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Therapeutic efficacy of *Lonchocarpus sericeus* leaf extract on ethanol induced gastric ulcer

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Abstract

Background Senegal lilac (*Lonchocarpus sericeus* (Poir.)) is a medicinal plant with a long history of folkloric use in the treatment of pathological conditions, particularly gastric ulceration.

Aim This study was designed to evaluate the therapeutic potential of *Lonchocarpus sericeus* leaf extract against experimentally induced gastric ulceration.

Materials and methods Forty (40) Wistar rats were used and were assigned into five groups of eight (8) animals each with similar body weight. Gastric ulcers were induced via oral administration of ulcerogenic agents (ethanol), followed by oral treatment. Ethanol leaf extract of *Lonchocarpus sericeus* (ELLS) was administered at doses of 100 mg/kg and 200 mg/kg body weight (BWT). A standard drug group received at 20 mg/kg BWT for 28 days. At the end of the treatment period, the animals were sacrificed, and biochemical assays were conducted to evaluate excitatory, inflammatory, and anti-ulcer parameters. Excitatory assay was conducted through quantification of Na⁺/K⁺-ATPase activity, whereas inflammatory responses were rigorously assessed by measuring tumor necrosis factor-alpha (TNF-α), interleukin-1 beta (IL-1β), and interleukin-6 (IL-6) levels. Anti-ulcer parameters were systematically evaluated by determining gastric pH, gastric volume, ulcer index, percentage inhibition, mucin concentration, and pepsin activity.

Results Administration of ELLS significantly attenuated the damaging effects of ethanol-induced gastric injury. This was evidenced by enhanced Na⁺/K⁺-ATPase activity, improved gastric indices, and preservation of gastric mucosal integrity. Rats treated with 100 mg/kg and 200 mg/kg BWT of ELLS (Groups 3 and 4) showed pronounced protection, as reflected in reduced ulcer index, elevated mucin concentration, and suppression of inflammatory cytokines. These effects were comparable to those observed in the standard drug group.

Conclusion The findings demonstrate that ethanol leaf extract of *Lonchocarpus sericeus* effectively mitigates gastric mucosal damage by reducing inflammation, inhibiting excessive pepsin activity, and restoring gastric protective factors. Thus, the extract shows strong potential as a therapeutic agent for the management of gastric ulcers.

Keywords Gastric ulcer, *Lonchocarpus sericeus*, Pro-inflammatory, Excitatory activities



1 Introduction

Gastric ulceration is a non-malignant lesion of the gastric mucosa, primarily associated with excessive gastric acid secretion and increased pepsin activity [1]. It remains one of the most prevalent gastrointestinal disorders globally, accounting for approximately 15 deaths per 15,000 reported complications annually [2]. Despite therapeutic advances including vagotomy, prostaglandin analogs, H₂-receptor antagonists, antacids, and proton pump inhibitors the clinical application of these treatments is often limited by gastrointestinal toxicity.

Ethanol is a well-established ulcerogenic agent that induces acute erosive gastritis and compromises gastric mucosal integrity. At high concentrations, ethanol rapidly causes necrosis of superficial mucosal cells through cytoplasmic protein precipitation and membrane disruption. This triggers the release of vasoactive mediators such as leukotriene C₄ (LTC₄) and histamine, which act synergistically to initiate vascular constriction beginning in the small mucosal venules and extending to submucosal and larger veins [3].

Medicinal plants offer a promising alternative due to their abundance of bioactive secondary metabolites, including tannins, terpenoids, alkaloids, anthraquinones, glycosides, carotenoids, phenols, pyrrolidine alkaloids, rotenone [4], and flavonoids such as chalcones [5, 6]. These phytochemicals are recognized for their antioxidant, anti-inflammatory, and cytoprotective properties, positioning medicinal plants as effective and safer options in ulcer management. Notably, it is estimated that nearly two-thirds of the world's plant species possess medicinal potential, with many exhibiting strong antioxidant activities [7].

Lonchocarpus sericeus (Poir.), commonly known as Senegal lilac or Cube Root, is a leguminous, dry-deciduous tree native to West Africa, particularly Nigeria and Ghana. Belonging to the family Papilionaceae, it can grow up to 16 m in height. Its seeds are oblong, reddish-brown, and measure about 7 × 5 mm. Traditionally, the bark and roots have been employed for medicinal purposes [8]. Phytochemical analyses of the plant's leaves, stems, and roots reveal the presence of alkaloids, saponins, carotenoids, flavonoids, tannins, triterpenes, and steroids [9, 10]. Among these, flavonoids and chalcones are particularly noted for their potent antioxidant and antimicrobial activities, which validate its folkloric applications. Previous studies have also reported antioxidant, anti-fungal, and insect-repellent properties of *L. sericeus* [11]. However, systematic evaluation of its leaf extracts using ethanol solvent remains limited.

