhagic streaks, 2.0 = ulcers with area >3 but ≤5mm^2, 3.0 = ulcers > 5mm^2.

Percentage Inhibition of Ulcer.

This was determined using the formula below.

$$PI = \frac{UI_c - UI_T}{UI_c} \times 100$$

Where PI is percentage inhibition, UI_C is ulcer index for control group and UI_T is ulcer index for treatment group.

Determination of Gastric Content

The contents of each stomach were collected in centrifuge tubes. The tubes were centrifuged at 8000 rpm for 10 min. The volume of supernatant fluid was measured and the pH measured using a pH meter (Wang, 2005).

Measurement of Gastric Acidity

The supernatant of gastric contents from each pylorus ligated rat was used. 0.2 ml of the supernatant was analyzed for hydrogen ion concentration by titrating against a 0.01N solution of NaOH using phenolpthlein indicator (Sameh et al.,2019). The experiment was done in triplicate.

Total Acidity Determination

Acidity was expressed according to the formular described by Omayone et al. (2016):

$$\text{Acidity} = \frac{\text{Vol. of NaOH x Normality}}{\text{0.1 mEq/L}} \times 100$$

The HRRS ulcer inhibition effect was measured using the Ethanol-induced gastric ulcer model as described by Manasa et al. (2024). Wistar rats were randomly divided into two groups of five animals each. Rats in group one served as the control group and received Normal saline (10 mL/kg). Rats in group two served as treatment group and received 250mg/kg of HRRS. Treatments were for a period of fourteen days. After treatment, the rats were fasted for 24 hours but had free access to drinking water. Rats in all groups received 1mL/200g of absolute ethanol via gastric intubation for the induction of gastric ulcers, 60minuites after the last pretreatment. One hour later, the animals were sacrificed and their stomachs excised. Each stomach was opened along the greater

curvature and rinsed with normal saline to remove gastric contents and blood clots.

The lengths of the lesions were measured using a vernier caliper and the ulcer index taken as the sum of length of the lesions (Robert et al.,1979; Wei et al.,2018). The percentage of ulcer inhibition by the HRRS was calculated using the following formula: [(ulcer length (control) − ulcer length(treated))/ulcer length(control)] ×100% Wei *et al.,*2018; Xu *et al.,*2013).

Histopathological Study

Small sections were taken from each stomach of randomly selected rats across treatment groups and placed in 10% formalin for histological examination using standard procedure (Laine & Weinstein, 1988).

Ethical Clearance

Ethical approval was obtained for the study from the Institutional Animal Ethics Committee with clearance number EDSUREC25/131. Animals handling protocol conforms to the guidelines of the Edo State University Animal Research Ethics Committee (EDSU-AREC) for laboratory animal care and use.

STATISTICAL ANALYSIS

Data obtained in this study were analyzed using SPSS (version 22) software package. The results were expressed as Mean± SEM and analyzed using one-way analysis of variance, followed by LSD post-hoc test for the pyloric ligated model. The independent t-test was used for the ethanol model. Results with $P< 0.05$, were considered significant.

RESULTS

Phytochemical Constituents of Hydro-Ethanol Root Extract of *Rinorea Subintegrifolia*

The result of the qualitative phytochemical screening of both hydro-ethanol etract and aqueous extract of the plant is as shown in Table 1. The hydro-ethanol root extract of *Rinorea Subintegrifolia* of contains Steroid, Terpenoid and Flavonoid which are present in small amount. However, reducing sugar and Cardiac Glycoside are present in high amount in the extract. The aqueous root extract of *Rinorea Subintegrifolia* contains small amount of Terpenoid and Saponin. Appreciable amount of Reducing sugar was also found.

Table 1. Phytochemical constituents of *Rinorea subintegrifolia* Root (Aqueous and Ethanol)

Phytochemical	Hydro- ethanol Extraction	Aqueous Extraction
Alkaloid	-	-
Phlobatanin	-	-
Reducing Sugar	+++	+++
Flavonoid	+	-
Cardiac Glycoside	++	-
Starch	-	-
Tannins	-	-
Terpenoid	+	+
Saponin	-	+
Steroid	+	-

+ = Trace amount present, +++= Appreciable amount - = Absent

Effect of *Rinorea subintegrifolia* Root Extract on Ulcer Index (UI) and Protection in Pyloric Ligation Model (PLM).

