

Original Research Article

Phytochemical and pharmacological evaluation of *Dennettia tripetala* stem bark extract as an antidiarrhoeal agent

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Abstract

Purpose: To evaluate the antidiarrhoeal activity of ethanol stem bark extract of *Dennettia tripetala* (ETEDT).

Methods: Antidiarrhoeal activity was evaluated using castor oil-induced (10 mL/kg orally) diarrhoea, enteropooling, and gastrointestinal transit models in mice, alongside Gas Chromatography-Mass Spectrometry (GC-MS) phytochemical profiling. Thirty mice, six per group, were treated orally with ETEDT (250, 500, and 1000 mg/kg), loperamide (2 mg/kg), or distilled water (control) before diarrhoeal induction. One hour after treatment, diarrhoea was induced by oral administration of castor oil (10 mL/kg orally).

Results: ETEDT significantly delayed onset of diarrhoea and reduced wet stool frequency and weight compared with control ($p < 0.05$) at 500 and 1000 mg/kg doses. The highest dose (1000 mg/kg) produced 82.20 % inhibition of diarrhoea, comparable to loperamide. The extract also significantly reduced intestinal fluid accumulation (46.34 % inhibition) and suppressed intestinal transit (84.11 % inhibition) in a dose-dependent manner ($p < 0.05$) in comparison with control. GC-MS analysis identified bioactive compounds including eugenol, caryophyllene derivatives, phytol, fatty acid esters, and phytosterols.

Conclusion: These findings demonstrate that ETEDT possesses significant antimotility and antisecretory effects, supporting its traditional use and highlighting its potential as a source of novel antidiarrhoeal agents.

Keywords: Antidiarrhoeal activity, *Dennettia tripetala*, Enteropooling, Gastrointestinal transit, GC-MS profiling

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INTRODUCTION

Diarrhoeal diseases remain among the leading causes of morbidity and mortality worldwide, particularly affecting populations in developing countries where sanitation, potable water supply, and access to effective treatment remain limited [1]. According to global health estimates,

diarrhoea accounts for millions of diarrhoea cases annually and remains a significant contributor to childhood mortality, largely due to dehydration, electrolyte imbalance, and malnutrition resulting from prolonged intestinal fluid loss [2]. Although synthetic antidiarrhoeal agents such as loperamide and diphenoxylate are clinically effective, their availability and

affordability remain challenges in resource-limited settings, and prolonged use may be associated with undesirable effects, including constipation, abdominal discomfort, and intestinal obstruction [2].

Traditional medicinal plants continue to serve as primary therapeutic resources for gastrointestinal disorders in many African communities [2]. Among these, *Dennettia tripetala* (*D. tripetala*) G. Baker (family Annonaceae), commonly known as pepper fruit in English and Ata igberi or Ata igbere by the Yoruba [3], occupies an important ethnomedicinal position. It is a woody shrub or small tree in the *Annonaceae* family, native to the tropical rainforest regions of West and West-Central Africa, particularly Nigeria. It is highly valued for its edible fruits, which have a distinct, sharp, and pungent peppery taste [3]. The plant is widely distributed across West Africa and is commonly consumed as both a spice and medicinal fruit. Traditional practitioners utilise various parts of the plant—including fruits, seeds, leaves, and stem bark—for treatment of cough, fever, toothache, stomach upset, and diarrhoeal conditions [4].

Scientific investigations have reported antimicrobial, antioxidant, analgesic, anti-inflammatory, and gastroprotective properties of extracts derived from bark and leaves of *D. tripetala* [5-6]. These pharmacological properties suggest possible mechanisms through which the plant may exert antidiarrhoeal effects, particularly by modulating intestinal motility, secretion, and inflammatory responses [3]. However, despite widespread traditional claims, comprehensive evaluation of the ethanol stem bark extract remains limited.

Persistent dependence on plant-based remedies necessitates scientific validation to ensure safety, efficacy, and reproducibility. Therefore, the present study aimed to evaluate the antidiarrhoeal effects of ethanol stem bark extract of *Dennettia tripetala* using standard models and to characterise phytochemical constituents responsible for potential biological activity using Gas Chromatography-Mass Spectrometry (GC-MS) analysis.