Therefore, this study investigates the protective role of ethanol leaf extract of *Lonchocarpus sericeus* against ethanol-induced gastric ulceration in Wistar rats.

2 Materials and method

The experimental aspect of this study was carried out at the Department of Biochemistry, Federal University of Technology, Akure, Ondo State, Nigeria.

2.1 Chemicals

Ethanol, anesthesia, and omeprazole and other chemicals (reagents) used were Sigma Aldrich chemical and purchased from Pascal Scientific Limited, Akure, Nigeria.

2.2 Plant collection

Fresh samples of *Lonchocarpus sericeus* (Senegal lilac) leaves were collected at a garden within the Federal University of Technology, Akure staff quarters, Nigeria. The plant was identified and authenticated by Mr. Momoh Bernard Eromosele, Center for Research and Development (CERAD), Federal University of Technology, Akure. A voucher specimen (accession number FUTA/020) was deposited in the herbarium of Federal University of Technology, Akure. The leaves were washed, air-dried, ground into fine powder using a blender, the powdered leaves was macerated in 80% ethanol for 72 h and then filtered using Whatman filter paper. The filtrate was concentrated to a small volume using rotary evaporator and thereafter lyophilized in order to obtain the methanol extract of *L. sericeus* leaf. This was stored in an amber bottle and refrigerated at 20 °C to preserve freshness and subsequently kept for further experiments. The yield of the extract was calculated.

2.3 Animal and experimental design

A total of forty (40) male Wistar rats, weighing between 150 and 240 g, were procured from a private animal holding facility in Ogbomoso, Oyo State, Nigeria, for use in the ulceration study involving the leaf extract. Upon acquisition, the rats were housed under controlled conditions of temperature (22 ± 1 °C), humidity (50–55%), and light (12 h light/12 h dark cycle). For 14 days before the start of the experiment, they were acclimatized to the laboratory conditions. Throughout the experiment, the animals have unlimited access to food and water. All experimental procedures including euthanasia were conducted following the ethical regulation and guide for the care and use of laboratory animals of The Federal University of Technology, Akure Nigeria (ethical approval number: FUTA/CRD/EC/23/146).

2.4 Animal design

The experiment was conducted at the Applied Clinical Laboratory, Department of Biochemistry, Federal University of Technology, Akure, Nigeria. The study involved with forty (40) Wistar rats and the animals were divided into five groups, comprising eight (8) rats per group. Group 1 (negative control), normal rats administered with normal saline for 30 days; group 2 (positive control), rats were administered with 1 mL absolute ethanol for 2 days without any treatment, group 3 rats were administered with 1 mL/100 mg/kg BWT (i.e. 1 mL of ethanol for 2 days followed with a low dose of ELLS for 28 days), group 4 rats were administered with 1 mL/200 mg/kg BWT (i.e. 1 mL of ethanol for 2 days with an high dose of ELLS for 28 days), and group 5 rats were administered with 1 mL/20 mg/kg BWT (i.e. 1 mL of ethanol and omeprazole both the induction and the treatment were carried out orally).

Group 1: Sham-operated with oral administration of vehicle

Group 2: Ethanol-induction respectively

Group 3: Ethanol-induction, treated with ELLS 100 mg/kg BWT

Group 4: Ethanol-induction treated with ELLS 200 mg/kg BWT

Group 5: Ethanol-induction treated with omeprazole 20 mg/kg BWT

2.5 Euthanization

By the end of the study, rats were sacrificed by cervical dislocation, the stomachs were extracted.

2.6 Biochemical evaluations

Inflammatory markers: Na^+/K^+ ATPase, $\text{TNF-}\alpha$, $\text{IL-1}\beta$ and IL-6 degree of protection, ulcer index, pH, and volume, mucin and pepsin.

2.7 Statistical analysis

The results were pooled and expressed as mean $\pm$ standard deviation. One way analysis of variance (ANOVA) was used to analyze the results and the Duncan multiple test was also used for the post hoc (DMRT). Statistical package for social science (SPSS) 17.0 for windows was used for the analysis/and the significance level was set at $p < 0.05$.