The result (Table 2) showed that hydro-ethanol root extract of *Rinorea Subintegrifolia* significantly reduced ulcer index when compared with control (P<0.01). The ethanol root extract (HRRS) offered 69.6% protection against gastric ulceration. Ranitidine which serves as a standard drug (+) also significantly reduce ulcer index when compared with control (P<0.01) with a 69.6% gastroprotection. There was no significant difference in the ulcer indices when ranitidine pretreatment was compared with the root extract pretreatment (P<0.05).

Effect of *Rinorea subintegrifolia* Root Extract on Ulcer Index (UI) and Protection in Ethanol Model (EM).

Using this model, the hydro-ethanol root extract of *Rinorea Subintegrifolia* showed no significant reduction in ulcer index when compared with control (P>0.05), (Table 3). The root extract offered 14.4% protection against gastric ulcer.

Table 2. Effect of *Rinorea subintegrifolia* Root Extract on UI and Protection (PLM)

Group	Treatment	Ulcer index	% protection
A	Control (5ml of Normal saline/kg)	12.50±1.26	
B	Ranitidine(30mg/kg)	3.80±0.75*	69.60
C	250mg/kg HRRS	3.80±0.46*	69.60

Results are expressed as mean ± standard error of mean. P value less than 0.05(P<0.05) were considered significant (P<0.05).

Table 3. Effect of *Rinorea subintegrifolia* Root Extract on UI and Protection (EM)

Group	Treatment	Ulcer Index (cm)	% Protection
A	Ulcer Control (1mL/kg Ethanol)	2.29±0.09	-
B	250mg/kg HRRS	1.96±0.06	14.41

Values are presented as mean ± SEM

Photomacrograph of rat stomach

The stomach in the control group showed severe gastric ulceration causing severe perforation. The ranitidine group showed mild ulceration in the stomach tissue. In like manner, the HRRS group showed small ulcerations in the stomach tissue.

Effect of hydro-ethanol root extract of *Rinorea Subintegrifolia* on gastric juice volume, pH and total acidity.

As shown in Table 4, hydro-ethanol root extract of *Rinorea Subintegrifolia* significantly reduce gastric juice volume in the pretreated animals when compared with control (P<0.05). There was a significant increase in pH in the pretreated groups when compared with control (P<0.05). Total acidity (Table 5) in the pretreated animals was significantly decreased when compared with control (P<0.01).

Histopathological Findings

Figure 2, showed micrographs of histopathology stomach sections in rats. In the control group, the stomach tissue of the animals showed degeneration of the stomach

lining with severe ulceration (U), moderate granulated tissue slough (GTS) and chronic inflammatory cell (CIC). In the HRRS group, the stomach tissue of the animals exhibited moderate ulceration with mild aggregate of inflammatory cells around the ulcerated area. The ranitidine group showed mild ulceration (U).

Table 4. Effect of *Rinorea subintegrifolia* root extract on gastric juice volume and pH

Group	Treatment	Volume(ml)	pH
A	Control (5ml of Normal saline/kg)	1.26±0.27	2.55±0.29
B	Ranitidine(30mg/kg)	0.54±0.07*	5.89±0.14*
C	250mg/kg HRRS	0.74±0.15*	4.82±0.35*

Values are presented as mean ± SEM. * indicates data that are statistically significant when compared with control at P <0.01.

Table 5. Effect of *Rinorea subintegrifolia* extract on gastric juice acidity

Group	Treatment	Total acidity(mE/L)
A	Control (5ml of Normal saline/kg)	12.33±1.24
B	Ranitidine(30mg/kg)	3.82±1.06*
C	250mg/kg HRRS	5.84±0.60*

Values are presented as mean ± SEM. * indicates data that are statistically significant when compared with control at P <0.01.

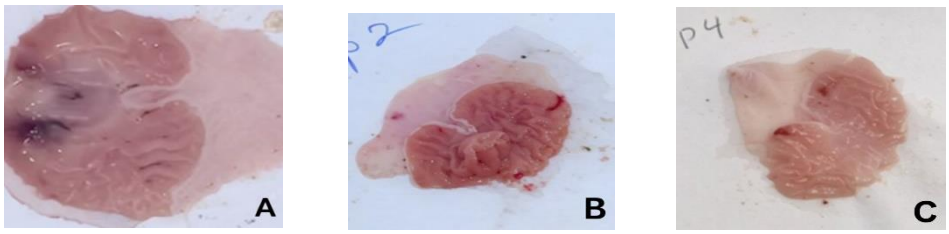

Figure 1. Photomacrograph of Rat Stomach.
A= indicates control group, B= ranitidine pretreated group and C = HRRS pretreated group.

