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Assessment of Gastroprotective Effects of Ethanolic Extract of *Ipomoea pes-tigridis* in Ethanol Induced Gastric Ulcer Model

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Abstract

Common gastrointestinal disease peptic ulcer results from the misalignment between defensive functions of the gastric mucosa along with harmful elements which include high acid production with helicobacter pylori infection and oxidative stress. Proton pump inhibitors and antibiotics need replacement as treatments because they generate side effects and treatment resistance. This research investigates *Ipomoea pes-tigridis* potential for reducing gastric ulcers through experimental studies with Wistar albino rats exposed to ethanol.

The extraction carried out using ethanol through Soxhlet apparatus, exhibited an extractive value of 28.64% w/w. The phytochemical screening revealed that the extract contains a wide range of phytoconstituents including alkaloids, carbohydrates, flavonoids, glycosides, proteins, saponins, tannins. The safety of the extract was evaluated through acute toxicity studies following OECD 423 guidelines. There are no signs of toxicity at the dose of 2000 mg/kg. The assessment of gastric parameters was carried out, it shows that the extract (IPM 400 mg/kg) having high gastrointestinal protection effect as like standard drug omeprazole. On gastric mucosa, the extract shows protective effect in dose dependent manner. On inflammatory markers, the extract helps to decrease the level of inflammatory markers like IL-6, TNF- α and IL-1β. The research validates ancient approaches using this plant for treating ulcers because it shows capacity for reducing ulcer index and acidic environment, cellular protective power, reduction in the level of inflammatory mediators. A well established study required to grow up the therapeutic value as well as feasibility of natural antiulcer treatment development.

Keywords: Peptic ulcer, Proton pump inhibitors, Soxhlet apparatus, Acute toxicity.

Introduction

Peptic ulcer disease continues to be a leading worldwide health problem because it displays significant geographical discrepancies and temporal fluctuations. According to the Global Burden of Disease Study 2019 the total worldwide PUD cases rose from 6.43 million in 1990 to 8.09 million in 2019. Absolute prevalence rates increased but the age-standardized prevalence rate decreased from 143.4 in 1990 to 99.4 in 2019 which showed relative decline after considering population changes together with age dynamics. Research reveals higher PUD case numbers since population growth combined with advanced lifespans but PUD occurs less

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frequently in the population. Better control of Helicobacter pylori infection combined with non-steroidal anti-inflammatory drug (NSAID) management alongside medical progress and cleaner environments have most likely decreased the prevalence of PUD [1]. High PUD incidence in Eastern Europe and South Asia matches the both higher prevalence of Helicobacter pylori infections and widespread NSAID use and unique area-specific risk factors. Worldwide studies indicate PUD prevalence declined from 1990 to 2015 until it rose marginally throughout 2015 to 2019. The increase of NSAID consumption coupled with higher stress levels and changing life patterns has elevated PUD susceptibility among people in recent times [2]. The discovery of modern pharmacological medicines led to a temporary decrease in herbal medicine popularity. People have rediscovered their interest in natural healing traditions which led them to incorporate plant-based substances for disease management along with health optimization [3].

The gastrointestinal disorder named peptic ulcer damages tissue in the stomach walls along with those in the duodenum. Acid and pepsin overproduction serves as the main factor leading to ulcer development compared to all other possible pathogenic agents. Gastric acid exists naturally in the human body through the activity of parietal cells which settle in the stomach lining. Hydrochloric acid (HCl) functions in two ways by assisting digestion and defending the body from dangerous pathogens. When stomachs lining acid levels surpass their natural range it will start to erode and form ulcers. The stomach produces proteolytic enzyme pepsin against the backdrop of inactive form pepsinogen that originates from chief cells located in the stomach lining surface. The stomach fluid reaches a pH value under 4 which simultaneously activates pepsinogen to form functional pepsin enzyme. Pepsin breaks down proteins within acidic conditions and thus damages the gastric lining while still playing an essential role in protein digestion.

Role of Inflammatory Mediators

Substantial evidence confirms that inflammation leads to tissue damage at the mucosal level. H. pylori infection, for instance, induces the release of inflammatory cytokines such as interleukin-1 (IL-1), tumor necrosis factor-alpha (TNF-α), and interleukin-8 (IL-8). Acid secretion is stimulated and the protective barrier becomes compromised while mucosal regeneration is impaired when these mediators act [4].

Functions of Gastric Acid in Digestion

Various physiological processes of gastric acid combination serve both digestion efficiency and intestinal protection purposes.

1. Activation of Digestive Enzymes

The main function of gastric acid becomes its activation of pepsinogen into pepsin to start protein breakdown that continues during small intestine digestion. When gastric acid is absent pepsin remains nonactive thus hindering protein metabolism along with nutrient absorption.

2. Protein Denaturation

Gastric acid helps to unfold complex protein structures, a process known as denaturation. This makes proteins more accessible for enzymatic digestion, allowing pepsin to hydrolyze peptide bonds efficiently.

3. Defense Against Microorganisms

The low pH of stomach acid serves as a protective barrier, killing harmful bacteria, viruses, and parasites that enter the digestive system through food and water. This reduces the risk of gastrointestinal infections.

4. Facilitating Absorption of Nutrients

Gastric acid plays a crucial role in the absorption of iron, vitamin B_{12}, calcium and magnesium.

Role of Pepsin in Protein Digestion

Pepsin is a key enzyme in the breakdown of dietary proteins, working in synergy with gastric acid to ensure efficient digestion.