3 Results

3.1 Prevention of ethanol induced excitatory activities in rat stomach by ELLS

A significant decrease in Na^+/K^+ -ATPase activity was observed in the ethanol-induced, untreated group (positive control) compared to the negative control group ($p < 0.05$). However, administration of Ethanolic Leaf Extract of *Lonchocarpus sericeus* (ELLS) resulted in a dose-dependent, significant increase in Na^+/K^+ -ATPase activity relative to the induced group ($p < 0.05$). Similarly, treatment with standard antiulcer agents omeprazole also significantly elevated Na^+/K^+ -ATPase activity (Fig. 1).

3.2 Anti-inflammatory potential of ethanol leaf extract of *L. sericeus*

Figure 2 analysis of $\text{TNF-}\alpha$ concentrations revealed a significant increase ($p < 0.05$) in the stomach tissue of the ethanol-induced, untreated group (positive control) compared to the experimental groups. Treatment with ELLS significantly reduced $\text{TNF-}\alpha$ levels in a dose-dependent manner ($p < 0.05$).

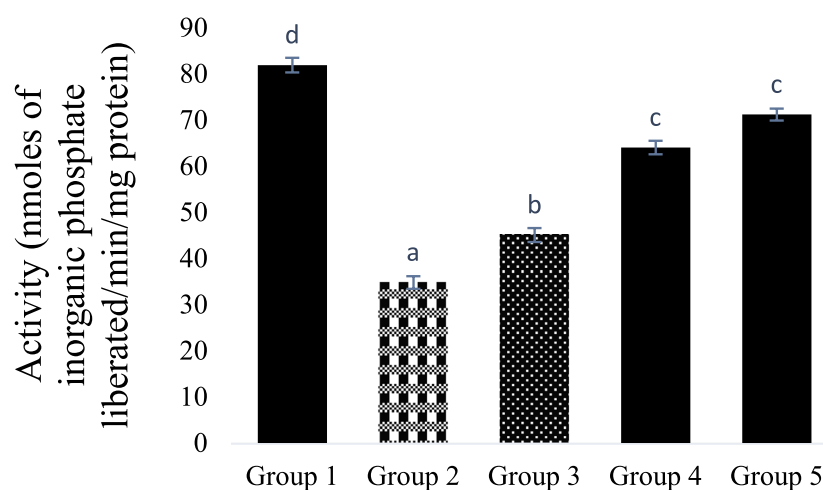


Fig. 1 Effects of ELLS extracts on the activity of Na^+/K^+ ATPase in the stomach of indomethacin/ethanol-induced gastric ulcer Wistar rats. Bars are expressed as mean ($n = 8$), bars with different superscripts are significantly different ($p < 0.05$). Keys: Group 1: Negative control. Group 2: Positive control (ethanol-induced but not treated). Group 3: Ethanol-induced, treated with 100 mg/kg BWT ELLS. Group 4: Ethanol-induced, treated with 200 mg/kg BWT ELLS. Group 5: Ethanol-induced, treated with 20 mg/kg omeprazole

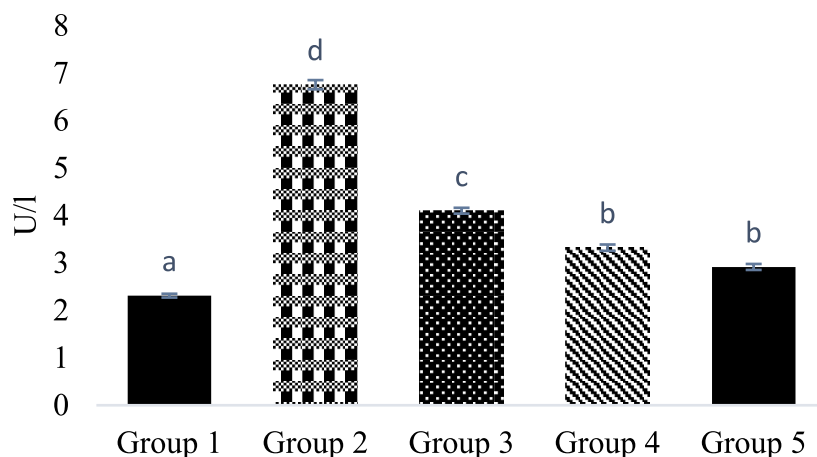


Fig. 2 Effects of ELLS extracts on the concentration of TNF- α in the stomach of ethanol-induced gastric ulcer Wistar rats. Bars are expressed as mean ($n=8$), bars with different superscripts are significantly different ($p<0.05$)