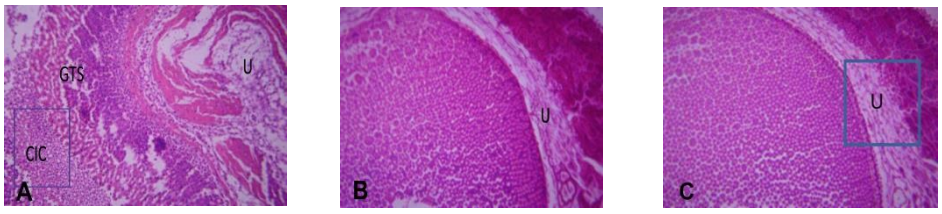

Figure 2. Histology of Stomach Tissue of Rat in Pyloric Ligated Ulcer Model.
(H&E; x150). A(Control group), B(Ranitidine pretreated group), C (HRRS pretreated group)

DISCUSSION

This study show the presence of flavonoids, terpenoids, saponins and steroid in the root extract of *Rinorea Subintegrifolia.*. These phytoconstituents are known to play a major role in successful medical treatments in ancient times as they posses broad biological and pharmacological activities, and their use has persisted till date. Antiulcerogenic effect related to cytoprotective activity has been

ascribed to the phenolic compounds (Bristo et al.,2018). Flavonoids have been found to protect the gastric mucosa from damage by boosting mucosal prostaglandin levels, reducing histamine release from mast cells, and inhibiting histidine decarboxylase (Bristo et al.,2018). Research has also shown that

flavonoid have high free radical scavenging activity(Manasa et al, 2024).

Saponins and triterpenoids have been reported to have antiulcer activity in several experimental models by the formation of protective mucus on the gastric mucosa and also protect the mucosa from acid effects by selectively inhibiting prostaglandin (Puja et al., 2024). Also, tannins have been shown to precipitate microproteins at the site of ulcers thereby forming an impervious protective pellicle over the lining to prevent adsorption of toxic substance thereby preventing the attack of proteolytic enzyme (Akinola et al., 2025). The phytochemical status in this study has therefore corroborated previous report on phytochemicals in the medicinal herb.

Peptic ulcers are lesions that occur when gastric acid erodes the protective lining of the gastrointestinal (GI) tract (Thomas & Lamont, 2024). Although gastric acid plays a vital role in food digestion, mineral absorption, and prevention of bacterial overgrowth, excessive secretion can contribute to the development of acid-related disorders, including peptic ulcer disease (PUD) (Engevik et al.,2020).

Pylorus ligation is a widely employed surgical method for inducing experimental gastric ulcers. This model facilitates the evaluation of pharmacological agents that modulate gastric secretion (Simona et al.,2019). In this study, pyloric ligation resulted in significant ulcer formation, confirming the reliability of this model. The findings are consistent with those of Grace (2023) who suggested that ulcerogenesis in pylorus-ligated rats is driven by stress-induced hypersecretion of gastric hydrochloric acid and acid retention. The volume of gastric secretions is also implicated, as accumulation of gastric acid may increase mucosal exposure and injury.

Pretreatment with hydro-ethanol root extract of *Rinorea Subintegrifolia* (HRRS) significantly reduced the ulcer index compared to the control group. The extract offered approximately 70% protection against ulceration in the pylorus-ligation model, indicating substantial gastroprotective activity which is likely related to the inhibition of gastric acid secretion. In contrast, the ethanol-induced ulcer model, which is independent of acid secretion, is employed to assess the cytoprotective and antioxidant properties of test compounds (Manasa et al., 2024). Ethanol causes direct damage to gastric mucosal cells and mimics acute ulcerative lesions observed in humans (Abdel-Kawi et al.,2022). In this model, HRRS did not provide significant protection against ethanol-induced gastric lesions.

