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Anti-ulcer activity of polyphenols of *Eleusinian corocana* (L.) Gaertn, in Aspirin plus pyloric ligation induced gastric ulcer in Wistar albino rats

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The polyphenols of *Eleusinian corocana* (L.) Gaertn have various nutraceutical and therapeutic values in human health. It has been reported to possess potent anti-inflammatory, antioxidant, antimicrobial, antidiabetic, and gastroprotective effects. However, there is no experimental evidence to reveal its gastroprotective action. The present study was carried out to evaluate the protective effect of polyphenols from Ragi (PPR) against Aspirin plus pyloric ligation-induced gastric ulcers in Wistar albino rats. The Aspirin plus pyloric ligation induced a significant increase in the ulcer index, pH, total and free acidity of the gastric juice in the ulcer control group rats. Macroscopic examination of the internal aspects of stomach tissue in the ulcer control group rats showed more severe mucosal erosion, with large areas of haemorrhagic streaks. Histopathological examination of stomach tissue showed marked destruction of the epithelial layer (EL), submucosal oedema, cell infiltration, and severe congestion of blood vessels in ulcer control rats. Pre-treatment with polyphenols of Ragi and Pantoprazole significantly reduced pH ($p < 0.01$), total acidity, and Ulcer index as compared to the ulcer control group ($p < 0.05$). Aspirin plus pyloric ligation induced mucosal erosion and haemorrhagic streaks, which were significantly attenuated with polyphenols of Ragi and Pantoprazole group as compared with ulcer control ($p < 0.05$). Histopathological examination revealed moderate protection in the polyphenols of the Ragi-treated group. The reference standard and polyphenols of Ragi group rats showed almost normal cytoarchitecture of the stomach. There was no epithelial destruction; however, we observed mild submucosal oedema and mild congestion in the blood vessels, and the severity of ulceration was considerably less in comparison to the ulcer control group. These results show that the polyphenols of Ragi have the potential to protect gastric tissue against NSAIDs and stress. The gastroprotective actions of polyphenols in Ragi might be due to their antioxidant, anti-inflammatory, and cytoprotective properties. Further studies are required to elucidate its dose-dependent actions and mechanism of action at the molecular level.

Keywords: Antioxidant, Anti-ulcer, Aspirin, NSAIDs, Polyphenols of ragi, Pyloric ligation

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Introduction

Nonsteroidal anti-inflammatory drugs (NSAIDs) are widely available over-the-counter drugs and are commonly used to treat pain, inflammation, and fever. Examples include Aspirin, Ibuprofen, Diclofenac sodium, Acyclofenac, and Indomethacin. Most NSAIDs work by reversibly inhibiting cyclooxygenase (COX) enzymes (COX1 and COX2), whereas Aspirin irreversibly inhibits these enzymes. This inhibition reduces the synthesis of prostaglandins (PGs)[1]. Prostaglandins play an essential role in maintaining normal body homeostasis. At the same time, they are involved in pathological processes such as pain, inflammation, and fever. PGs are also important in maintaining proper mucosal blood circulation, secreting bicarbonate, and gastric mucosa. Because of this protective role, regular or high-dose use of NSAIDs can reduce gastric mucosal defence, increasing the risk of gastric and duodenal ulcers. In addition to NSAIDs' use, the other common causes of peptic and duodenal ulcers include chemotherapeutic agents, radiation therapy, stress, anxiety, diseases, and *H. pylori* infections. Ulcer formation may lead to complications such as increased blood loss from the gastrointestinal tract (GIT), anaemia, generalised weakness, and gastritis[2,3].

Currently, a wide range of therapeutic agents is available in the market for the management of gastric

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ulcers, including proton pump inhibitors, antihistamines (H2-receptor antagonists), prostaglandin analogues, antacids, and ulcer protective agents[4]. These drugs have shown promising effects in the control of different ulcer complications; however, the majority of these agents are associated with adverse effects during both short and long-term use. Proton pump inhibitors are highly effective anti-ulcer drugs; however, they may cause serious complications such as bone fractures, Vitamin B12 deficiency, dementia, kidney damage, and increased risk of infectious diseases[5-8]. Therefore, there is a continuous search for better-tolerated drugs with high efficiency and a better safety profile. Plants are rich sources of therapeutically diverse secondary metabolites, which generally have fewer side effects compared to synthetic molecules.

Eleusinian corocana (L.) Gaertn (Finger millet) commonly known as Ragi, is extensively cultivated in Asia and African countries. It possesses high nutraceutical value and well-recognised therapeutic potentials. It offers several health benefits, including antidiabetic, anti-tumorigenic, wound healing, gastroprotective, anti-atherosclerotic, antioxidant, and antimicrobial effects[9-11]. It has been reported that these well-recognised biological effects of Finger millets are mainly attributed to their rich content of polyphenols and dietary fibers[12]. The whole Ragi flour is utilised to prepare traditional foods such as *ambali* (thin porridge), *Ragi mudde* (dumpling), and *Ragi roti* (unleavened breads). Regular consumption of Ragi may help protect against the development of serious health complications such as metabolic diseases, cardiovascular complications, and gastrointestinal cancers[13,14].