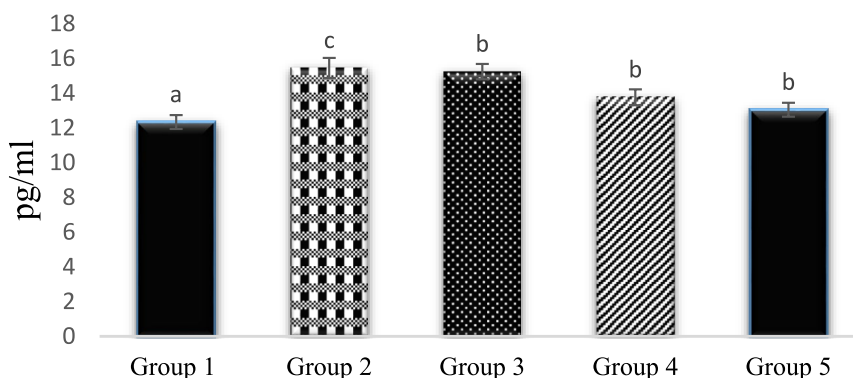


Fig. 3 Effects of ELLS extracts on the activity of IL-6 in the stomach of ethanol-induced gastric ulcer Wistar rats. Bars are expressed as mean ($n=8$), bars with different superscripts are significantly different ($p<0.05$)

Figure 3 revealed the concentration of Interleukin-6, it was shown that, there was a significant increase ($p<0.05$) in the concentration of Interleukin-6 in the stomach of ethanol-induced rats group (positive control group) compared to the experimental groups. Treatment with ELLS significantly decreased the concentration of Interleukin-6 in a dose-dependent manner ($p<0.05$).

Effects of ethanol-intoxication on the concentration of Interleukin-1 β was revealed in Fig. 4, The results showed a significant increase ($p<0.05$) in the concentration of IL-1 β in the stomach tissues of rats with ethanol-induced gastric ulcers (positive control group) compared to the negative control. However, treatment with Ethanol ELLS significantly reduced IL-1 β levels in a dose-dependent manner ($p<0.05$) relative to the untreated, ulcer-induced group.

3.3 Effect of ELLS on gastric ulcer

Administration of ethanol resulted in a significant decrease in gastric pH ($p<0.05$), accompanied by a significant increase in gastric volume ($p<0.05$) when compared to the normal control group. Pre-treatment with ELLS led to a significant elevation in gastric pH and a corresponding significant reduction in gastric volume relative to the ulcerated control group. Furthermore, ethanol exposure caused a significant increase in specific

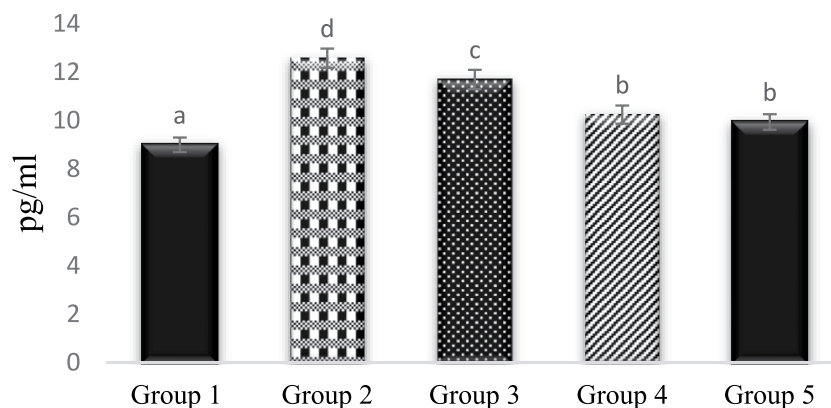


Fig. 4 Effects of ELLS extracts on the activity of IL-1 β in the stomach of ethanol-induced gastric ulcer Wistar rats. Bars are expressed as mean ($n=8$), bars with different superscripts are significantly different ($p < 0.05$)