These findings suggest that while the hydro-ethanol root extract of *Rinorea Subintegrifolia* demonstrates antisecretory and acid-inhibitory activity effective in acid-mediated ulceration, it may lack significant cytoprotective properties necessary for defense against cytotoxic agents such as ethanol. The management of acid-related gastrointestinal disorders typically involves either the reduction of gastric acidity or the enhancement of mucosal defense mechanisms (Zaghlool et al., 2019). A primary therapeutic strategy for these conditions is the inhibition of gastric acid secretion using antisecretory agents (Herszényi et al.,2020).

In the present study, pylorus ligation significantly increased gastric juice volume and

total acidity while reducing pH in the control group when compared with pretreated groups. These results align with earlier findings by Yuan et al. (2015) who reported that hypersecretion of gastric juice contributes to mucosal erosion and the development of peptic ulcers due to excessive acidity and volume. Administration of the hydro-ethanol root extract of *Rinorea Subintegrifolia* in rats produced a significant reduction in gastric juice volume and total acidity, alongside a corresponding increase in pH. These changes suggest that the extract possesses antisecretory activity and can enhance mucosal protection.

Total acidity, an indicator of the concentration of hydrogen ions in gastric juice, reflects overall gastric acid output. The observed decrease in total acidity in treated groups is consistent with previous reports that inhibition of gastric secretion can protect the gastroduodenal mucosa from pylorus ligation-induced injury (Zaghlool et al*.,* 2019). Furthermore, the current findings support the work of Nabil et al. (2021), who demonstrated that a reduction in gastric volume and acidity is associated with decreased ulcer index. Collectively, these findings highlight the gastroprotective potential of *Rinorea Subintegrifolia*, which may be attributed to its ability to suppress gastric secretion, elevate gastric pH, and reduce total acidity. These mechanisms likely contribute to its efficacy in preventing ulcer formation under experimental conditions.

Histopathological assessment of stomach in the acetic acid (ulcer control) group shows severe ulceration of surface epithelium. The intervening stroma is thinly fibrocollagenous and is infiltrated by chronic population of mononuclear inflammatory cells, predominantly lymphocytes. These features were not evidently present in the extract pretreated group as they only show mild to moderate mucosal surface epithelial ulcerations. The intervening stroma in the extract groups were only infiltrated by mild population of mononuclear inflammatory cells. These characteristic features are consistent with the results obtained from ulcer indices and further corroborate the biochemical finings in this study.

CONCLUSION

This study showed that the hydro-ethanol root extract of *Rinorea Subintegrifolia* exhibited gastroprotective activity against pyloric ligated induced gastric ulcer while offering insignificant gastroprotection against ethanol induced gastric ulcer. This study also showed that the gastroprotective effect of hydro-ethanol root extract of *Rinorea Subintegrifolia* is linked to its ability to reduce gastric juice secretion, decrease total gastric acidity and increase pH level.

ACKNOWLEDGMENTS

We appreciate the effort of Rita Soludo and Nwanze Precious for their support during the bench work.

CONFLICT OF INTEREST

We declare no conflict of interest.

FUNDING

The study did not receive any external funding.

AUTHORS' CONTRIBUTIONS

Okonudo, P.O. conceptualized and designed the study, and drafted the manuscript. Otoikhilia, C.O. contributed to the project's implementation, including conducting the experiment and analyzing the data. Both authors participated in revising the manuscript. They have read and approved the final version and agree to be accountable for all aspects of the work.

REFERENCES

Abdel-Kawi, S.H., Hashem, K.S., Saad, M.K., Fekry, G., Abdel-Hameed, E.M. (2022). The Ameliorative effects of cinnamon oil against ethanol-induced gastric ulcer in rats by regulating oxidative stress and promoting angiogenesis. J. Mol. Hist., 53, 573-587. oi: 10.1007/s10735-022-1007.

Abdullah, R.A. (2019). Investigation on the effect of cannabinoid agonists and antagonists in gastric acid secretion and gastric ulcer in rats. Unpublished PhD Dissertation, Department of Pharmacology and Toxicology, Cairo University.

Aiyeola A, Oluwole FS (2023) Gastro-protective Effect of Corn Dietagainst Indomethacin-Induced Ulceration in Experimental Rats. JALSI, 26, 1–12. doi:10.9734/jalsi/2023/v26i4608.