Overuse or high doses of synthetic drugs such as NSAIDs may lead to adverse effects in both the short and long term. Additionally, stress and environmental factors can further aggravate the formation of gastric ulcers. Therefore, the efficient utilisation of natural resources in pharmacology may provide a safer and more effective therapeutic alternative for patients. The present study is anticipated to evaluate the anti-ulcer activity of polyphenols derived from Ragi and to provide insights into the future development of value-added formulations. Hence, this study is designed to screen the anti-ulcer activity of a polyphenol-rich extract from *E. corocana* in Aspirin plus pylorus ligation-induced gastric ulcers in Wistar albino rats.

Materials and Methods

Plant material collection and identification

E. corocana was purchased in November 2023 from the local market at Nagamangala Taluk, Mandya district, Karnataka. The procured material was thoroughly washed with water, then with 50% ethanol, and shade-dried. A representative specimen was authenticated and deposited at the ICAR-All India Coordinated Research Project (AICRP), Pearl Millet Centre, University of Mysore, Manasagangotri, Mysore, Karnataka (ICAR-AICRP Mysore, 07/2025).

Extraction of polyphenols from *Finger millet*

The whole grain was pulverised and sieved to obtain polyphenol-rich seed coat fraction (PRSCF). About 100 g of PRSCF was weighed, refluxed with about 500 mL of 1% HCl-methanol solvent, filtered, and the extracts were pooled for experimental studies[15]. A yield of 0.32g/100g of Ragi was obtained. The yield was calculated and expressed as Gallic Acid equivalent (GAE)

Experimental animals

In the present study, we selected Wistar albino rats weighing 225±25 g, of either sex. Rats were housed in polypropylene cage bedded with sterilised husk, 6 in each cage. The rats were maintained in a 12-hour (light and darkness) cycle in a controlled environment with a temperature of 22±03ºC and a relative humidity of 55%. Rats were fed with rat pellets and water *ad libitum*. Experiments were conducted after obtaining Institutional Animal Ethics Committee (IAEC) permission (IAEC/AIMS/002/2023) dated 30.08.2023.

Gastric ulcer induction in Wistar albino rats

Selected rats were randomly assigned to the ulcer control, test drug, and reference standard groups, with six rats per group. Ulcer control group rats were administered 0.5% carboxylmethyl cellulose (CMC). Polyphenols of Ragi (PPR) were made into a suspension in 0.5% CMC and administered to the test group rats at a dose of 400 mg/kg body weight. The dose 400 mg/kg was selected based on acute oral toxicity studies and literature evidence supporting the gastroprotective efficacy of polyphenol of Ragi within this range. As the study was designed as an initial efficacy evaluation, a single effective dose was used. Pantoprazole was made into a suspension in 0.5% CMC and administered to the standard group rats at a dose of 20 mg/kg body weight[16]. Group-specific drugs were administered p.o. for seven consecutive days.

Aspirin was made into a suspension in 0.5% CMC and administered orally at a dose of 200 mg/kg for 3 consecutive days after an hour of group-specific drugs starting from the fifth day. Experimental rats were kept in individual metabolic cages and fasted for 18 hours, with only ad libitum access to water. On the day of pyloric ligation (7^{th} day), an hour after the aspirin dose, all the rats were anaesthetised with a single intraperitoneal injection of Ketamine (50 mg/kg) and Xylazine (3 mg/kg i.m.).

A small incision measuring 2 cm was made just below and lateral to the xiphoid process, and a portion of the abdomen was cut open. A cotton thread was passed around the pyloric sphincter and ligated without damaging blood vessels. Carefully relocate the stomach to the same anatomical position. The incision was closed by interrupted sutures in layers. The pyloric-ligated rats were kept in individual metabolic cages without access to food or water for 4 hours. At the end of four hours, rats were sacrificed under inhalation of an overdose of CO_2. Care should be taken during the isolation of the stomach and the collection of gastric juice. The oesophageal sphincter was ligated before the excision of the stomach to prevent loss of gastric contents during excision. The collected gastric juice was centrifuged at 2500 rpm for 20 min. The volume of gastric juice was expressed in mL/100g body weight. Stomach biopsies were used for histopathological studies[17-19].