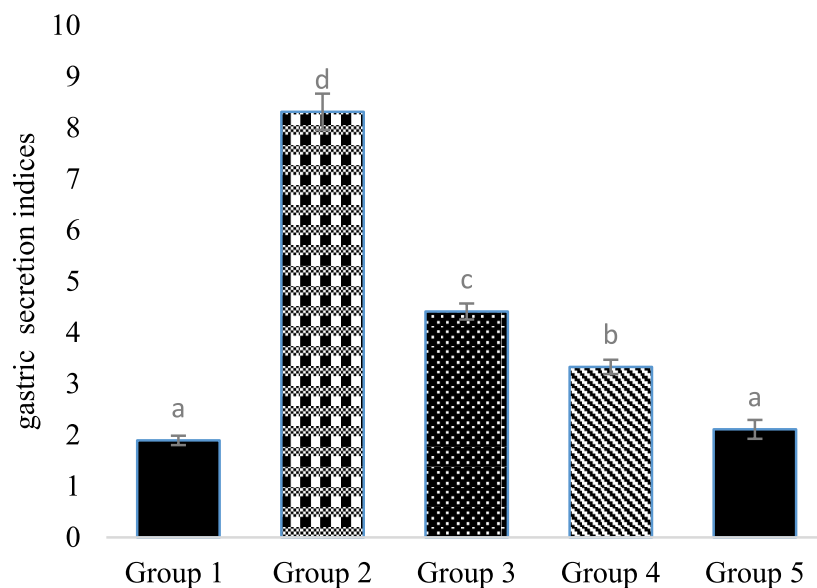


Fig. 5 Effects of ELLS extracts on the activity of gastric volume of ethanol-induced gastric ulcer Wistar rats. Bars are expressed as mean ($n=8$), bars with different superscripts are significantly different ($p < 0.05$)

pepsin activity and a significant decrease in gastric mucin content ($p < 0.05$), indicating mucosal damage. These alterations were significantly ameliorated ($p < 0.05$) in rats treated with ELLS (Figs. 5, 6, 7, 8).

3.4 Antiulcer characteristics of ELLS

Induction with indomethacin/ethanol produced significant increase in ulcer index and ulcer score while pre-treatment with ELLS and ranitidine reduced areas and severity of gastric lesions in the term of ulcer score and index (Figs. 9, 10).

4 Discussion

Gastric ulceration is a benign lesion of the gastric mucosal epithelium that develops when the stomach lining is excessively exposed to gastric acid and aggressive pepsin activity [1, 12]. Peptic ulcer disease represents one of the most prevalent gastrointestinal disorders globally, with approximately 15 deaths occurring per 15,000 reported

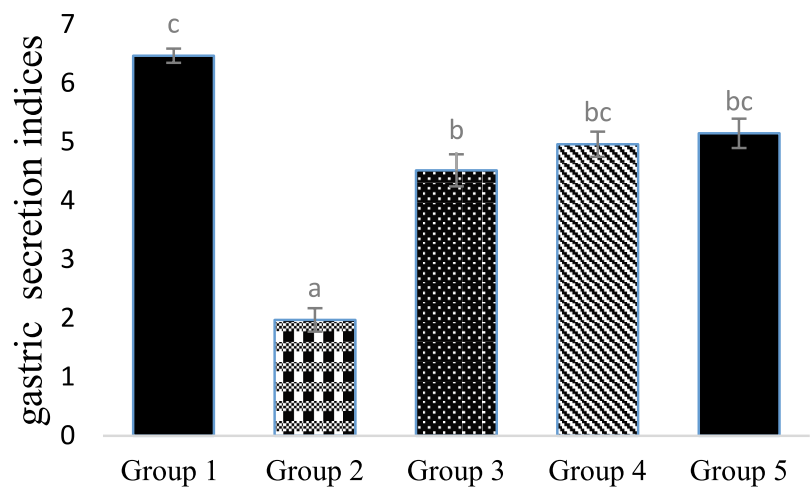


Fig. 6 Effects of ELLS extracts on the activity of gastric pH of ethanol-induced gastric ulcer Wistar rats. Bars are expressed as mean ($n=8$), bars with different superscripts are significantly different ($p < 0.05$)