1. Pepsinogen Activation
2. Protein Hydrolysis
3. Optimal Conditions for Pepsin Activity
4. Regulation of Gastric Acid and Pepsin Secretion

Helicobacter pylori

The infection with Helicobacter pylori leads to gastric ulcers as its primary causal factor. The gram-negative bacterium uses various methods to break down mucosal barriers through processes that produce ammonia through urease activity resulting in both gastric acid neutralization and epithelial cell harm. Through infection with Helicobacter pylori the cytotoxins VacA and CagA set off inflammatory reactions followed by cell destruction which diminishes mucosal stability [5]. Infection with H. pylori bacteria produces different gastrointestinal illnesses starting from mild inflammation through ulcer development to cancer diagnosis [6].

Treatment Approaches

H. pylori infection requires a combination of antibiotics and acid-suppressing agents for successful eradication. Common treatment regimens include:

- Triple therapy:
  Proton pump inhibitor (PPI) + Clarithromycin + Amoxicillin or Metronidazole (14 days)
- Quadruple therapy (for antibiotic resistance cases):
  PPI + Bismuth subsalicylate + Metronidazole + Tetracycline.
- Sequential and combination therapies are also explored to improve eradication rates.

Due to increasing antibiotic resistance, alternative therapies such as probiotics, phytomedicine (e.g., curcumin, garlic extract), and vaccine development are being studied to combat H. pylori infections [7].

Herbal Remedies for Ulcers: Historical Uses of Plants in Treating Gastrointestinal Disorders

Ulcers of the gastrointestinal tract have been a significant health concern for centuries. Historically, herbal remedies have been used extensively to treat these disorders. Throughout this article, we examine the historical and cultural practices associated with herbal ulcer treatments, emphasizing their efficacy, mechanisms, and evolving relevance in modern medicine [8].

Herbal Remedies in History

- Aloe vera: It is traditionally used to soothe and heal the stomach lining.
- Liquorice root (Glycyrrhiza glabra): Protects mucosa and reduces inflammation.
- Slippery elm (Ulmus rubra): Application in the protection of the gastrointestinal tract.
- Cabbage (Brassica oleracea): A rich source of vitamin U, historically used for the treatment of ulcers [9].

Anti-ulcer therapies based on phytoconstituents and mechanisms of action

Natural products have received considerable attention in recent years for their role in treating peptic ulcers. Multiple mechanisms of action have been established for phytoconstituents such as flavonoids, tannins, and alkaloids, which contribute to anti-ulcer effects.

Flavonoids

Plants are abundant with flavonoids, which are polyphenolic compounds. Antioxidant and cytoprotective properties make them effective against gastric ulcers. The major mechanisms of action are the inhibition of lipid peroxidation, the enhancement of mucosal defense, and the suppression of pro-inflammatory cytokines [10].

Tannins

Astringent polyphenolic compounds, tannins, form a protective layer over the gastric mucosa by precipitating proteins. A barrier such as this prevents acid and pepsin from penetrating into the mucosa, thus

reducing mucosal injury. Also, tannins possess antimicrobial properties that assist in the fight against Helicobacter pylori, an etiological factor of peptic ulcer disease [11].

Alkaloids

Pharmacological activities happen through alkaloids because these compounds contain nitrogen. Alkaloids like berberine and papaverine exhibit anti-ulcer action because they block acid production and help enhance mucus formation. Research indicates that berberine possesses two distinct pharmacological capabilities to block stomach inflammation while controlling the movement of gastric content [12].

Mechanisms of Action

These phytoconstituents possess anti-ulcer properties via several mechanisms:

- Antioxidant Activity
- Enhancement of Mucosal Defense
- Anti-inflammatory Effects
- Antibacterial Action
- Acid Secretion Modulation

Activates H+/K+ ATPase or histamine receptors to inhibit gastric acid secretion. The management of peptic ulcers becomes possible through treatment with flavonoids and tannins and alkaloids. These phytoconstituents demonstrate importance in drug discovery because they can achieve their effects through different action mechanisms [13].

Ipomoea pes-tigridis: The Tiger's Foot Vine

One particularly interesting species is *Ipomoea pes-tigridis*, commonly known as Tiger's Foot, due to the distinctive shape of its leaves, which resemble the footprint of a tiger. This unique leaf morphology sets it apart from other members of the genus and enhances its ornamental appeal. It is primarily found in tropical and subtropical regions, thriving in diverse habitats such as coastal areas and forest edges. Although its medicinal uses are not as well-documented as those of other *Ipomoea* species, it is often studied for its phytochemical properties and potential ecological interactions. The genus *Ipomoea* represents a group of plants with immense botanical, cultural, and ecological significance. Their wide range of applications in medicine, horticulture, and conservation continues to make them a subject of scientific interest and research worldwide [14].

Ipomoea pes-tigridis is a plant of significant medicinal and pharmacological importance, with a wide range of bioactive compounds that contribute to its antioxidant, antimicrobial, anti-inflammatory, and cytotoxic activities. The research into Ipomoea pes-tigridis for PUD treatment finds additional support from the rising worldwide shift toward plant-based medicines because of safety and sustainability concerns about synthetic pharmaceuticals.