Determination of ulcer index (Macroscopic examination of the stomach)

The stomach was cut open along its greater curvature, and the inner surface was exposed. It is gently cleaned in running water and rinsed in ice-cold saline solution. Without tissue damage, the stomach tissue was spread on a wax board so that the mucus surface faced upwards, avoiding corrugation. Using a magnified lens, the ulcer index was scored according to the method described by Kulkarni and Goel. The ulcer scoring was carried out in the following pattern: reddish colour (0.5), small ulcer spots (1), hemorrhagic streaks (1.5), ulcers more than 3 mm and less than 5 mm (2) and ulcers more than 5 mm (3). Mean ulcer score for each experimental group was calculated and expressed as the ulcer index[20].

Determination of gastric volume, pH, free and total acidity of gastric juice

Supernatant of gastric juice was separated into a measuring jar, and the volume of gastric juice was expressed in mL/100g body weight. The pH of the gastric juice was measured using pH indicator paper (pH 1.0-14.0 purchased from MERCK, Life Sciences Private Limited, Mumbai)[21].

Estimation of free and total acidity in gastric juice

The gastric juice (0.5 mL) was pipette into a small conical flask, and a few drops of methyl orange reagent were added. Gastric juice was titrated with 0.01N sodium hydroxide (NaOH) till the colour of the solution turned yellowish. The volume of 0.01N NaOH was noted, and it corresponds to the free acidity of the gastric juice. Added 2-3 drops of Phenolphthalein indicator to the above solution and titrated again with 0.01N NaOH until a definite red tinge appears. The total volume of 0.01N NaOH was noted, and it corresponds to the total acidity of the solution. The acidity was calculated using the following formula[22];

$$Acidity\left(\frac{mEq}{L}\right) = Volume\ of\ NaOH\ X\ Normality\ of\ NaOH\ X\ 100/0.1$$

Histopathological studies

Histopathology of stomach tissue was carried out using a standard protocol. Stomach tissue was transferred to a fixative solution (10% buffered formalin). Stomach tissue was embedded in paraffin wax. Tissue was cut into 5 µm-thick sections using a rotary microtome. The sections were stained using a hematoxylin and eosin stain for examination under a compound microscope. Photomicrophotographs were captured using an automated scanner (MORPHLE slide scanner, Morphle Labs Pvt. Ltd)[23].

Statistical analysis

Data obtained in the above experiment were expressed I n mean±SEM and analysed by one-way ANOVA followed by Dunnett's t-test as a post hoc test. The Statistical analysis was carried out using SPSS (version 16). A p-value <0.05 was taken as the level of significance.

Results

Effect of Polyphenols of Ragi (PPR) on volume of gastric juice, pH, free acidity, total acidity, and ulcer index in Aspirin + Pyloric ligation induced gastric ulcer in Wistar albino rats.

Repeated administration of polyphenols of Ragi (PPR) decreased the gastric juice volume by 24.5%, whereas the reference standard drug (Pantoprazole) decreased it by 26.4% in comparison to the ulcer control group. However, a decrease in gastric juice

volume was not statistically significant (Table 1). There was a significant increase in the pH of the gastric juice both in the test (PPR 400 mg/kg) and reference standard group (Pantoprazole 20 mg/kg) in comparison to the ulcer control group ($p < 0.01$) (Table 2). Treatment with polyphenols derived from *Ragi* (PPR 400 mg/kg) considerably reduced free acidity and total acidity of gastric juice by 46.4 and 10.5%, respectively. In contrast, the reference standard Pantoprazole significantly reduced free acidity and total acidity of gastric juice ($p < 0.05$; 90.47% and 64.57%, respectively) compared with the ulcer control group (Table 3). Ulcer index was significantly reduced in the treatment of polyphenols of Ragi ($p < 0.05$) as well as the reference standard drug ($p < 0.001$) in comparison to the ulcer control group. These results showed promising evidence of anti-ulcer activities of polyphenols of Ragi in Aspirin plus pyloric ligated gastric ulcer induced in Wistar albino rats (Table 4).

Effect of PPR on ulcer index in Aspirin + pyloric ligation-induced gastric ulcer

Macroscopic examination of internal aspects of stomach tissue in the ulcer control group rats showed more intense mucosal erosion with large areas of haemorrhagic streaks. Polyphenols of Ragi pre-treatment reduced the intensity of gastric mucosal erosion. We could observe only a few small haemorrhagic spots in two rats. Pantoprazole showed

Table 1 — Effect of PPR on volume of gastric juice in Aspirin + Pyloric ligation induced gastric ulcer in Wistar albino rats

Group	Volume of Gastric juice (mL)	% change
Ulcer control	3.75±0.271	
Test drug (PPR 400mg/kg)	2.76±0.436	⬇ 24.5
Reference standard (Pantoprazole 20mg/kg)	2.83±0.714	⬇ 26.4

Data expressed in Mean ± SEM (n = 6), PPR- Polyphenols of Ragi.