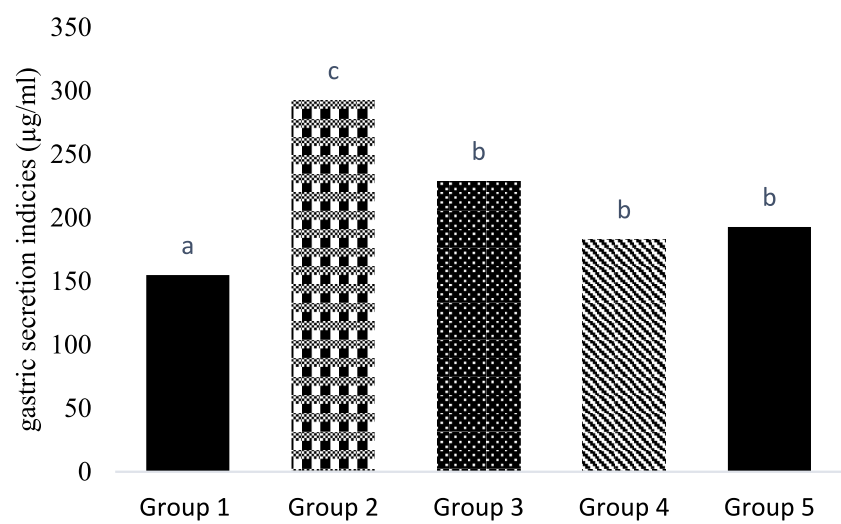


Fig. 7 Effects of ELLS extracts on the activity of pepsin of ethanol-induced gastric ulcer Wistar rats. Bars are expressed as mean ($n=8$), bars with different superscripts are significantly different ($p < 0.05$)

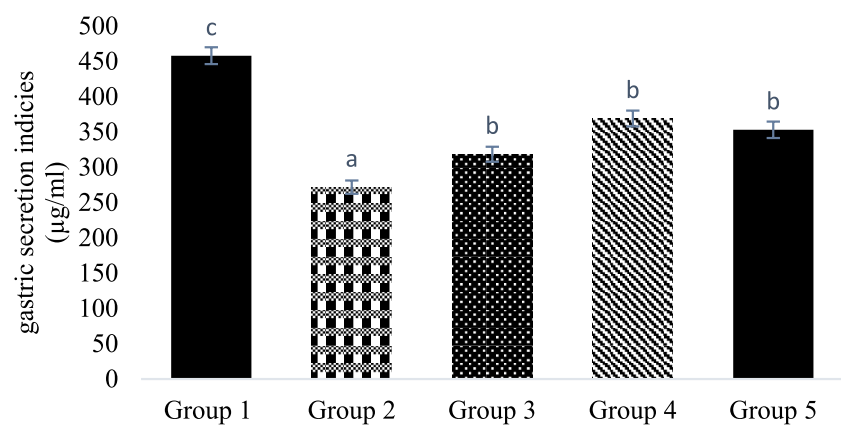


Fig. 8 Effects of ELLS extracts on mucin concentration of ethanol-induced gastric ulcer Wistar rats. Bars are expressed as mean ($n=8$), bars with different superscripts are significantly different ($p < 0.05$)

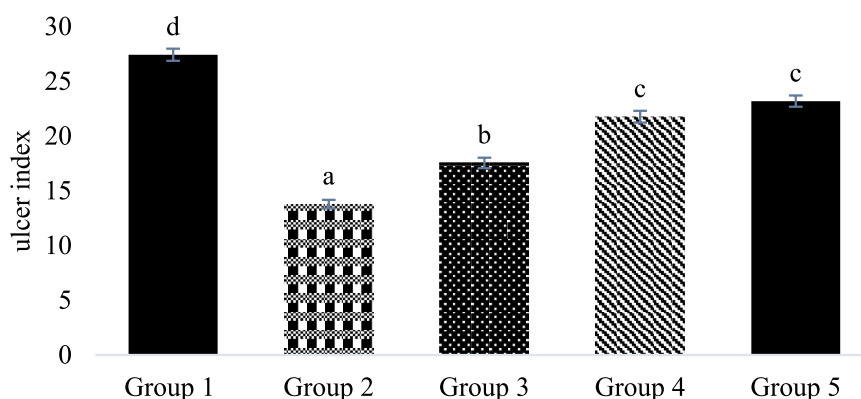


Fig. 9 Effects of ELLS extracts on ulcer index of ethanol-induced gastric ulcer Wistar rats. Bars are expressed as mean ($n=8$), bars with different superscripts are significantly different ($p < 0.05$)