Materials and Methods

Extraction

Plant leaves of *Ipomoea pes-tigridis* which were gathered from local area and received a thorough washing with fresh water before surface and dirt contaminants were removed, authentified by a botanist. The leaves underwent five days of covered drying under shade conditions to protect essential phytochemicals from being lost by sunlight. The mechanical grinder produced 500g of coarse leaf powder after drying the materials. The evaluation of bioactive compounds from *Ipomoea pes-tigridis* leaves used ethanol extraction (60–80°C) through a Soxhlet apparatus. The solvent transformation into clear color indicated that the extraction reached its maximum point. The rotary vacuum evaporator was used to concentrate the extracted solution while filtering it to obtain a semi-solid product mass. Laboratory personnel placed the extract into an airtight container before storing it at 4°C for analysis procedure [15].

Preliminary Phytochemical Screening

Standard chemical procedures helped identify different phytoconstituents from the ethanol extract of *Ipomoea pes-tigridis* during the phytochemical evaluation. The testing of phytochemical compounds allows scientists to uncover essential secondary metabolites within plants including alkaloids and glycosides, flavonoids, steroids, phenolic compounds, tannins and saponins. Analysis methods determined and measured the bioactive compounds by following both qualitative and quantitative approaches [16].

Detection of Alkaloids

The solution of test material received 5 ml distilled water and required acidification through adding 5 ml 2M hydrochloric acid (HCl). The addition of one milliliter Dragendorff's reagent proceeded after. An orange-red precipitate formed in order to detect alkaloids. A small extract fraction was combined with diluted hydrochloric acid before receiving Mayer's reagent as part of this test. A white precipitate formation indicated the presence of alkaloids in the substance. The sample received Wagner's reagent treatment to yield reddish-brown precipitates due to alkaloid presence.

Detection of Glycosides

The test solution underwent heating with 1 ml sulfuric acid during five minutes to perform Borntrager's test. The cooled filtrate received a shaking treatment with chloroform that was equal in volume. The scientists separated the chloroform layer into two parts before combining half the volume of chloroform with diluted ammonia solution. The presence of anthraquinone glycosides could be marked by a rose-pink to crimson color that developed in the ammoniacal layer.

Weak sulfuric acid (2 ml) heated the test sample while boiling took place. A brand new 5% solution of ferric chloride in water became added to the mixture that remained for five minutes before testing. The researcher added diluted ammonia after obtaining the bottom layer. Roses or crimsone hues in the ammonia mixture indicated the existence of glycosides [17].

Detection of Flavonoids

The Shinoda test required addition of small magnesium turnings into extract solution that received concentrated hydrochloric acid (HCl) treatment. The detection of flavonoids depended on the observation of a color change from pink to crimson red which sometimes became green then blue.

Detection of Steroids and Triterpenoids

The extract underwent Liebermann-Burchard's test when it received treatment with acetic anhydride while gently heating before the addition of concentrated sulfuric acid to verify tetraterpenes. The test tube received concentrated sulfuric acid (H_2SO_4) additions down its walls after it had cooled. Studying a brown ring at the interface during this test allows scientists to determine the presence of steroids and color changes to deep red indicate triterpenoids.

The extract received treatment from a few drops of concentrated sulfuric acid. The appearance of a yellow-colored portion in the lower part of the solution through this test indicated the presence of triterpenoids while a red-colored portion showed the presence of steroids.

Detection of Phenolic Compounds and Tannins

The research team introduced 2 ml of aqueous extract into 5% aqueous ferric chloride ($FeCl_3$) solution drops. A blue-black color reaction produced through this test indicated both phenolic compounds and tannin presence in the sample. The analyst tested the solution by adding basic lead acetate solution to it. The appearance of a white precipitate during tests showed the existence of tannins in the samples [18].

Detection of Saponins

The extract received a single drop of sodium bicarbonate solution after which it was energetically mixed and remained undisturbed for three minutes. The extract generated a stable foam honeycomb structure through the saponin compounds present.

Detection of Carbohydrates

The test solution received alcoholic alpha-naphthol treatment then concentrated sulfuric acid was added slowly along the test tube sides during the Molisch's test procedure. The appearance of a purple to violet-colored ring between liquids during the test showed that the solution contained carbohydrate content.

Equal amounts of Fehling's solution I and II were combined for testing the solution through their mixture. Heating the mixture inside the boiling water bath resulted in reducing sugar detection through the appearance of a red precipitate.

Detection of Proteins and Amino Acids

A test sample required treatment with 5-8 drops of a 10% w/w copper sulfate solution through which the Biuret test was conducted. Violet hue appearance in the solution indicated that proteins and peptides were present in the sample [19].

Detection of Gum and Mucilage

During testing an analyst added 5-10 milliliters acetic anhydride to a small portion of the sample which required cooling afterwards. A small amount of concentrate sulfuric acid received addition into a 0.05 milliliter volume of solution. An intense purple-red color formation in this solution proved the gums and mucilage presence in the sample.

Detection of Fixed Oils and Fats

The researchers used filter papers to place each extract before pressing it under compression. A fixed oil or fat can be detected through the formation of an oily spot on the filter paper [20].

In Vivo Activity

Selection of animals

The research employed using Wistar rats in the 150-200 gram weight range as the subjects for their acute toxicity assessments and their anti-ulcer experimental component. The research animals lived in conditions with scheduled light and dark times which included unrestricted food and water for all animals.