EXPERIMENTAL

Plant collection and authentication

Stem bark of *Dennettia tripetala* was collected on 12 August 2024 from a local botanical garden in Tanzania (3°21'00" S, 37°20'00" E) and authenticated by a qualified taxonomist. A voucher specimen was deposited at the

Department of Botany, Kampala International University, with the reference number 112765. Collected bark materials were washed, air-dried at ambient temperature to preserve thermolabile compounds, and pulverised into coarse powder using a mechanical grinder.

Preparation of ethanol extract

Pulverised plant material (7.2 kg) was subjected to Soxhlet extraction using analytical-grade 70% ethanol as solvent. Extraction was continued until complete exhaustion of plant constituents. The extract was filtered and concentrated under reduced pressure using a rotary evaporator at a controlled temperature to prevent compound degradation. The crude extract obtained was weighed to determine percentage yield and stored at 4 °C until use.

Animals

Healthy adult male Swiss albino mice weighing between 20 and 30 g were obtained from Durasallam laboratory animal facility in Tanzania. Animals were maintained under standard laboratory conditions with controlled temperature, humidity, and light cycles. Standard feed and water were provided *ad libitum*, and animals were acclimatised for 7 days before experiment. The Animal Ethics Committee of the College of Health Sciences, Kampala International University, Tanzania, approved the use of animals in this study (KIU/2025/11). Mice (n = 6) were randomly assigned to different treatment groups. All procedures complied with institutional animal care guidelines [7].

Castor oil-induced diarrhoea

Animals were randomly divided into groups of six mice each receiving distilled water (control), standard drug loperamide (2 mg/kg), or extract doses of 250, 500, and 1000 mg/kg orally. The dose administered was determined from available literature [8]. One hour after treatment, diarrhoea was induced by oral administration of castor oil. All mice received 10 mL/kg of castor oil orally and white blotting paper was lined under each of their cages.

Diarrhoea was considered the presence of stool or any fluid material that stained the blotting paper placed under every cage lined with the floor. When the faeces became uniform, muddy, or watery, it was considered diarrhoea. Time taken before the first defecation was considered the 'latent period'. The total number of faecal output as well as the diarrhoeic faeces (muddy or watery faeces) excreted by the animal for a

period of 4 h after the latent period was determined [8].

Gastrointestinal transit test

To evaluate intestinal motility, treated animals, as previously described in the castor oil model, received charcoal meal suspension orally. After a defined interval, animals were anaesthetised with diethyl ether, and the small intestine was removed. The distance travelled by charcoal relative to total intestinal length was measured to calculate the percentage intestinal transit [8].

Enteropooling test

To assess intestinal secretion, animals were treated as previously described prior to castor oil administration. After sacrifice, the intestines were isolated, and accumulated intestinal contents were measured by weight and volume to determine inhibition of fluid accumulation [8].

GC–MS analysis

A portion of ethanol extract was subjected to GC–MS analysis using a capillary column and electron ionisation detection. Identification of compounds was achieved by comparison with spectral libraries such as NIST database. Relative percentage composition was calculated from peak area integration [9].

Statistical analysis

Data obtained from diarrhoeal, transit, and enteropooling were expressed as mean $\pm$ standard error of mean (SEM). Statistical comparisons between groups were performed using one-way analysis of variance (ANOVA) followed by Tukey's post hoc test to determine intergroup differences. Differences were considered statistically significant at $p < 0.05$. Dose-dependent responses were evaluated to determine pharmacological activity trends.

RESULTS

Effect of *Dennettia tripetala* extract on castor oil-induced diarrhoea

Administration of castor oil produced profuse diarrhoea in control animals, characterised by early onset and high frequency of wet stools. Treatment with ethanol stem bark extract of *D. tripetala* significantly ($p < 0.05$) delayed onset of diarrhoea and reduced both frequency and weight at 500 and 1000 mg/kg of wet faeces compared with the control group.

A dose-dependent reduction in diarrhoeal severity was observed, with higher extract doses producing greater inhibition. Statistical analysis showed significant reductions in wet stool frequency and faecal output in treated groups ($p < 0.05$) relative to control animals, confirming antidiarrhoeal activity of the extract. Result also showed that plant extract produced almost equal effect as that of the group that received loperamide (Table 1).

