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EFFECTS OF METHANOLIC STEM BARK EXTRACT OF *FICUS PLATYPHYLLA* ON CASTOR OIL-INDUCED DIARRHOEA IN WISTAR RATS

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ABSTRACT

Diarrheal diseases are a significant global health challenge, necessitating the need for accessible and effective therapeutics. This study looked at the antidiarrheal and antimotility effects of the methanolic stem bark extract of *Ficus platyphylla*, a plant used in treating gastrointestinal disorders. The results of this study revealed that the extract dose-dependently, reduced diarrheal frequency and wet stool weight within four hours. Reductions in intestinal transit time, wet stool weight and diarrhoeal frequency were statistically significant when compared to control ($p < 0.005$). The high dose of the plant extract has greater efficacy when compared to Loperamide. The plant extract also demonstrated a marked, dose-dependent inhibition of intestinal transit, achieving over 60% reduction at the highest dose. These findings validate the traditional use of *Ficus p.* and also suggest that its bioactive components modulate intestinal secretion and motility.

KEYWORDS: Diarrhea, intestinal, motility, *Ficus p.*, Castor oil

INTRODUCTION

Diarrheal diseases remain a major global health burden, accounting for significant morbidity and mortality, particularly in Third World countries like Nigeria and other low-income regions where sanitation, nutrition, and access to healthcare remain limited. Diarrhea remains among the top ten causes of death worldwide, with children under five disproportionately affected (WHO, 2023). The condition is characterized by increased frequency, liquidity, and volume of stool resulting from disturbances in intestinal secretion, absorption, and motility. Central to its pathophysiology are disruptions of epithelial ion transport, mucosal inflammation, and accelerated gastrointestinal transit, all of which compromise the intestine's ability to maintain fluid and electrolyte balance (Farthing et al., 2020).

Current antidiarrheal medications, such as Loperamide, racecadotril, and oral rehydration solutions, provide symptomatic relief but remain limited due to inaccessibility, side effects, and reduced efficacy in secretory or infectious diarrhea. These limitations have strengthened the need to search for safer, affordable, plant-derived alternatives with multitarget mechanisms.

Medicinal plants remain integral to primary healthcare systems in Nigeria, as well as across Africa and Asia. An increasing body of evidence supports the pharmacological relevance of plant secondary metabolites, including flavonoids, tannins, saponins, and phenolic compounds, which help modulate intestinal motility, secretion, and microbial load. The potential of *Ficus p.* as a safer, more affordable, and readily available alternative to existing medications is a beacon of hope in the field of gastrointestinal treatments.

The genus *Ficus* (family Moraceae) is one of the most pharmacologically versatile plant groups, with many species reputed to be useful in the management of gastrointestinal disturbances. Recent studies have demonstrated that *Ficus* species possess antidiarrheal, antimicrobial, antioxidant, and anti-inflammatory properties, which are attributed to their rich phytochemical composition (Adegboye et al., 2022; Hassan et al., 2024). Extracts from *Ficus* stem bark have shown activity in reducing castor-oil-induced diarrhea, inhibiting intestinal secretion, and modulating smooth muscle activity. These golden effects of the plant are largely attributed to the presence of lupeol, glycosides, saponins, alkaloids, terpenoids, cis-vascenic acid, oleic acid, fucoside A and B, among others. Tannins in *Ficus p.* is reputed to enhance mucosal resistance, while the flavonoids present inhibit prostaglandin synthesis, and alkaloids suppress hypermotility (Kumar & Rajan, 2023).

Although there are several positive insights about the plant, the antidiarrheal potential of the methanolic stem bark extract of *Ficus p.* remains unexploited, particularly regarding its effects on both diarrheal output and intestinal motility. To evaluate these parameters, this study utilized robust physiological frameworks, namely the castor oil-induced diarrhea and charcoal meal transit models in rodents. Castor oil increases the release of ricinoleic acid, promoting intestinal secretion and propulsion, while the charcoal meal assay quantifies the extract's influence on peristaltic activity—two key mechanisms underlying diarrheal states. These models have been widely used in pharmacological research and are considered valid and reliable for evaluating the antidiarrheal effects of potential therapeutics (Awouafack et al., 2022).

Given the widespread traditional use of *Ficus* species for gastrointestinal disorders, the lack of experimental evidence for *Ficus p.* necessitates systematic investigation. This study, therefore, evaluates the antidiarrheal and antimotility effects of the methanolic stem bark extract of *Ficus p.* in Wistar rat models.