Acute toxicity studies

Scientists utilized Wistar rats for measuring the LD50 of the extract through an OECD 423 protocol-based test method. Six-week-old Wistar rats (n = 6 each group) received random selection through sampling for the study purposes. Six Wistar rats received 12-hour fasting while drinking freely from water sources. The animals received an oral administration of the leaf extract during 24 hours of dedicated observation for signs of toxicity or death. Testing revealed the highest dosage limit of the extract because mortality was detected when four of six to six of six animals died. No death occurred in the experiment so scientists continued to raise the extract dosage levels until establishing the maximum safe threshold amount.

A comprehensive examination of behavioral cues involving motor activity along with tremors and convulsions and Straub reaction followed by aggressiveness and piloerection and loss of righting reflex and sedation with muscle relaxation and hypnosis and analgesia functionally evaluated cryosis and diarrhoea and skin color variations was performed at one hour post drug delivery and at the 24-hour checkup.

Anti-ulcer activity studies

The anti-ulcer activity evaluation of *Ipomoea pes-tigridis* occurred through testing it in proven ulcer model.

Ethanol-induced gastric ulcer model

Wistar albino rats received random grouping with six groups (n = 6 per group) for each model investigation.

Group I (Normal control): Received no treatment.

The Group II received the ulcer-inducing agents ethanol (96%, 5 mL/kg, p.o.) through 0.6% carboxymethylcellulose (CMC) solution as the vehicle.

The Treatment groups consisting of Groups III, IV, and V received *Ipomoea pes-tigridis* extract at doses established from the acute toxicity stage which included 100 mg/kg, 200 mg/kg and 400 mg/kg respectively.
Group VI (Standard drug group): Received a standard anti-ulcer drug for comparative analysis [21].
The research subjects were put to death using high dose anesthesia before their stomach removal. The stomach tissues received cold saline solution (0.9%) for elimination of remaining gastric substances. The surgeon opened the organ through its greater curvature to provide the best view of gastric ulcerations [22].

Results and Discussion

Results

Physical Parameters of the Ethanol Extract of Ipomoea pes-tigridis

The ethanol extract of *Ipomoea pes-tigridis* exhibited an extractive value of 28.64% (w/w), indicating a significant yield of bioactive compounds. The high extractive value suggests that ethanol is an effective solvent for extracting a diverse range of phytoconstituents, including flavonoids, alkaloids, tannins, glycosides, phenolic acids, and saponins. Ethanol, being both polar and non-polar, facilitates the extraction of hydrophilic and lipophilic secondary metabolites, making it suitable for obtaining a broad-spectrum extract with pharmacological potential.

Table1: Extractive value and physical characters of *Ipomoea pes-tigridis* leaf extract

Solvent	Ethanol
Extractive value%w/w	28.64
Colour	Dark greenish borwn
Odour	Characteristic
Consistancy	Greesy

Preliminary Phytochemical Screening

The preliminary phytochemical screening of the ethanol extract of *Ipomoea pes-tigridis* was conducted to identify the presence of various bioactive compounds. The screening revealed that the extract contains a diverse range of phytoconstituents, including carbohydrates, alkaloids, glycosides, tannins, terpenoids, phenols, flavonoids, steroids, saponins, and proteins.

Table:2 Preliminary phytochemical screening of various extracts of *Ipomoea pes-tigridis* leaf extract

Test	Ethanol	Activity
Alkaloids	+	Analgesic, Anti-inflammatory, Antimicrobial
Carbohydrates	+	Defense mechanism, Energy metabolism
Flavonoids	+	Anti-inflammatory, Anti-microbial, Anti-oxidant
Glycosides	+	Cardiovascular effects, Laxative
Proteins & Aminoacids	+	Physiological process
Saponins	+	Anti-fungal, Cholesterol lowering, Immunomodulatory
Tannins & Phenolic compounds	+	Anti-inflammatory, Anti-microbial,Anti-oxidant, Astringent, Gastroprotective
Triterpenoids & Steroids	+	Anti-cancer, Anti-inflammatory, Hepatoprotective

Acute toxicity studies

The acute toxicity study of *Ipomoea pes-tigridis* (IPM) extract was conducted to evaluate its safety profile at a high-dose level of 2000 mg/kg (IPM 2000), following the OECD 423 guidelines. The study aimed to assess the potential toxic effects of the extract on neurological, physiological, behavioral, and gastrointestinal parameters. The animals were carefully observed for 24 hours post-administration and monitored periodically for 14 days to detect any signs of toxicity. Throughout the observation period, no mortality or signs of severe toxicity were observed in any of the treatment groups, including the control group. Importantly, no deaths were recorded in any treatment group, demonstrating that the IPM extract was non-lethal and well-tolerated at the tested dose. The absence of severe clinical symptoms suggests that the median lethal dose (LD50) of *Ipomoea pes-tigridis* extract is likely greater than 2000 mg/kg, which classifies the extract as relatively safe for further pharmacological applications.

Table 3: Effect of IPM in acute toxicity studies

Parameter	Control	IPM 2000
Tremor	NIL	NIL
Excess salivation	NIL	NIL
Catalepsy	NIL	NIL
Epilepsy	NIL	NIL
Diarrhea	NIL	NIL
Excess sleep	NIL	NIL
Sensitivity to touch	Normal	Normal
Skin	Normal	Normal
Fur	Normal	Normal
Eyes	Normal	Normal
Mobility	Normal	Normal
Coma	NIL	NIL
Death	NIL	NIL

Effect of extracts of Ipomoea on the gastric parameters in ethanol induced ulceration

The anti-ulcer efficacy of *Ipomoea pes-tigridis* (IPM) extract was evaluated using the ethanol-induced gastric ulcer model in Wistar albino rats. The study involved six groups: a normal control (Group I), a negative control treated with ethanol (Group II), three treatment groups receiving IPM at doses of 100 mg/kg (Group III), 200 mg/kg (Group IV), and 400 mg/kg (Group V), and a reference group treated with omeprazole (20 mg/kg, Group VI).