Effect of extract on gastrointestinal transit (charcoal meal test)

Control animals showed rapid intestinal transit, indicated by extensive progression of charcoal meal along the intestine in a dose-dependent manner. Extract-treated groups demonstrated significant reduction in charcoal meal movement, indicating inhibition of intestinal motility.

The inhibitory effect increased with dose, suggesting pharmacological modulation of gastrointestinal peristalsis. Animals receiving higher extract doses exhibited significantly lower intestinal transit indices compared with controls ($p < 0.05$). The standard drug group showed the greatest inhibition, although the highest extract dose approached similar levels of effect (Table 3).

Effect of extract on castor oil-induced enteropooling

Castor oil administration caused marked intestinal fluid accumulation in control animals, reflected by increased intestinal content weight and volume. Pretreatment with extract significantly ($p < 0.05$) reduced intestinal fluid accumulation compared with control animals. Dose-dependent inhibition of intestinal secretion was observed, with higher extract doses producing stronger antisecretory effects. Statistical analysis demonstrated significant reductions in both intestinal content volume and weight ($p < 0.05$) relative to controls (Table 2). At 1000 mg/kg dose extract produced effect that is comparable to the group that received loperamide.

GC–MS phytochemical composition of ethanol stem bark extract

The GC–MS analysis revealed multiple bioactive compounds, including phenolic derivatives, terpenoids, fatty acid esters, and phytosterols. Major constituents identified were eugenol, caryophyllene derivatives, phytol, fatty acid esters, and sterol compounds (Table 4).

Table 1: Antidiarrhoeal effects of ethanol stem bark of *Dennettia tripetala* on castor oil-induced diarrhoeal model in mice

Treatment/ Dose	Onset of diarrhoea (Min)	No of wet faeces	Total number of faeces	Average weight of wet faeces (g)	Average weight of total faeces (g)	Inhibition of diarrhoea (%)	Weight of wet faeces (%)	Weight of total faeces (%)
Distilled water 10 mL/kg	73.23±6.77	8.54±3.22	9.17±1.28	0.42±0.05	0.46±0.06			
Loperamide 2 mg/kg	178.69±27.62*	2.63±0.50*	3.33±0.92*	0.09±0.03*	0.12±0.04*	69.20	21.43	26.09
ETEDT 250 mg/kg	104.33±6.14	6.17±0.60	6.67±0.49	0.29±0.03	0.31±0.04	27.26	69.05	67.39
ETEDT 500 mg/kg	143.00±25.07*	4.33±0.77*	4.90±1.05	0.22±0.05*	0.24±0.06*	46.56	52.38	52.17
ETEDT 1000 mg/kg	180.60±21.66*	1.52±0.91*	3.50±1.23*	0.07±0.06*	0.10±0.06*	82.20	16.67	21.74

Values are mean ± SEM (n = 6); analysis was performed using one-way ANOVA followed by Tukey post hoc test; a compared with control values; $p < 0.05$, ETEDT = Ethanol extract of *D. tripetala*

Table 2: Effects of *Dennettia tripetala* ethanol stem bark on gastrointestinal fluid accumulation in mice

Treatment/Dose	Volume of intestinal contents (mL)	Inhibition (%)	Weight of intestinal contents (g)	Inhibition (%)
Distilled water 10 mL/kg	0.82±1.65		1.10±0.06	
Loperamide 2 mg/kg	0.46±0.09*	43.90	0.70±0.04*	36.36
ETEDT 250 mg/kg	0.64±0.04	21.95	0.94±0.05	14.54
ETEDT 500 mg/kg	0.51±0.09	37.80	0.80±0.06	27.27
ETEDT 1000 mg/kg	0.45±0.03*	46.34	0.60±0.08*	45.45

Values are mean ± SEM (n = 6); analysis was performed using one-way ANOVA followed by Tukey post hoc test; $p < 0.05$. ETEDT = Ethanol extract of *D. tripetala*

Table 3: Effect of *D. Tripetala* on castor oil-induced intestinal transit in mice