METHODOLOGY

- **Plant Collection, Identification, and Preparation of Extract**

Fresh stem bark of *Ficus p.* was collected from the wild in Ampang East, Kanke Local Government Area of Plateau State, Nigeria. The plant was collected during the rainy season (August, 2025). The plant was authenticated by a plant taxonomist in the Department of Botany at the University of Maiduguri, and a voucher specimen (Voucher No. FIC-2025-05) was deposited in the institutional herbarium for reference.

The stem bark samples were washed, shade-dried at room temperature (25–28 °C) for 14 days, and then pulverized using a porcelain pestle and mortar. Approximately 750 g of powdered material was macerated in 70% methanol (2.5 L) for 72 hours with intermittent agitation. The filtrate was obtained using Whatman No. 1 filter paper and concentrated under reduced pressure using a rotary evaporator at 40 °C. The resulting crude extract was dried to constant weight and stored in an airtight container at 4 °C until use. The percentage yield was calculated relative to the dry weight of the plant material.

- **Experimental Animals**

Adult male Wistar rats (150–180 g) were chosen as the animal model for this study due to their physiological similarities to humans in terms of gastrointestinal function. These rats were procured from the Animal House, Department of Physiology, University of Maiduguri. Animals were housed in polypropylene cages under standard laboratory conditions (12-h light/dark cycle, temperature 22–25 °C, relative humidity 50–60%) with free access to standard rat chow and potable water.

All animals were acclimatized for seven days before experimentation. This acclimatization period enabled the animals to adjust to the new environment, including the housing conditions and the researchers' handling, thereby minimizing stress and ensuring humane treatment throughout the study.

- **Ethical Approval**

All experimental protocols were done in accordance with the internationally accepted guidelines for the care and use of laboratory animals (NIH Publication No. 85–23, revised 2011) and were approved by the Animal Care and Use Committee (ACUC), University of Maiduguri (Approval No: ACUC-PHY-2025-017).

- **Acute Toxicity Study**

The acute toxicity potential of the extract was evaluated in rats according to the OECD Guideline 423 (Acute Toxic Class Method). Animals were observed for 24 hours to detect behavioral changes (piloerection, tremors, and salivation) and mortality, followed by daily observations for 14 days to assess safety and inform dose selection for pharmacological testing.

- **Experimental Design**

- **Castor oil-induced diarrhea model**

The method was adopted from Awouafack et al. (2022) with modifications. Rats were fasted for 18 hours with free access to tap drinking water that was withdrawn an hour before treatments in the study. Twenty (20) male Wistar rats were randomly allocated into four groups (n = 5 per group for each assay). Rats in Group I, Control received (distilled water, 10 mL/kg), while groups II and III

received 50 and 100 mg/kg of the plant extract respectively by intragastric intubation. The doses were selected based on the outcome of acute toxicity study. Loperamide, 3 mg/kg was given as standard drug. Thirty minutes after oral administration of the extract to rats in groups II, III and IV, or standard drug to group V, each rat in all the groups (I-IV) received castor oil (1 mL) to induce diarrhea.

➤ **Monitoring of Diarrheal Parameters**

Animals were placed singly in metabolic cages lined with pre-weighed blotting paper. For 4 hours, the following parameters were recorded. Time of onset of diarrhea, frequency of wet and total faecal output, and weight of diarrheal stools (wet faecal mass)

The percentage inhibition of diarrhea was calculated using stool emission frequency (SEF).

SEF = Total number of stool/ Time (4hours)

$I (\%) = \frac{\text{SMDC} - \text{SMDT}}{\text{SMDC}} \times 100$

Where I= inhibition;

SMDC = stool mass of diarrheal control;

SMDT = stool mass of diarrheal test extract (Yusuf et al., 2023)

All papers were weighed and replaced every hour to avoid overlapping contamination.

• **Gastrointestinal Motility (Charcoal Meal Transit) Assay**

Gastrointestinal transit was assessed using the modified standard charcoal meal method described by Adeniyi, et al., (2014) with modification.

➤ **Administration of test substances**

Rats were fasted for 18 hours, but were allowed to drink water. The extract of *Ficus p.* 25mg, 50mg and 100 mg/kg to groups II, III and IV respectively. Group V, received the Loperamide 3mg/kg orally. after thirty minutes, a charcoal meal (5% charcoal suspension in 10% gum acacia; 1 mL) was given to each animal in all the groups.