Table:4 Effect of IPM on the gastric parameters in ethanol induced gastric ulcer in rats

Group	Design of Treatment	Ulcer Index	Percentage Inhibition (% I)	Gastric volume (ml/100g)	pH (Unit)
I	Normal control (0.6%w/v CMC, 10 ml/kg b.w) p.o	No ulcers	---	0.42±0.05	5.26±0.36
II	Negative Control (0.6%w/v CMC, 10 ml/kg b.w) p.o +Ethanol	18.46±1.61	---	2.77±0.26	1.31±0.17
III	IPM (100mg/kg b.w) p.o +Ethanol	12.65±1.04	31.47	1.69±0.11	3.95±0.44*
IV	IPM (200mg/kg b.w) p.o +Ethanol	9.96±0.78*	46.04	0.95±0.06*	4.29±0.48**
V	IPM (400mg/kg b.w) p.o +Ethanol	5.85±0.44**	69.59	0.54±0.05**	5.02±0.42**
VI	Omeprazole (20mg/kg b.w) p.o +Ethanol	5.06±0.39**	72.58	0.49±0.03**	5.15±0.45**

The values were expressed as mean±SEM; Significance of differences were compared using ANOVA followed by dunnets test where *indicates p<0.05 and ** indicates p<0.01 compared to the group II

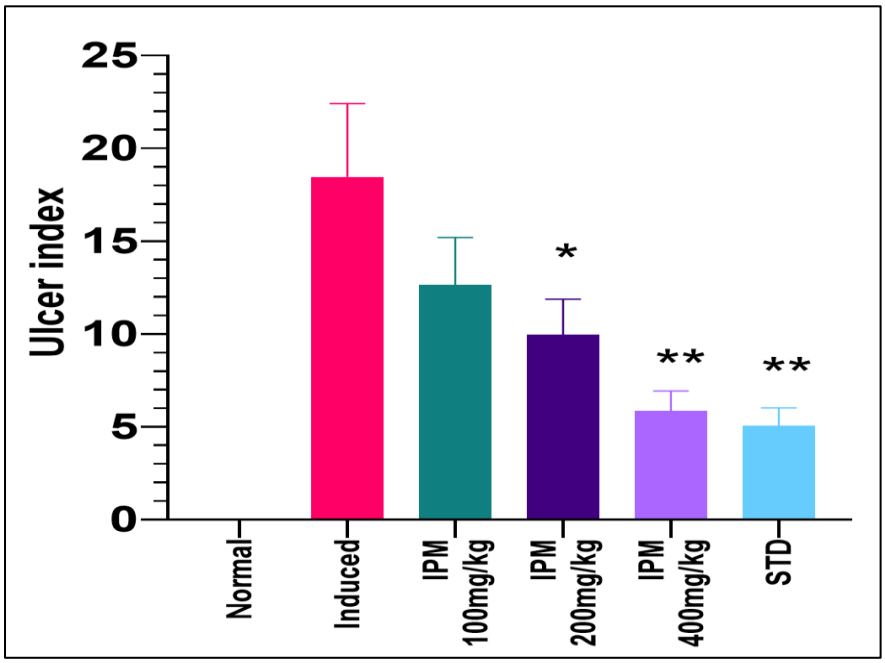

Figure1: Effect of IPM on the ulcer index of ethanol induced ulceration

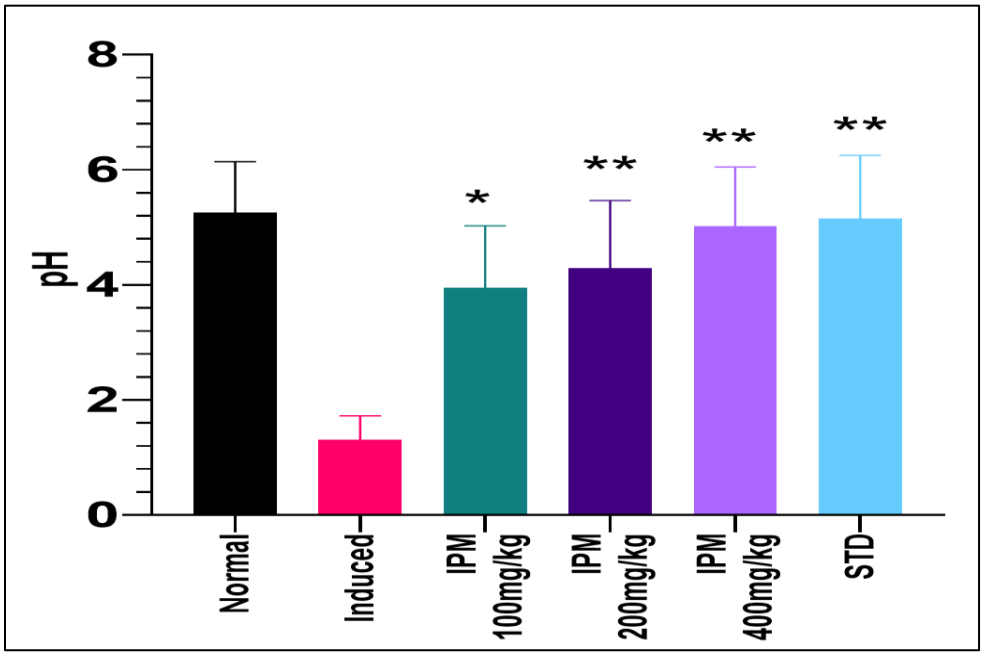

Figure 2: Effect of IPM on the pH of ethanol induced ulceration

Effect of extract of *Ipomoea pes-tigridis* on the inflammatory markers in ethanol induced ulceration

The effect of *Ipomoea pes-tigridis* (IPM) extract on inflammatory markers in ethanol-induced gastric ulceration was assessed by measuring levels of IL-6, TNF-α, and IL-1β in different experimental groups.