Table 2 — Effect of PPR on pH of gastric juice in Aspirin + Pyloric ligation induced gastric ulcer in Wistar albino rats

Group	pH	% change
Ulcer control	1.80±0.280	
Test drug (PPR 400 mg/kg)	3.08±0.583 **	⬆ 71
Reference standard (Pantoprazole 20 mg/kg)	5.66±0.586 **	⬆ 214

Data expressed in Mean ± SEM (n =6), p <0.01** in comparison to the ulcer control group. PPR- Polyphenols of Ragi

Table 3 — Effect of PPR on free acidity and total acidity of gastric juice in Aspirin + Pyloric ligation induced gastric ulcer in Wistar albino rats

Group	Free acidity (mEq / dL)	% change	Total acidity (mEq / dL)	% change
Ulcer control	8.40±1.50		17.5±2.17	
Test drug (PPR 400 mg/kg)	4.50±0.84	⬇ 46.4	15.66±2.31	⬇ 10.5
Reference standard (Pantoprazole 20 mg/kg)	0.80±0.12*	⬇ 90.47	6.2±0.37 *	⬇ 64.57

Data expressed in Mean ± SEM (n =6), p <0.05* in comparison to ulcer control group. PPR- Polyphenols of Ragi

Table 4 — Effect of PPR on Ulcer index in Aspirin + Pyloric ligation induced gastric ulcer in Wistar albino rats

Group	Ulcer index	% change
Ulcer control	20.8±9.44	
Test drug (PPR 400 mg/kg)	1.916±0.768*	⬇ 90.45
Reference standard (Pantoprazole 20 mg/kg)	0.33±0.16**	⬇ 98.35

Data expressed in Mean±SEM (n=6), p <0.05, p <0.01** in comparison to ulcer control group. PPR- Polyphenols of Ragi

complete protection against Aspirin + pyloric ligation-induced gastric ulcer in Wistar albino rats (Figs. 1-3).

Effect of PPR on histopathological examination of stomach tissue in Aspirin + pyloric ligation induced gastric ulcer

Histopathological examination of stomach tissue showed marked destruction of the epithelial layer (EL), submucosal oedema, cell infiltration and severe congestion of blood vessels in ulcer control rats. The reference standard group rats pre-treated with Pantoprazole showed almost normal cytoarchitecture. There was no epithelial destruction; however, we observed mild submucosal oedema and mild congestion in the blood vessels. The test group rats pre-treated with polyphenols from Ragi showed mild submucosal oedema and congestion of blood vessels; however, the severity of ulceration was considerably less in comparison to the ulcer control group (Fig. 4).

Discussion

NSAIDs or Aspirin-like drugs are commonly used to treat diseases associated with pain, inflammation and fever. Aspirin causes its anti-inflammatory action by inhibiting prostaglandin synthesis. However, the constitutive type of prostaglandins (PGE2) is required to protect the gastric mucosa and epithelial barriers of gastric tissue against gastric juice. PGE2 is responsible for increased turnover of mucus and bicarbonate levels, as well as inhibiting excessive secretion of gastric juice. Thus, inhibiting the synthesis of PGE2 may significantly contribute to the formation of gastric ulcers. Infection with *Helicobacter pylori* plays a crucial role in the

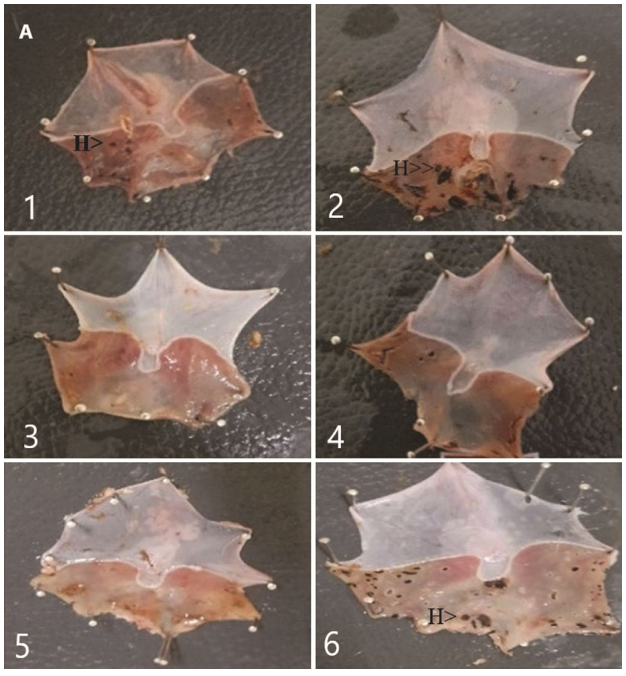

Fig. 1 — Macroscopic examination of internal aspects of stomach tissue in ulcer control group rats (A) (1-6), Hemorrhagic spots- H.