Akinola, O.O., Ogunyemi, A., Oyewumi, S.O., Kayode, A.(2025). Gastroprotective Effects of Cabbage Extracts on Ethanol-Induced Gastric Ulcer in Wistar Rats. Glob. South Health Horiz., 1(2), 31-38. doi:10.63950/gshh.2025.1.2.23.

Amandeep, K., Robin, S., Ramica, S., & Sunil, K. (2012). Peptic Ulcer: A Review on Etiology and Pathogenesis. International Research Journal of Pharmacy, 3(6), 34–38.

Brito, S.A., Almeida, C.L., Santana, T.I., Silva, A.R., Nascimento, J.C., Souza, I.T., Almeida, L.L., Silva, M.V., Borges, A.S., Medeiros, J.W., Costa, N.J.(2018). Antiulcer activity and potential mechanism of action of the leaves of Spondias mombin L. Oxidative medicine and cellular longevity, 2018(1), 1731459. doi: 10.1155/2018/1731459. eCollection 2018.

Coana S, Reviono R, Wachid P, Eti PP, Hartono H, Risya C, Paramasari D (2025). Gastroprotective effects of Zingiber officinale in rodent models of peptic ulcers: A systematic review and meta-analysis. Journal of Pharmacy & Pharmacognosy Research 13(6):1978-1995.doi: 10.56499/jppres25.2370_13.6.1978

Cristina RF, Pablo GA, Javier VU, Fernando MN, Marcos BE, Miriam MJ (2025). Perforated peptic ulcer: our experience. Annals of Mediterranean Surgery 8(2):3-11. doi: 10.22307/2603.8706.2025.02.002

El-Allaoui, H., El-Ahmadi, K., El-Abdouni, A., Dira, I., El Bastrioui, M., Bouhrim, M., Eto, B., Shahat, A.A., Hergash, R.N., Haboubi, K. (2024). Trends and insights in medicinal plant extract research: A ten-year bibliometric and visualization study. Horticulturae, 10(11), 1163. doi.org/10.3390/horticulturae10111163

Engevik, A.C., Kaji, I., & Goldenring, J.R. (2020). The Physiology of the Gastric Parietal Cell. Physiological Reviews, 100(2), 573–602. doi.org/10.1152/physrev.00016.2019

Gilbert, A., Télesphore, B.N., Hippolyte, K.W., Pierre, W., Pierre, T., & Albert, K. (2006). Antiulcer Effects of the Aqueous and Organic Extracts of the Stem Bark of Anthocleista vogelii in Rats. Pharmaceutical Biology, 44(3), 166-17. doi.org/10.1186/s12906-015-0713-5

Grace Iyabo Adebayo-Gege (2023). Protective functions of methanol extract of Cucumis Melo (L. INODOROUS) seeds on Pyloric ligation induced gastric ulceration in male Wistar rats. Magna Scientia Advanced Research and Reviews, 08(01), 102–113. doi: 10.30574/msarr.2023.8.1.0076

Herszényi, L., Bakucz, T., Barabás, L., & Tulassay, Z. (2020). Pharmacological approach to gastric acid suppression: past, present, and future. Dig Dis, 38(2), 104-111. doi.org/10.1159/000505204

Izumi, T., Yuri, K., Emiko, T., Yoshifumi, M., Shingo, K., Atsushi, N., & Motoyoshi, I. (2017). Effect of Vonoprazan on the treatment of artificial gastric ulcers after endoscopic submucosal dissection: Prospective randomized controlled trial. Dig Endosc, 29(5), 576-583. doi: 10.1111/den.12857.

Jean, P.D., Victor, K., & Jacobus, N.E. (2014). Biochemical parameters in toxicological studies in Africa: Significance, principle of methods, data interpretation, and use in plant screenings. In V. Kuete (Ed.), Toxicological Survey of African Medicinal Plants (1st ed., pp. 659-715). Elsevier. doi.org/10.1016/B978-0-12-800018-2.00023-6

Khodake KN and Bhargav S (2025). Evaluation of a Polyherbal Formulation in Gastric Ulcer Models Induced By Naproxen and Acetic Acid in Wistar Rats. JAPR, 13(5), 165 – 174. doi:10.69857/joapr.v13i5.1223

Khushtar, M., Kumar, V., Javed, K., & Uma, B. (2009). Protective effect of ginger oil on aspirin and pylorus ligation-induced gastric ulcer model in rats. Indian J Pharm Sci, 71(5), 554–558. doi.org/10.4103/0250-474X.58195

Kulkarni, S.K. (2005). Hand Book of Experimental Pharmacology (3rd ed.). Vallabh Prakashan.