➤ **Assessment of intestinal transit**

After 30 minutes of intragastric administration of the charcoal meal, animals were euthanized humanely using cervical dislocation under light ether anesthesia. The small intestine, from the pylorus to the cecum, was excised and stretched on a clean board, measured, and recorded.

The intestinal transit distance was measured with metric ruler in centimetre.

• **Statistical Analysis**

Data analyses were performed using JMP version 11 software (SAS Institute Inc, Cary, NC). All values are expressed as mean $\pm$ standard error of the mean (SEM). Differences between groups were assessed using a one-way ANOVA followed by Dunnett's post hoc test for multiple comparisons. A p-value < 0.05 was considered statistically significant.

RESULTS

• **Acute Oral Toxicity of *Ficus platyphylla***

The median lethal dose (LD₅₀) of the methanolic stem bark extract of *Ficus platyphylla* via oral route was greater than 2000 mg/kg.

• **Effect of *Ficus platyphylla* Stem Bark Extract on Castor Oil–Induced Diarrhea**

➤ Diarrheal frequency

Intragastric administration of castor oil to the rats in this study resulted in diarrhea in the control group during the observation period. The frequency of diarrhea was reduced in a dose-dependent

manner upon administration of the plant extract. The highest level of inhibition was observed in the high-dose group (Figure 1). Both the high-dose extract and the standard drug (Loperamide) demonstrated comparable antidiarrheal activity.

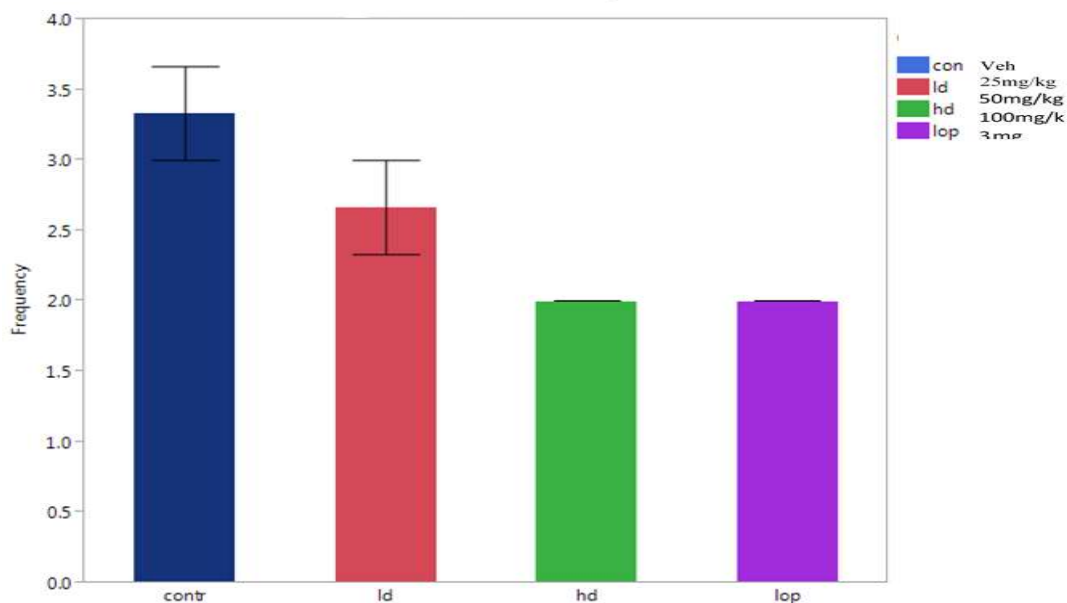


Figure 1. Effect of *Ficus platyphylla* Stem Bark Extract on Frequency of Diarrhea in Castor Oil–Induced Diarrhea in Wistar Rats

• Wet Faecal Weight After 4 Hours

A marked reduction in the weight of diarrheal stool was observed in extract-treated animals when compared to the control group (10.07 ± 0.42 g), the extract significantly reduced wet fecal weight at both low (2.87 ± 0.42 g; $p < 0.001$) and high dose (2.27 ± 0.42 g; $p < 0.001$), representing more than 70% inhibition of diarrheal mass. The high-dose extract demonstrated equivalent efficacy to the standard drug (2.27 ± 0.42 g).