Treatment/ Dose	Length of small intestine (cm)	Distance moved by the charcoal meal (cm)	Peristaltic index (%)	Inhibition (%)
Distilled water 10 mL/kg	57.98±0.67	49.54±1.09	82.12±0.99	
Loperamide 2 mg/kg	58.23±0.87	12.09±0.57	22.56±1.23	79.65
ETEDT 250 mg/kg	56.43±1.43	31.87±1.32	45.13±1.00	39.41
ETEDT 500 mg/kg	58.67±0.54	19.87±3.33	38.51±0.43	54.29
ETEDT 1000 mg/kg	57.18±1.59	10.46±0.63	20.69±0.67	84.11

Values are mean ± SEM (n = 6); analysis was performed using one-way ANOVA followed by Tukey post hoc test; a compared with control values, $p < 0.05$. ETEDT = Ethanol extract of *D. tripetala*

DISCUSSION

The present investigation provides evidence supporting the antidiarrhoeal activity of ethanol stem bark extract of *Dennettia tripetala*. Diarrhoea induced by castor oil remains one of the most widely accepted models for evaluating antidiarrhoeal agents because it mimics secretory diarrhoea observed in humans. Castor oil undergoes hydrolysis in the intestine to produce ricinoleic acid, which stimulates intestinal secretion and motility through prostaglandin release and irritation of intestinal mucosa [13]. Consequently, inhibition of castor oil-induced diarrhoea indicates potential interference with these pathological processes. Administration of ethanol stem bark extract

significantly delayed onset of diarrhoea and reduced frequency and weight of wet stools, indicating protective effects against intestinal hypersecretion and motility. These findings suggest that the extract contains bioactive constituents capable of counteracting ricinoleic acid-induced intestinal disturbances. The dose-dependent nature of the extract's inhibition further indicates pharmacological relevance of the extract.

The charcoal meal gastrointestinal transit test demonstrated significant reduction in intestinal motility following extract administration. Enhanced intestinal motility contributes to diarrhoeal progression by reducing time available for fluid and electrolyte absorption [14].

Table 4: GC–MS Analysis of Ethanol Stem Bark Extract of *Dennettia tripetala*

Peak No.	Compound identified	Retention Time (min)	Molecular Formula	Molecular weight (g/mol)	Relative abundance (%)	Reported biological relevance
1	Phenol, 2-methoxy-4-(2-propenyl) (Eugenol)	12.41	C ₁₀ H ₁₂ O ₂	164	18.5	Antioxidant, antimicrobial [10]
2	Caryophyllene	14.32	C ₁₅ H ₂₄	204	12.7	Anti-inflammatory activity [11]
3	Caryophyllene oxide	15.10	C ₁₅ H ₂₄ O	220	9.8	Anti-inflammatory, cytoprotective [11]
4	Hexadecanoic acid ethyl ester	16.85	C ₁₈ H ₃₆ O ₂	284	14.3	Antioxidant, antimicrobial [10]
5	9,12-Octadecadienoic acid (linoleic acid) ethyl ester	17.92	C ₂₀ H ₃₆ O ₂	308	11.6	Anti-inflammatory activity [12]
6	Octadecanoic acid ethyl ester	18.34	C ₂₀ H ₄₀ O ₂	312	8.2	Membrane stabilizing property [11]
7	Phytol	19.05	C ₂₀ H ₄₀ O	296	10.9	Antioxidant, anti-inflammatory [10]
8	Squalene	20.44	C ₃₀ H ₅₀	410	6.1	Antioxidant, chemoprotective [12]
9	Stigmasterol	22.76	C ₂₉ H ₄₈ O	412	4.5	Anti-inflammatory, lipid-lowering [12]
10	β-Sitosterol	23.15	C ₂₉ H ₅₀ O	414	3.4	Anti-inflammatory activity [12]

Therefore, inhibition of transit facilitates restoration of fluid balance by allowing increased absorption within intestinal mucosa. Comparable suppression observed with standard drug treatment confirms that the extract exhibits antimotility properties.