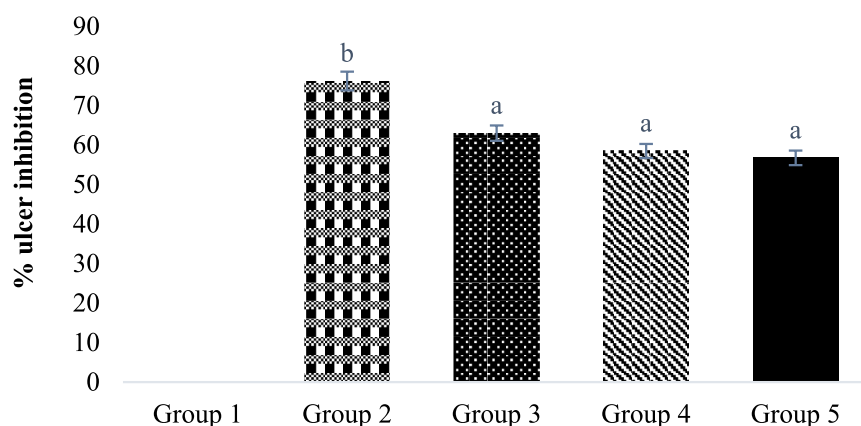


Fig. 10 Effects of ELLS extracts on degree of protection against ulceration in ethanol-induced gastric ulcer Wistar rats. Bars are expressed as mean ($n=8$), bars with different superscripts are significantly different ($p < 0.05$)

complications annually [2, 13]. Although therapeutic strategies have evolved from conventional vagotomy and the administration of prostaglandin analogs, H_2 -receptor antagonists, and antacids to the widespread use of proton pump inhibitors, gastrointestinal toxicity continues to pose a significant limitation to their clinical utility. Several synthetic anti-ulcer drugs, including cimetidine, misoprostol, ranitidine, omeprazole, and esomeprazole, are commonly used to manage Non-Steroidal Anti-Inflammatory Drug (NSAID)-induced gastric ulcers. However, ethanol-induced gastric ulceration (EIGU) remains one of the most reliable experimental models for studying the pathogenesis of gastric mucosal injury. Ethanol exerts a direct cytotoxic effect on the gastric mucosa by impairing blood flow, thereby hindering the clearance of back-diffusing ethanol and depriving deeper glandular cells of nutrients and oxygen, ultimately resulting in cellular necrosis and tissue damage [14]. Ethanol readily penetrates the mucosa, reaches the submucosa, and dilates arterioles that regulate gastric blood flow [15]. Both ethanol and indomethacin inhibit prostaglandin synthesis and promote free radical formation, events regarded as central to the pathogenesis of gastric ulceration [16–18]. Understanding these mechanisms is crucial in the search for safer and more effective anti-ulcer therapies. Given the high cost and adverse effects of synthetic drugs, natural products

from medicinal plants believed to be efficacious, affordable, and relatively safe represent promising therapeutic alternatives.

Gastric ulceration is strongly driven by inflammation, oxidative stress, and disruption of mucosal integrity. Pro-inflammatory cytokines, particularly IL-6, IL-1 β , and TNF- α , play central roles in ulcer development by amplifying mucosal damage, promoting oxidative injury, and impairing epithelial healing. In this research, these inflammatory cytokines (TNF- α , IL-1 β , and IL-6) were significantly elevated in the gastric tissues of ethanol-induced ulcer models (group 2), confirming their role as key mediators of ulcerogenesis. The elevated cytokine levels stimulate neutrophil infiltration, promote the release of inflammatory mediators, and induce inducible nitric oxide synthase (iNOS), all of which aggravate mucosal damage [19]. However, in the extract-treated group (group 3 and 4), findings indicated that *Lonchocarpus sericeus* significantly reduced the levels of these inflammatory mediators, consequently decreasing tissue necrosis, limiting neutrophil-driven oxidative injury, and shortening the inflammatory phase. These effects collectively enhanced mucosal healing and support a potent anti-ulcer mechanism.

Biochemical markers of gastric secretions including pH, gastric volume, mucin concentration, and pepsin activity are widely used to assess gastric mucosal integrity following exposure to ulcerogenic agents [20]. A decrease in gastric pH, reflecting increased hydrogen ion concentration, is strongly associated with mucosal injury in ulcer models [21]. Similarly, depletion of gastric mucin, a critical defensive barrier, has been linked to ulcer pathogenesis. This erosion may result from endogenous factors such as pepsin and reactive oxygen species, or exogenous agents such as ethanol, all of which compromise mucosal protection [20].

In addition to these parameters, Na⁺/K⁺-ATPase activity serves as a critical biochemical marker in gastric ulcer studies, providing insight into mucosal integrity, electrolyte balance, oxidative injury, and overall cellular viability. Ulceration typically suppresses Na⁺/K⁺-ATPase activity due to membrane damage and oxidative stress, whereas restoration of this enzyme following treatment indicates improved membrane stability, effective cytoprotection, and accelerated healing. In this study, ethanol-induced ulceration markedly reduced Na⁺/K⁺-ATPase activity, consistent with membrane injury; however, *L. sericeus* treatment restored enzyme activity, further confirming its protective effect on the gastric mucosa.