Table 5: Effect of IPM on the inflammatory parameters in ethanol induced gastric ulcer in Rats

Group	Design of Treatment	IL-6 (pg/ml)	TNF-α (pg/ml)	IL-1β (pg/ml)
I	Normal control (0.6%w/v CMC, 10 ml/kg b.w) p.o	3.66±0.29	4.53±0.43	8.29±0.85
II	Negative Control (0.6%w/v CMC, 10 ml/kg b.w) p.o +Ethanol	10.05±1.44	19.62±1.56	24.07±2.77
III	IPM (100mg/kg b.w) p.o +Ethanol	7.55±0.65*	11.64±0.89	18.88±1.21
IV	IPM (200mg/kg b.w) p.o +Ethanol	5.41±0.41**	8.44±0.75*	12.47±0.97*
V	IPM (400mg/kg b.w) p.o +Ethanol	4.04±0.28**	5.18±0.47**	9.48±0.68**
VI	Omeprazole (20mg/kg b.w) p.o +Ethanol	4.13±0.32**	4.98±0.41**	8.99±0.62**

The values were expressed as mean±SEM; Significance of differences were compared using ANOVA followed by dunnets test where *indicates $p<0.05$ and ** indicates $p<0.01$ compared to the group II

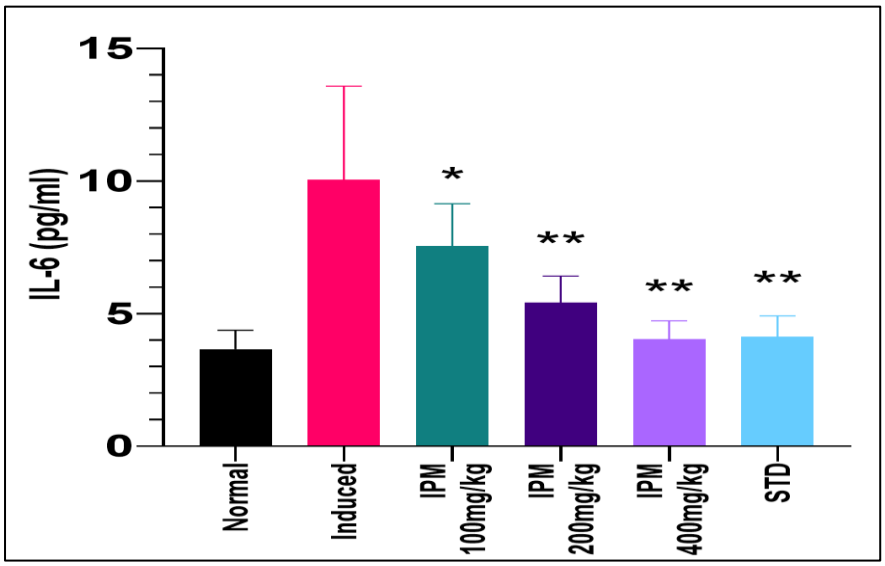

Figure3: Effect of IPM on the IL-6 of ethanol induced ulceration

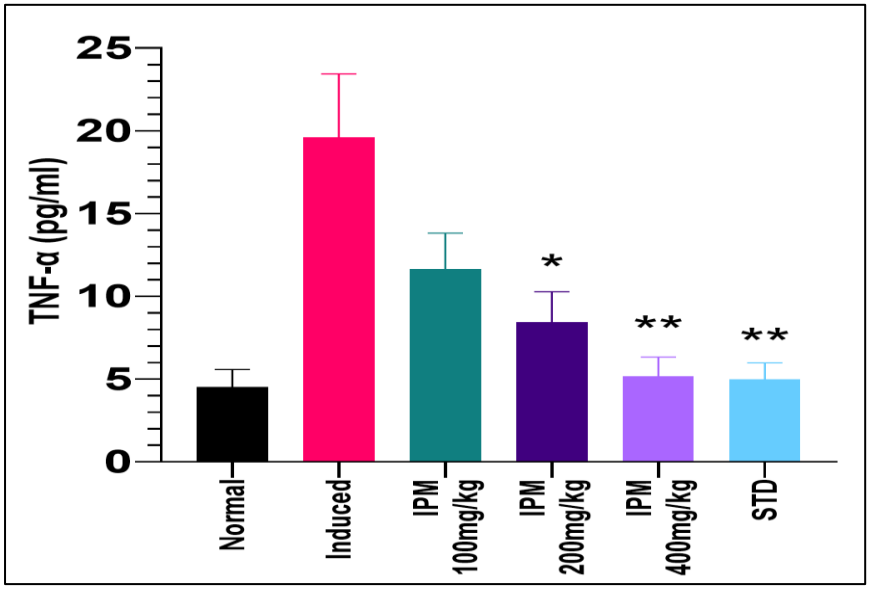

Figure 4: Effect of IPM on the TNF-α of ethanol induced ulceration

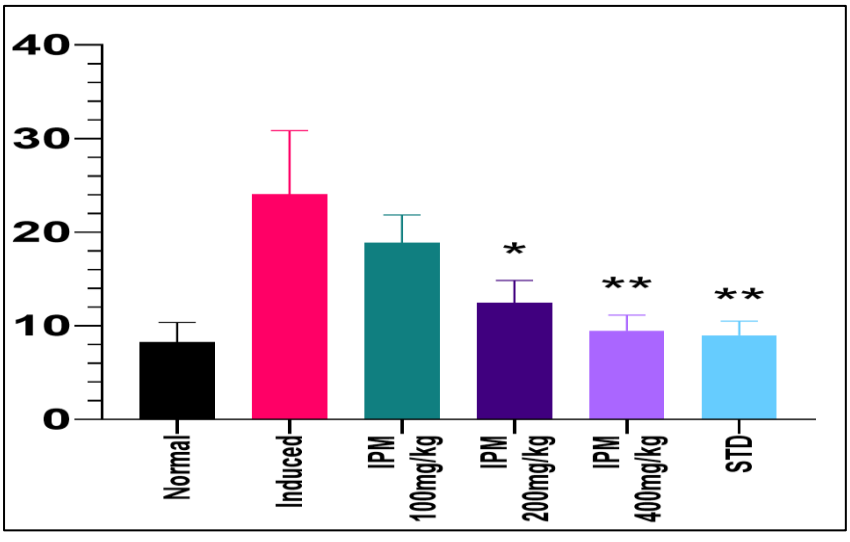

Figure 5: Effect of IPM on the IL-1β of ethanol induced ulceration

Effect of *Ipomoea pes-tigridis* Extracts on the Gastric Mucosa in Ethanol-Induced Ulceration

The protective effects of *Ipomoea pes-tigridis* (IPM) extract on gastric mucosa were assessed in Wistar albino rats subjected to ethanol-induced ulceration. The study compared the gastric mucosal integrity among six experimental groups: normal control (Group I), ethanol-induced ulcer group (Group II), three treatment groups receiving IPM at 100 mg/kg (Group III), 200 mg/kg (Group IV), and 400 mg/kg (Group V), and a reference standard group receiving omeprazole (Group VI).

Normal Control (Group I)

The gastric mucosa in the normal control group appeared smooth, intact, and well-preserved, without any visible signs of ulceration, hemorrhage, or damage. The epithelial lining was continuous, with no disruptions, and no signs of inflammatory responses were observed. There were no mucosal lesions or edema, correlating with an ulcer index of 0, confirming the physiological integrity of the gastric tissue.

Ethanol-Induced Ulcer Group (Group II)