Kumar, V., Andola, H.C., Lohani, H., & Chauhan, N. (2011). Pharmacological review on Ocimum sanctum Linnaeus: A queen of herbs. J Pharm Res, 4(1), 366-368.

Laine, L., & Weinstein, W.M. (1988). Histology of alcoholic hemorrhagic "gastritis": a prospective evaluation. Gastroenterology, 94(6), 1254–1262. doi.org/10.1016/0016-5085(88)90661-0

Lamont, J.T. (2024). Patient education: Peptic ulcer disease (Beyond the basics). UpToDate. Retrieved from https://www.uptodate.com/contents/peptic-ulcer-disease-beyond-the-basics

Lanas, A., & Chan, F.K.L. (2017). Peptic ulcer disease. The Lancet, 390(10094), 613-624. doi.org/10.1016/S0140-6736(16)32404-7

Lekana-Douki, J.B., Bongui, J.B., OyegueLiabagui, S.L., ZangEdou, S.E., Zatra, R., Bisvigou, U., Druilhe, P., Lebibi, J., ToureNdouo, F.S., & Kombila, M. (2011). In vitro antiplasmodial activity and cytotoxicity of nine plants traditionally used in Gabon. J Ethnopharmacol, 133(3), 1103–1108. doi.org/10.1016/j.jep.2010.11.056.

Lewis, D.A., & Hanson, P.J. (1991). Anti-ulcer drugs of plant origin. Progress in Medicinal Chemistry, 28, 210-229. doi.org/10.1016/S0079-6468(08)70365-5.

Manasa, S., Kusu. S. C., Deepak, K.J., Raveena, S.R. (2024). Protective Action of Leaves of Epipremnum aureum in Gastric Ulcer Prevention Induced by Ethanol in Rats. Int. J. Pharm. Sci. Drug Res., 16(6), 990-996. doi.org/10.25004/IJPSDR.2024.160609.

McConnell, E.L., Basit, A.W., & Murdan, S. (2008). Measurements of rat and mouse gastrointestinal pH, fluid and lymphoid tissue, and implications for in-vivo experiments. J Pharm Pharmacol, 60(1), 63–70. doi.org/10.1211/jpp.60.1.0008.

Montaut, S., De Nicola, G. R., Agnaniet, H., Issembe, Y., Rollin, P., & Menut, C. (2017). Probing for the presence of glucosinolates in three Drypetes spp. (Drypetes euryodes (Hiern) Hutch., Drypetes gossweileri S. Moore, Drypetes laciniata Hutch.) and two Rinorea spp. (Rinorea subintegrifolia O. Ktze and Rinorea woermanniana (Büttner) Engl.) from Gabon. Natural Product Research, 31(3),308–313. doi.org/10.1080/14786419.2016.1236099.

Nabil, M., ElRaey, M.A., Abdo, W., Abdelfattah, M.A.O., El-Shazly, A.M., & Sobeh, M. (2021). Gastro-protective effects of Albizia anthelmintica leaf extract on indomethacin-induced gastric ulcer in Wistar rats: In silico and in vivo studies. Antioxidants, 10(2), 176. doi.org/10.3390/antiox10020176

Omayone, T.P., Salami, A.T., Oluwole, F.S., & Olaleye, S.B. (2016). Gastroprotective effect of vanadium in rats - the roles of gastric acid and nitric oxide. J Afr Assoc Physiol Sci, 4(1), 32-40.

Pahadiya, A.R.S., & Sisodia, S.S. (2018). Indian medicinal plants for treatment of ulcer: Systematic review. Pharm Biosci J,

6(6), 38-44. doi.org/10.20510/ukjpb/6/i6/179237

Puja, B., Rajashekhar, U., Deepak, K.(2024). Antiulcer Effects of Trianthema Portulacastrum Leaves in Rats. Int. J. Pharm. Sci. Drug Res., 16(6), 968-974. doi: 10.25004/IJPSDR.2024.160606

Raju, D., Ilango, K., Chitra, V., & Ashish, K. (2009). Evaluation of anti-ulcer activity of methanolic extract of Terminalia chebula fruits in experimental rats. J Pharm Sci Res, 1(3), 101–107.