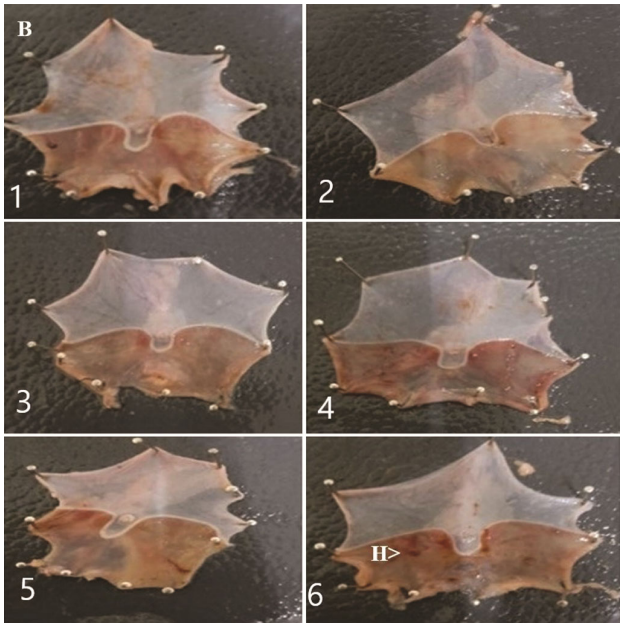

Fig. 2 — Macroscopic examination of internal aspects of stomach tissue in PPR (400 mg/kg) group rats (B) (1-6), Hemorrhagic spots- H.

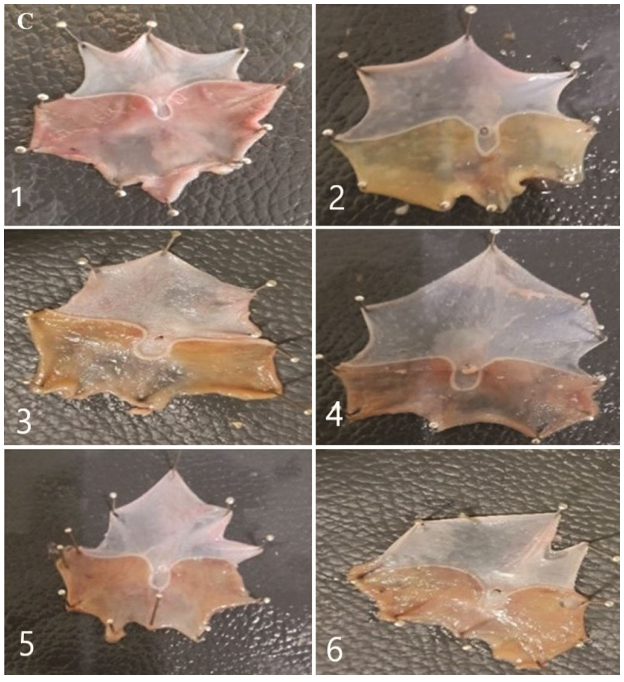

Fig. 3 — Macroscopic examination of internal aspects of stomach tissue in pantoprazole (20 mg/kg) group rats (C) (1-6).

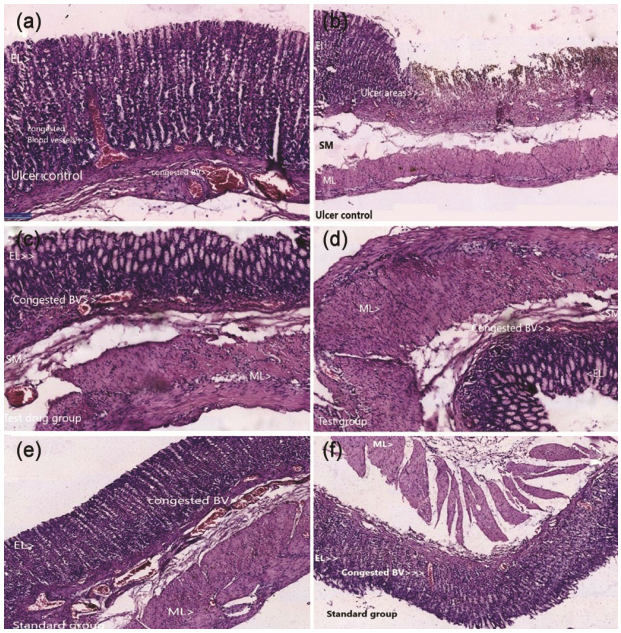

Fig. 4 — Photomicrograph representative of histopathology of stomach tissue of different treatment groups. (a-b) Ulcer control, (c-d), Test drug PPR 400 mg/kg, and (e-f), Standard Pantoprazole 20 mg/kg, EL- Epithelial layer, ML- Muscular layer, SM- Submucosal layer, BV- Congested blood vessels.

pathogenesis of peptic ulcer disease. The organism survives in the acidic gastric environment by producing urease and disrupting the mucosal barrier through the release of cytokines and inflammatory mediators. This results in increased gastric acid secretion, oxidative stress and mucosal inflammation, ultimately leading to ulcer formation. Additionally, the pyloric ligation can also aggravate the formation of gastric ulcers by the accumulation of gastric acid and pepsin, which leads to auto-digestion of the gastric mucosa and breakdown of the gastric mucosal barrier. This results in increased protein content in the gastric juice and gastric erosion in the ulcer control group[1,24].