Severe gastric mucosal damage was observed in the negative control group due to ethanol administration. The gastric mucosa exhibited large hemorrhagic streaks, deep ulcerative lesions, and significant epithelial disruption, indicating severe mucosal erosion. The ethanol exposure led to increased gastric secretion, excessive acid production, and reduced mucosal protection, contributing to extensive tissue damage. The ulcer index was 18.46 ± 1.61, highlighting the severity of ethanol-induced gastric injury.

IPM 100 mg/kg Treatment Group (Group III)

In this group, moderate protection against ethanol-induced mucosal damage was observed. The gastric mucosa exhibited fewer ulcerative lesions and reduced hemorrhagic streaks compared to the negative control, though small erosions and mild hemorrhage were still visible. The ulcer index was 12.65 ± 1.04, indicating that IPM at 100 mg/kg provided partial protection against ethanol-induced damage by reducing the severity of gastric lesions and inflammation.

IPM 200 mg/kg Treatment Group (Group IV)

The gastric mucosa showed significant improvement with fewer lesions, mild epithelial damage, and only small superficial hemorrhagic areas. The protective effects of IPM were more pronounced at this dose, as evidenced by increased mucosal thickness and improved epithelial integrity. The ulcer index was 9.96 ± 0.78, indicating that the extract at 200 mg/kg effectively reduced gastric ulcer severity by nearly 46% compared to the negative control.

IPM 400 mg/kg Treatment Group (Group V)

At the highest dose, the gastric mucosa was nearly restored, with only minor superficial lesions and no significant hemorrhagic streaks or deep ulcerative damage. The epithelial surface appeared smooth and well-preserved, and the mucosal layer showed improved regeneration compared to lower doses. The ulcer index was 5.85 ± 0.44, demonstrating strong gastroprotective effects at this dose, significantly reducing the severity of ethanol-induced mucosal injury.

Omeprazole-Treated Group (Group VI)

In the omeprazole-treated group, the gastric mucosa appeared almost entirely normal, with very few or no ulcerative lesions. The mucosal surface was smooth, intact, and comparable to the normal control, with well-defined epithelial layers and no visible inflammation. The ulcer index was 5.06 ± 0.39, indicating excellent protection against ethanol-induced gastric injury, similar to the highest dose of IPM.