Robert, A., Nezamis, J.E., Lancaster, C., & Hanchar, A.J. (1979). Cytoprotection by prostaglandins in rats. Prevention of gastric necrosis produced by alcohol, HCl, NaOH, hypertonic NaCl, and thermal injury. Gastroenterology, 77(3), 433–443. doi.org/10.1016/0016-5085(79)90002-7

Sameh, S.Z., Ali, A.A., Mohamed, A.R., Usama, R.A., & Basim, A.S.M. (2019). Gastro-protective and anti-oxidant potential of Althaea officinalis and Solanum nigrum on pyloric ligation/indomethacin-induced ulceration in rats. Antioxidants, 8(11), 512. doi.org/10.3390/antiox8110512

Simona, F., Ana-Maria, P., Cristina, M.G., & Elena, C.L. (2019). Particularities of experimental models used to induce gastric ulcer. ARS Medica Tomitana, 25(4), 179-184. doi.org/10.2478/arsm-2019-0035.

Snowden, F.M. (2008). Emerging and reemerging diseases: a historical perspective. Immunol Rev, 225(1), 9-26. doi.org/10.1111/j.1600-065X.2008.00677.x

Tokuoka, T. (2008). Molecular phylogenetic analysis of Violaceae (Malpighiales) based on plastid and nuclear DNA sequences. J Plant Res, 121(3), 253–260. doi.org/10.1007/s10265-008-0153-0

Trease, G.E., & Evans, W.C. (1989). Textbook of Pharmacognosy (13th ed.). Bailliere Tindall.

Tulassay, Z., & Herszényi, L. (2010). Gastric mucosal defense and cytoprotection. Best Pract Res Clin Gastroenterol, 24(2), 99-108. doi.org/10.1016/j.bpg.2010.02.006.

Ugwu OP, Alum EU, Ugwu JN, Eze VH, Ugwu CN, Ogenyi FC, Okon MB (2024). Harnessingtechnology for infectious disease response in conflict zones: Challenges, innovations, and policyimplications. Medicine. 2024 12;103(28):e38834

Vinay, K.I., Patibandla, N.B., Prasad, K., Nagaraju, B., & Prasanthi, K.S. (2014). Evaluation of anti-ulcer and in-vitro antioxidant activities of aqueous and methanolic extracts of Neolamarckia cadamba leaves and bark in Wistar albino rats. Int J Pharm Sci Res, 5(5), 1852-1858. doi.org/10.13040/IJPSR.0975-8232.5(5).1852-58

Wang, C.C. (2005). Effects of indomethacin and aspirin on gastric acid secretion in C57BL/6 and Balb/c mice. Shijie Huaren Xiaohua Zazhi, 13(14), 1717-1720.

Wei, L., Mengling, Y., Xuejian, C., Li, L., Aijun, Z., Shuhe, C., Pengtao, Y., & Yanwen, L. (2018). Mechanisms of antiulcer effect of an active ingredient group of modified Xiao Chaihu decoction. Evid Based Complement Alternat Med, 2018, 5498698. doi.org/10.1155/2018/5498698

World Health Organization. (1993). Research Guidelines for Evaluating the Safety and Efficacy of Herbal Medicines. WHO Regional Office for the Western Pacific.

World Health Organization. (2019). WHO Global Report on Traditional and Complementary Medicine 2019.

Xu, J.J., Huang, P., Wu, Q.H., Cao, H.Y., Wen, S., & Liu, J. (2013). Study on efficacy and mechanism of Weiyangning pills against experimental gastric ulcer. Zhongguo Zhongyao Zazhi, 38(5), 736–739.

Yuan, X.G., Xie, C., Chen, J., Xie, Y., & Zhang, K.H. (2015). Seasonal changes in gastric mucosal factors associated with peptic ulcer bleeding. Exp Ther Med, 9(1),125-130. doi.org/10.3892/etm.2014.20.

Zaghlool, S.S., Abo-Seif, A.A., Rabeh, M.A., Abdelmohsen, U.R., Messiha, B.A. (2019). Gastro-Protective and Anti-Oxidant Potential of Althaea officinalis and Solanum nigrum on Pyloric Ligation/Indomethacin-Induced Ulceration in Rats. Antioxidants, 8(11),512. doi: 10.3390/antiox8110512.