In this study, ethanol administration caused a marked increase in ulcer index and gastric volume, effects largely attributed to excessive free radical generation and the inhibition of prostaglandin synthesis. The resultant decline in prostaglandin levels compromises gastric defenses by reducing mucosal protection and increasing acid secretion, thereby predisposing the stomach to ulcer formation findings consistent with previous reports [22–24]. Notably, ethanol induced gastric lesions more rapidly than indomethacin and required a longer healing period, suggesting that chronic or heavy alcohol intake may predispose individuals to ulcer disease in a manner comparable to indiscriminate NSAID use. The dosage of *Lonchocarpus sericeus* leaf extract administered in this study was determined based on outcomes from a preliminary toxicological evaluation, which established its safety margin and informed the selection of therapeutically effective concentrations. Pre-treatment with the extract significantly accelerated ulcer healing in ethanol-induced models. The extract effectively reduced pepsin activity, enhanced mucin secretion, and restored Na⁺/K⁺-ATPase activity, reflecting improved gastric mucosal

protection and membrane stability. These therapeutic actions collectively mitigated the cytotoxic effects of ethanol on the gastric epithelium. The pronounced increase in mucus production further underscored the gastroprotective potential of the extract. Importantly, the 200 mg/kg body weight dose produced the most notable healing effect, demonstrating strong therapeutic efficacy comparable to that of omeprazole.

5 Conclusion

The findings of this study indicate that *L. sericeus* leaf extract have protective effects against ethanol-induced gastric ulceration in the experimental model used. Administration of the extract was associated with changes in key gastric parameters, including gastric pH, volume, mucin content, and pepsin activity, with values tending toward normal physiological levels when compared with the untreated ulcer group. In addition, treatment with the extract was associated with reduced levels of pro-inflammatory cytokines, such as IL-16, IL-1 β , and TNF- α , suggesting a potential anti-inflammatory effect. Taken together, these observations suggest that *L. sericeus* leaf extract may possess both gastroprotective and anti-inflammatory properties. Further studies are required to identify the active compounds involved, evaluate the safety and efficacy of the extract in other experimental models and clinical settings.

Abbreviations

NSAIDs	Non-Steroid Anti-inflammatory Drug
PG	Prostaglandins
COX	Cyclooxygenase
ELL	Ethanol leaf extract of <i>Lonchocarpus sericeus</i>
TNF- α	Alpha Tumor Necrosis Factor
IL-6	Interleukin-1—6

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Author contributions

E.U.U: Conception, supervision, work, intellectual content development and as well sponsor. E. O. I.: Research conception, supervise, critical review. E. E. G.: Identification and collection of the plant. G. O.: Data acquisition and analysis. F. O. D.: Induction/treatment and data acquisition. A.T.T.: Induction/treatment process. All author reviewed the manuscript.

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Data availability

The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate

The research was carried out following the guidelines of the ethical regulation and guide for the care and use of laboratory animal of the Federal University of Technology, Akure, Nigeria. Approval was obtained from committee listed in the ethics statement (Center for Research and Development/Federal University of Technology, Akure) with approval number FUTA/CRD/EC/23/146.

Animal ethics

A total of forty (40) male Wistar rats, weighing between 150 and 240 g, were procured from a private animal holding facility named Temilade Rat Farm in Ogbomoso, Oyo State, Nigeria, for use in the ulceration study involving the leaf extract. Upon acquisition, the rats were housed under standard laboratory conditions, fed a standard laboratory diet, and provided water ad libitum throughout the experimental period following the ethical approval standard of The Federal University of Technology Akure, Ondo State, Nigeria.

Plant ethics

The fresh leaves were collected from wild *Lonchocarpus sericeus* (Senegal lilac) plant at a garden within the Federal University of Technology, Akure staff quarters, Nigeria, there was no licenced regarding the plant leaves collection because, the plant was not cultivated. The plant was identified and authenticated with a voucher specimen (accession number FUTA/020) deposited in the herbarium at Center for Research and Development (CERAD), Federal University of Technology, Akure Nigeria. The study was approved by Center for Research and Development/Federal University of Technology, Akure Ethics Committee. Plant collection was consistent with the Nagoya Protocol for biodiversity.

Consent for publication

Not applicable.

Competing interests

The authors declare no competing interests.

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