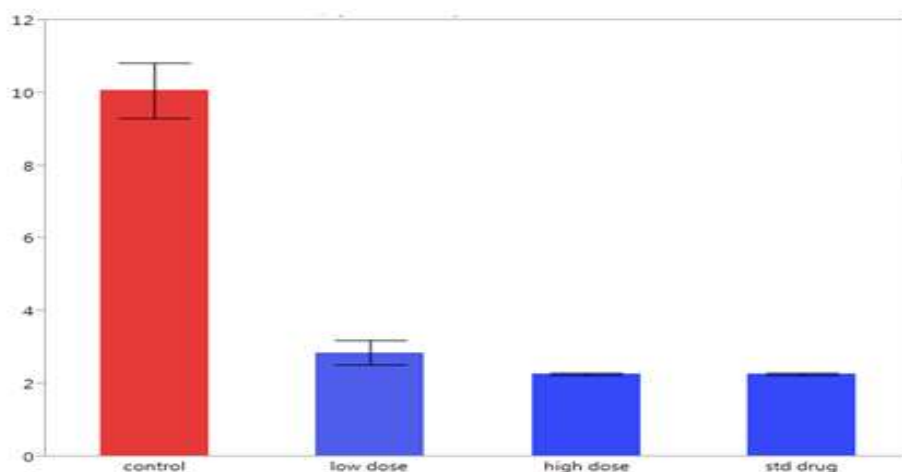


Figure 2. Effect of *Ficus platyphylla* Stem Bark Extract on Mean Wet Faecal Weight after 4 hours in Castor Oil-Induced Diarrhea in Wistar Rats

- **Effect of *Ficus platyphylla* Extract on Intestinal Motility (Charcoal Meal Transit)**

- **Intestinal Transit Length**

The methanolic extract of *Ficus platyphylla* showed a dose-dependent reduction in intestinal transit time, indicating significant antimotility activity (Figure 3). The control group exhibited the highest mean charcoal transit distance (61.5 ± 0.70 cm). Extract-treated groups demonstrated progressive inhibition: Low dose: 49.87 ± 0.70 cm, medium dose, 45.17 ± 0.70 cm and high dose, 22.33 ± 0.70 cm

The high-dose extract exhibited the greatest inhibition of intestinal propulsion, surpassing the standard drug group (40.67 ± 0.70 cm).

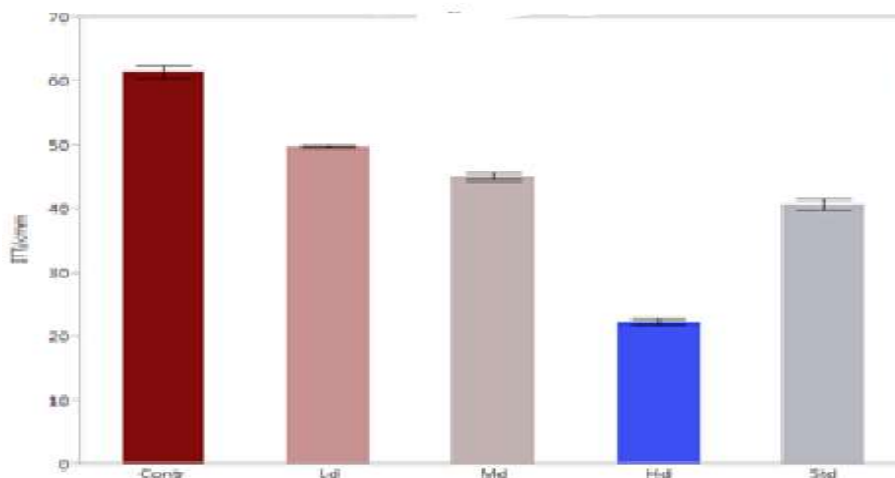


Figure 3. Effect of *Ficus platyphylla* Extract on Intestinal Motility (Charcoal Meal Transit Distance) in Wistar Rats

DISCUSSION

The methanolic stem bark extract of *Ficus platyphylla* was evaluated for acute toxicity in Wistar rats. The fixed dose method was used in accordance with OECD Test Guideline 420. Clinically related signs of toxicity, like tremors, convulsions, salivation, diarrhea, piloerection, sedation, or coma, were not observed. Behavioral changes such as locomotor activity, grooming, feeding, and water intake remained normal throughout the study. Results of this study suggest that the extract did not induce acute neurotoxic or systemic effects at the tested dose. There were no observable toxic effects or mortality. Based on the Globally Harmonized System (GHS) of classification, substances with LD₅₀ greater than 2000 mg/kg are considered to have low acute oral toxicity. The low acute toxicity profile in this study may be beneficial to the antidiarrheal and antimotility effects of *Ficus platyphylla* observed in the present study. Since treatment for diarrheal diseases involves repeated administration, the absence of acute toxicity at a high dose provides preliminary indication of a wide safety margin. Flavonoids and tannins may be responsible for the safety margin and gastrointestinal protective effects of the plant. On the whole, the results of the acute toxicity study support the ethnomedicinal use of *Ficus platyphylla* in gastrointestinal disorders and justify its further pharmacological evaluation and sub-chronic toxicity assessment.