Similarly, the enteropooling model revealed that extract treatment reduced intestinal fluid accumulation. Diarrhoeal conditions are often characterised by excessive secretion of electrolytes and fluids into intestinal lumen [4]. Reduction of enteropooling indicates antisecretory activity, which may involve inhibition of prostaglandin synthesis or modulation of ion transport mechanisms within intestinal epithelium. Combined antimotility and antisecretory actions therefore explain the overall antidiarrhoeal efficacy observed.

Phytochemical analysis through GC–MS revealed several bioactive compounds, including phenolic derivatives, terpenoids, fatty acid esters, and phytosterols. Phenolic compounds such as eugenol possess known antimicrobial and anti-inflammatory activities that may reduce intestinal inflammation and microbial load contributing to diarrhoea [1]. Caryophyllene and its oxide derivatives have demonstrated anti-inflammatory and analgesic properties, which may mitigate intestinal irritation caused by castor oil metabolites [15].

Fatty acid esters detected in the extract may contribute to membrane stabilisation and modulation of inflammatory mediators, thereby enhancing intestinal barrier integrity [16]. Phytol and phytosterols identified are recognised for antioxidant and anti-inflammatory properties, which help protect intestinal tissues from oxidative and inflammatory damage [17].

Diarrhoeal diseases often involve interactions between infectious agents, intestinal inflammation, and oxidative stress [18]. Therefore, the presence of compounds with antimicrobial and antioxidant activity further supports the therapeutic potential of the extract. Reduction of oxidative stress may improve epithelial recovery and reduce mucosal damage associated with diarrhoeal episodes.

Traditional use of *Dennettia tripetala* in treating gastrointestinal disturbances is therefore scientifically justified by the present findings. Importantly, stem bark extraction offers an alternative plant part utilisation beyond fruits commonly consumed, thereby expanding medicinal applications of the plant.

Comparable activity between highest extract dose and standard drug suggests strong therapeutic potential; however, unlike synthetic drugs that act via single mechanisms, plant extracts may produce combined pharmacological effects due to multiple constituents acting

synergistically. Such synergy may enhance efficacy while potentially reducing adverse effects.

Nevertheless, crude extracts contain complex mixtures, and further studies are required to isolate and characterise specific active compounds responsible for observed biological activity. Toxicological studies are also necessary to establish long-term safety, dosage optimisation, and potential drug interactions.

Overall, the study bridges traditional knowledge with scientific evidence, demonstrating that ethanol stem bark extract of *Dennettia tripetala* possesses pharmacological properties capable of reducing diarrhoeal symptoms through modulation of intestinal secretion and motility. Continued investigation into this plant may contribute to development of affordable and effective antidiarrhoeal therapies, particularly beneficial in regions heavily reliant on herbal medicine.

CONCLUSION

The ethanol stem bark extract of *Dennettia tripetala* exhibits significant antidiarrhoeal activity through inhibition of intestinal secretion and motility. GC–MS analysis revealed multiple bioactive phytoconstituents that may contribute to these effects. The findings validate the traditional use of the plant in managing diarrhoeal conditions and suggest its potential for development as a natural antidiarrhoeal agent. Further studies focusing on isolation of active compounds and mechanistic evaluations are recommended.

DECLARATIONS

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Ethics approval

The Animal Ethics Committee of the College of Health Sciences, Kampala International University, Tanzania, approved the use of animals in this study (KIU/2025/11)

Use of Artificial intelligence/Large language models

The authors confirm that AI-based tools were used solely for language editing and manuscript polishing purposes (e.g., grammar, phrasing, and

clarity). No AI tools were used to generate content, interpret data, or influence study design, results, or conclusions. All intellectual contributions, study analyses, and interpretations reported in the manuscript are the original work of the authors.

Availability of data and materials

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

Conflict of interest

No conflict of interest is associated with this work.

Contribution of authors

We declare that this work was done by the author(s) named in this article, and all liabilities pertaining to claims relating to the content of this article will be borne by the authors. JOS and OAM conducted the actual study, carried out the statistical analysis, and wrote the manuscript. JOS was involved in developing the idea, designing the study, and writing the manuscript. OAM was involved in developing the idea and designing the study. All authors approved the final version of the manuscript.

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