In the present study, there was a considerable decrease in gastric juice volume, free acidity, and total acidity in the PPR (24.5%) and Pantoprazole (26.4%) treatment groups compared to the ulcer control. Pre-treatment with PPR and Pantoprazole significantly reduced the pH of gastric juice as compared to ulcer control ($p < 0.01$). These data can support the anti-ulcer activities of PPR by its antisecretory property. Repeated administration of PPR significantly reduced the ulcer index score. Macroscopic examination of internal aspects of stomach tissue in the ulcer control group rats showed more intense mucosal erosion with large areas of haemorrhagic streaks. Pre-treatment of polyphenols of Ragi significantly reduced the intensity of gastric mucosal erosion. We could observe only a few small haemorrhagic spots in two rats. Pantoprazole showed complete protection against Aspirin + pyloric ligation-induced gastric ulcer in Wistar albino rats. Histopathological examination of stomach tissue showed marked destruction of the epithelial layer (EL), sub-mucosal oedema, cell infiltration and severe congestion of blood vessels in ulcer control rats. The reference standard group rats pre-treated with Pantoprazole showed almost normal cytoarchitecture. There was no epithelial destruction; however, we could observe mild submucosal oedema and mild congestion in the blood vessels. The test group rats pre-treated with polyphenols of Ragi showed mild submucosal oedema and congestion of blood vessels; however, the severity of ulceration was considerably less in comparison to the ulcer control group. These results indicate the cytoprotective activities of polyphenols of Ragi against Aspirin + pyloric ligation-induced gastric ulcer.

Studies have shown that the seed coat fraction of Ragi is a rich source of polyphenols[25,26,27,28]. Extraction with methanol plus 1% HCl is considered a very effective solvent for the extraction of polyphenols from *Finger millets* and yields the highest proportion of polyphenols (13%). HPLC analysis revealed the presence of phenolic constituents in the polyphenolic fraction of the seed coat of *Ragi*[29]. Reverse phase- high performance liquid chromatography (RP-HPLC), electrospray ionisation mass spectrometry (ESI-MS) and NMR studies revealed the presence of phenolic compounds such as gallic, protocatechui, p-hydroxybenzoic, vanillic and ferulic acids and cinnamic acid derivatives such as syringic, trans cinnamic and p-coumaric acids. It also revealed the presence of flavonoid compounds such as quercetin. *Finger millet* is also reported to contain high molecular weight polyphenols, such as proanthocyanidins, which are biologically active. It is reported to have anti-inflammatory, antioxidant, and antimicrobial activities in several *in vivo* studies[30]. It has a wide range of therapeutic properties, such as anti-tumorigenic, antidiabetic, anti-atherosclerotic, potent antioxidant, and antimicrobial activities. Epidemiological studies revealed that the regular consumption of whole grain cereal and their products can protect against the risk of cardiovascular diseases. Type 2 diabetes, gastrointestinal cancers, and a wide range of

disorders. It has been reported by Shobana *et al.* that the hypoglycaemic, hypocholesterolaemic, nephroprotective, and anti-carcinogenic properties of *Finger millet*[31]. The polyphenols extracted from *Finger millet* seed coat showed potent antioxidant activity determined by β- carotene- linoleic acid, DPPH (1,1-diphenyl-2 picrylhydrazyl), hydroxylquenching, 2,2-azinobis-3-ethylbenzothiazine -6- sulfonate (ABTS) tests[32]. The polyphenols showed a significant antibacterial activity on *Escherichia coli*, *Bacillus cereus*, *Staphylococcus aureus*, *Listeria monocytogenes*, *Streptococcus pyogenes*, *Proteus mirabilis*, *Pseudomonas aeruginosa, Klebsiella* species. The antibacterial activities were largely confined to the Quercetin fraction of the millet polyphenols[10].

As per the phytochemical evidence, the polyphenols may contribute to their anti-ulcer and cytoprotective activities. The polyphenols are reported to have potent antioxidant and cytoprotective activity. This might have contributed to its anti-ulcer activity against Aspirin plus pyloric ligation-induced gastric ulcer.