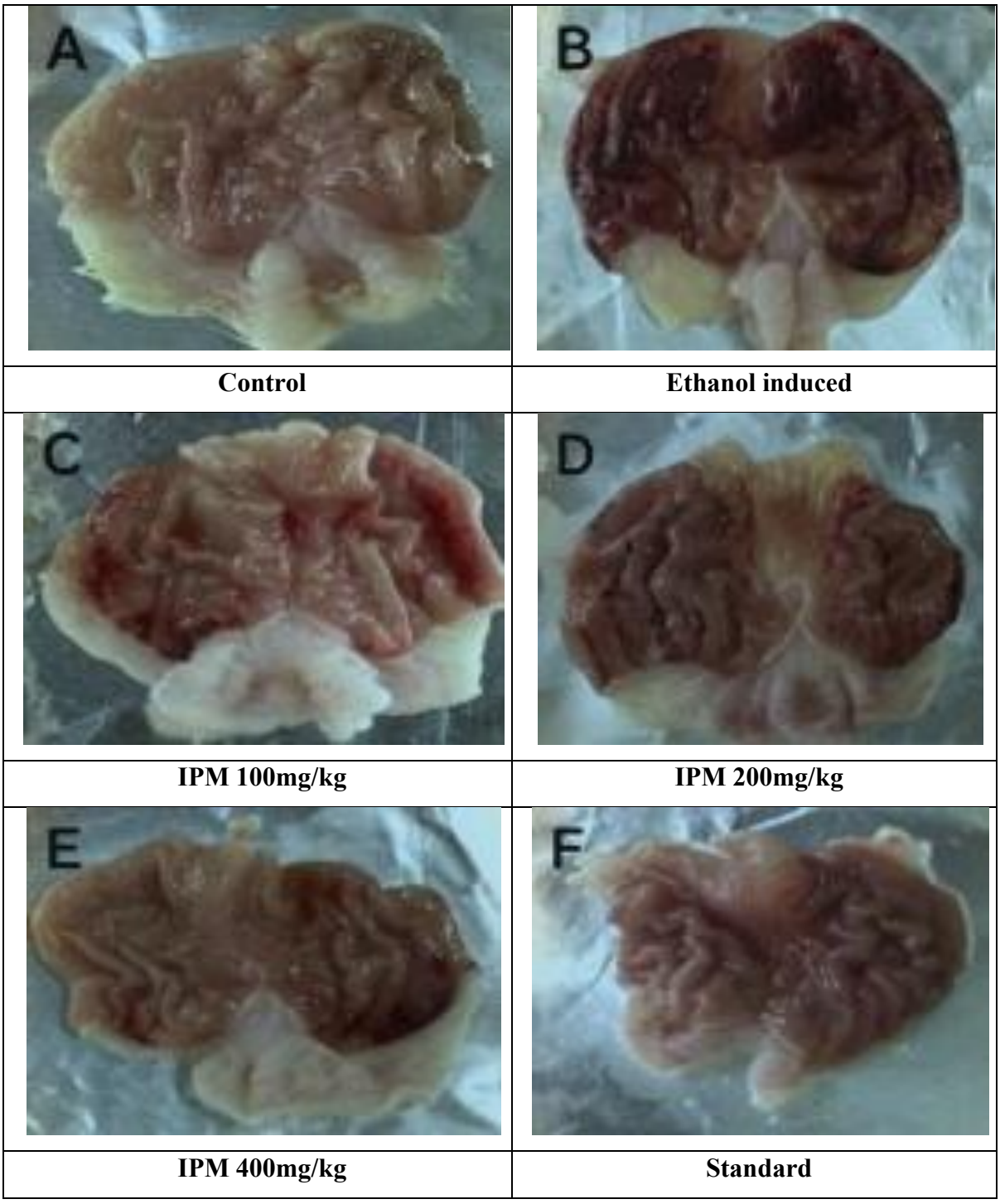

Figure 6: Changes in the gastric mucosa in ethanol induced ulceration

Discussion

Researchers investigated how ethanolic extract of *Ipomoea pes-tigridis* worked as an anti-ulcer agent by performing protective tests on gastric ulcers which Wistar albino rats received after intake of ethanol. Ulcers in the stomach develop from defensive-aggressive factor discrepancies of the gastric mucosa which results in mucosal damage through oxidative stress combined with inflammation and excessive acid production. This research investigated if IPM treatment proved effective at reducing pathogenic effects leading to gastric mucosal recovery during healing processes. Ethanol treatment produced three distinct effects on rats: it created high ulcer damage, produced greater gastric fluid volume while maintaining strong acidity which caused severe tissue destruction. Microscopic analysis showed ulcerative lesions with extensive hemorrhagic streaks together with necrotic patches and inflammatory cell infiltrations. Results from this study establish that *Ipomoea pes-tigridis* extract provides substantial protection against ulcers because it regulates oxidative stress and

inflammation and gastric acid production as well as stomach lining defenses. The gastroprotective potential of *Ipomoea pes-tigridis* exists at a strong level because it reduces oxidative stress effects while it regulates inflammatory pathways and restricts gastric acid secretion as well as enhancing mucosal defensive mechanisms. Its equal strength to omeprazole demonstrates the potential of natural anti-ulcer medication.

Conclusion

The ethanol extract of *Ipomoea pes-tigridis* demonstrated potent gastro-protective activity, as confirmed by its anti-ulcer, anti-inflammatory effects in ethanol induced gastric ulcer models. The extract significantly reduced gastric mucosal injury, inhibited pro-inflammatory cytokines (IL-6, TNF-α, IL-1β), reduction in ulcer index and rise in pH. The histopathological analysis confirmed that *Ipomoea pes-tigridis* extract protected the gastric mucosa, reduced ulcer severity, and facilitated epithelial regeneration in a dose-dependent manner.

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