This study also demonstrates that the methanolic stem bark extract of *Ficus platyphylla* has significant dose-dependent antidiarrheal and gastrointestinal antimotility activities *in vivo*. The castor oil-induced diarrhea and the charcoal meal transit test used in this study are validated physiological models. A dose-dependent reduction in stool output, diarrheal frequency, and intestinal propulsion observed in the study. These findings are in line with the ethnomedicinal use of *Ficus* species in managing gastrointestinal disorders across Africa and Asia

Ricinoleic acid in Castor oil triggers epithelial irritation, prostaglandin release, chloride ion over secretion, and increased intestinal motility, inducing diarrhea (Awouters et al., 1978). The extract's ability to significantly reduce diarrheal weight and frequency suggests the presence of certain phytoconstituents in *Ficus p.* that interfere with the secretory and inflammatory pathways. Recent phytochemical analyses of several *Ficus* species have revealed abundant flavonoids, tannins, terpenoids, and phenolic compounds known to inhibit prostaglandin synthesis, strengthen mucosal integrity, and suppress oxidative damage (Molefe-Kalonda et al., 2024). These bioactive constituents likely contribute to the anti-secretory effect observed in this study.

The extract also markedly suppressed gastrointestinal transit, with the highest dose reducing charcoal movement by more than 60%. This antimotility effect is consistent with smooth-muscle relaxation, possibly mediated via calcium-channel modulation, nitric-oxide signaling interference, or inhibition of excitatory enteric neurotransmitters. Similar mechanisms have been proposed in recent studies evaluating figs and related species for spasmolytic activity. For example, flavonoid-rich fractions of *Ficus racemosa* demonstrated significant inhibition of smooth-muscle contractions in isolated intestinal strips, attributed to L-type calcium channel blockade and reduced acetylcholine responsiveness (Prasad et al., 2023). In view of the similarity in phytoconstituents, the methanolic stem bark extract of *Ficus p* mechanism of actions may also be attributed to inhibition of L-type calcium channel in the gastrointestinal smooth muscle.

The findings of this study also agree with the clinical and public health context in which *Ficus* plants are traditionally used. Diarrhea remains a leading cause of morbidity in children under five globally, with Africa accounting for nearly 50% of diarrhea-related mortality in 2020 (Tantu et al., 2024). The World Health Organization has emphasized the value of safe, affordable plant-based therapies as a complement to oral rehydration solutions, particularly in resource-constrained

settings where synthetic antidiarrheals may be inaccessible (WHO, 2023). The present results, therefore, hold considerable translational value.

Recent studies highlight the antimicrobial and anti-inflammatory properties of *Ficus* extracts. For instance, *Ficus benjamina* bark fractions demonstrated potent inhibition of pathogenic bacteria implicated in infectious diarrhea, supporting their role in reducing luminal pathogen load (Díaz et al., 2025).

The antidiarrheal potentials observed in this study suggest the involvement of secretory and motility pathways, a multifaceted antidiarrheal approach with probably a synergistic interplay of phytochemicals acting on multiple components of intestinal physiology. Medicinal plants largely have multimodal efficacy, a characteristic that confers additional advantage over single-target synthetic agents.

CONCLUSION

The plant extract used in this study, the methanolic stem bark extract of *Ficus sp.*, exhibits significant antidiarrheal and antimotility properties in experimental rat models. By reducing stool output, suppressing diarrheal frequency, and markedly inhibiting intestinal transit, the extract demonstrates a strong therapeutic potential consistent with its ethnomedicinal use. Its effects likely arise from a combination of anti-secretory and anti-inflammatory smooth-muscle–modulating phytochemicals.

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• Conflicts of Interest

There were no conflicts of interest regarding the publication of this study. The research was conducted devoid of any potential conflict of interest.

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