Conclusion

The polyphenols of *Finger millets* have antisecretory properties by decreasing gastric acid secretion. Besides its antisecretory actions, macroscopic and histopathological examinations also revealed cytoprotective effects. Several studies have shown the potent antioxidant properties of polyphenols of *Finger millets*. This might be attributed to its generalised cytoprotective actions against Aspirin plus pyloric ligation-induced gastric ulcers. Polyphenols have demonstrated promising anti-*Helicobacter pylori* activity through multiple mechanisms, such as inhibiting bacterial growth, suppressing urease activity, and attenuating inflammation and oxidative stress. Their antioxidant and cytoprotective properties also help in preserving gastric mucosal integrity. Polyphenols may serve as adjunctive agents along with conventional treatment to combat bacterial load and gastric mucosal damage. Further studies are required to confirm its gastroprotective action by estimating protein, mucus in gastric juice, and antioxidant parameters to support its gastroprotective action.

Conflict of interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

References

1 Takeaki K and Tsuyoshi Y, Mechanisms of direct gastric mucosal damage by NSAIDs, *Nihon Rinsho*, 2007, **65**(10), 1803-1806.

2 Huang J Q, Sridhar S and Hunt R H, Role of *Helicobacter pylori* infection and nonsteroidal anti-inflammatory drugs in peptic-ulcer disease: a meta-analysis, *Lancet*, 2002, **359**(9300), 14-22, doi: 10.1016/S0140-6736(02)07273-2.

3 Lanas A, Carrera L P, Arguedas Y, Garcia S, Bujanda L, *et al*., Risk of upper and lower gastrointestinal bleeding in patients taking nonsteroidal anti-inflammatory drugs, antiplatelet agents, or anticoagulants, *Clin Gastroenterol Hepatol*, 2015, **13**(5), 906-912, doi: 10.1016/j.cgh.2014.11.007.

4 Yuan Y, Padol I T and Hunt R H, Peptic ulcer disease today, *Nat Clin Pract Gastroenterol Hepatol*, 2006, **3**(2), 80-89, doi: 10.1038/ncpgasthep0393.

5 Yu LY, Sun L N, Zhang X H, Li Y Q, Yu L, *et al*., A review of the novel application and potential adverse effect

6 s of proton pump inhibitors, *Adv Ther*, 2017, **34**(5), 1070-1086, doi: 10.1007/s12325-017-0532-9.

7 Black M, Scott J W and Kanter R, Possible ranitidine hepatotoxicity, *Ann Intern Med*, 1984, **101**(2), 208-210, doi: 10.7326/0003-4819-101-2-208.

8 Donovan J W, Hepatotoxic and hepatoprotective potential of histamine (H2)-receptor antagonists, *Am J Med*, 1988, **85**(6), 893-899, doi: 10.1016/0002-9343(87)90814-x.

9 Garcia Rodriguez L A, Wallander M A and Stricker B H, The risk of acute liver injury associated with cimetidine and other acid□suppressing anti-ulcer drugs, *Br J Clin Pharmacol*, 1997, **43**(2), 183-188, doi: 10.1046/j.1365-2125.1997.05268.x.

10 Devi P B, Vijayabharathi R, Sathyabama S, Malleshi N G and Priyadarisini V B, Health benefits of finger millet (*Eleusine coracana* L.) polyphenols and dietary fiber: a review, *J Food Sci Technol*, 2014, **51**(6), 1021–1040, doi: 10.1007/s13197-011-0584-9.

11 Sripriya G, Chandrasekharan K, Murty V S and Chandra T S, ESR spectroscopic studies on free radical quenching action of *finger millet* (*Eleusine coracana*), *Food Chem*, 1996, **57**(4), 537–540, doi: 10.1016/S0308-8146(96)00187-2.

12 McKeown N M, Meigs J B, Liu S, Wilson P W and Jacques P F, Whole grain intake is favourably associated with metabolic risk factors for type 2 diabetes and cardiovascular disease in the Framingham Offspring Study, *Am J Clin Nutr*, 2002, **76**(2), 390–398, doi: 10.1093/ajcn/76.2.390.

13 Chethan S and Malleshi N G, *Finger millet* polyphenols: Characterisation and their nutraceutical potential, *Am J Food Technol*, 2007, **2**(7), 582–592, doi: 10.3923/ajft.2007.582.592.

14 Bravo L, Polyphenols: Chemistry, dietary sources, metabolism, and nutritional significance, *Nutr Rev*, 1998, **56**(11), 317–333, doi: 10.1111/j.1753-4887.1998.tb01670.x.

15 Chandrasekara A and Shahidi F, Content of insoluble bound phenolics in millets and their contribution to antioxidant capacity, J Agric Food Chem, 2010, 58(11), 6706–6714, doi: 10.1021/jf100868b.

16 Chethan S and Malleshi N G, *Finger millet* polyphenols: optimisation of extraction and the effect of pH on their stability, Food Chem, 2007, 105(2), 862–870, doi: 10.1016/j.foodchem.2007.02.012.

17 Vanita G K and Singh J, Evaluation of antipyretic and anti-ulcer activity of ethanolic extract of leaves of *Trema orientalis* L. in albino Wistar rats, *Asian J Pharm Clin Res*,

2019, **12**(12), 149-154, doi: 10.22159/ajpcr. 2019.v12i12.35808.

18 Dai S and Ogle C W, A simple method for the production of peptic ulceration in the rat, *Life Sci*, 1973, **12**(11), 505-512, doi: 10.1016/0024-3205(73)90344-5.

19 El-Sheikh S M A, Bahaa H M, Galal A A, Metwally M M, Said M A, *et al*., Gastro protective, hepatoprotective, and nephroprotective effects of thymol against the adverse effects of acetylsalicylic acid in rats: Biochemical and histopathological studies, *Saudi J Biol Sci*, 2022, **29**(6), 103289, doi: 10.1016/j.sjbs.2022.103289.

20 Deshpande S S, Shah G B and Parmar N S, Anti-ulcer activity of Tephrosia purpose in rats, *Indian J Pharmacol*, 2003, **35**(3), 168-172, doi: 10.12691/ajbr-4-1-3.

21 Kulkarni S K and Goel R K, Gastric anti-ulcer activity of UL-409 in rats, *Indian J Exp Biol*, 1996, **34**(7), 683-688.

22 Bickel M, Activity on gastrointestinal tract, in *Drug discovery and evaluat ion: Pharmacological assays*, edited by G H Vogel, W H Vogel, B A Scholkens, J Sandow, G Muller, W F Vogel, 2nd edn, (Germany: Springer publications), 2002, 867–872.

23 Srivastava V, Viswanathaswamy A H and Mohan G, Determination of the anti-ulcer properties of sodium cromoglycate in pylorus-ligated albino rats, *Indian J Pharmacol*, 2010, **42**(3), 185-188, doi: 10.4103/0253-7613.66844.

24 Bancroft J D and Gamble M, Theory and practice of histological techniques, 5th edn, (Churchill Livingstone), 2002.

25 Caner G and Sirri B, Effects of nonsteroidal anti-inflammatory drugs at the molecular level, Eurasian J Med, 2018, **50**(2), 116–121, doi: 10.5152/eurasianjmed.2018.0010.

26 Chandra D, Chandra S and Sharma A K, Review of *Finger millet* (*Eleusine coracana* (L.) Gaertn): A power house of health benefiting nutrients, *Food Sci Hum Well*, 2016, **5**, 149-155, doi: 10.1016/j.fshw.2016.05.004.

27 Ramachandra G, Virupaksha T K and Shadaksharaswamy M, Relationship between tannin levels and *in vitro* protein digestibility in *Finger millet* (*Eleusine coracana Gaertn*), *J Agric Food Chem*. 1977, **25**(5), 1101–1104, doi: 10.1021/jf60213a046.

28 Siwela M, Taylor J R N, de Milliano W A J and Duodu K G, Occurrence and location of tannins in *Finger millet* grain and antioxidant activity of different grain types, *Cereal Chem*, 2007, **84** (2), 169–174, doi: 10.1094/CCHEM-84-2-0169.

29 *Rao M V S S T S and Muralikrishna G, Non-starch polysaccharides and bound phenolic acids from native and malted finger millet (ragi, Eleusine coracana, Indaf-15), Food Chem, 2001, 72, 187–192,* doi: 10.1016/S0308-8146(00)00217.

30 Chandrasekara A and Shahidi F, Determination of antioxidant activity in free and hydrolysed fractions of millet grains and characterisation of their phenolic profiles by HPLC-DAD-ESI-MS, *J Funct Foods*, 2011, **3**(3), 144-158, doi: 10.1016/j.jff.2011.03.007.

31 Viswanatha V, Urooj A and Malleshi N G, Evaluation of antioxidant and antimicrobial properties of *finger millet* polyphenols (*Eleusine coracana*), *Food Chem*, 2009, **114**(1), 340–346, doi: 10.1016/j.foodchem.2008.09.053.

32 Shobana S, Harsha M R, Platel K, Srinivasan K and Malleshi N G, Amelioration of hyperglycaemia and its associated complications by *finger millet* (*Eleusine coracana* L.) seed coat matter in streptozotocin-induced diabetic rats, *Br J Nutr*, 2010, 104(12), 1787–1795, doi: 10.1017/S0007114510002977.

33 Banerjee S, Sanjay K R, Chethan S and Malleshi N, *Finger millet* (*Eleusine coracana*) polyphenols: Investigation of their antioxidant capacity and antimicrobial activity, *AfrJ Food Sci*, 2012, **6**(12), 362-374, doi: 10.5897/AJFS12.031.