RESEARCH PAPER

In Vitro Anti-Inflammatory and Antibacterial Activities of *Crateva adansonii* Fruit Extracts

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Abstract

Crateva adansonii is a medicinally significant plant utilized in various traditional therapies. This study evaluated the in vitro anti-inflammatory and antibacterial activities of the fruit extracts of *Crateva adansonii*. The ethanolic extract of the fruit was analyzed for anti-inflammatory potential using albumin denaturation, antiproteinase action, and anti-lipoxygenase activity assays. Concurrently, the antibacterial efficacy of both ethanolic and chloroform extracts was tested against five bacterial strains—*Staphylococcus aureus*, *Bacillus subtilis*, *Escherichia coli*, *Pseudomonas aeruginosa*, and *Klebsiella pneumoniae*—utilizing the agar well diffusion method and minimum inhibitory concentration (MIC) evaluations. Results demonstrated that the ethanolic extract exhibited significant, concentration-dependent anti-inflammatory activity, achieving maximum inhibitions of 62.24% in albumin denaturation, 64.13% in proteinase action, and 72.68% in lipoxygenase activity at 500 µg/mL. Furthermore, the ethanolic extract showed superior antibacterial activity compared to the chloroform extract across all tested strains. The highest zone of inhibition (18.7 mm) and lowest MIC (6.25 mg/mL) were recorded against *Bacillus subtilis*, indicating higher susceptibility of Gram-positive organisms. These findings substantiate the therapeutic potential of *Crateva adansonii* fruit extracts in managing inflammation and bacterial infections.

Keywords: *Crateva adansonii*, anti-inflammatory, antibacterial, minimum inhibitory concentration, lipoxygenase, albumin denaturation.

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1. Introduction

Inflammation is a complex biological response of vascular tissues to harmful stimuli such as pathogens, damaged cells, or irritants, serving as a protective mechanism that involves immune cells, blood vessels, and molecular mediators (Chen et al., 2018). While acute inflammation is essential for host defense and tissue repair, chronic inflammation contributes to the pathogenesis of numerous diseases including arthritis, cardiovascular disorders, diabetes, neurodegenerative conditions, and cancer (Furman et al., 2019). The global burden of chronic inflammatory diseases has driven extensive research into safe and effective anti-inflammatory agents. Conventional therapies primarily rely on non-steroidal anti-inflammatory drugs (NSAIDs) and corticosteroids, which are associated with significant adverse effects including gastrointestinal ulceration, cardiovascular complications, and immunosuppression (Wongrakpanich et al., 2018). Consequently, there is growing interest in plant-derived natural products as alternative or adjunctive therapeutic agents with favorable safety profiles (Atanasov et al., 2021; Newman & Cragg, 2020).

Similarly, the escalating crisis of antimicrobial resistance (AMR) has emerged as one of the most pressing public health threats of the twenty-first century (Murray et al., 2022). The overuse and misuse of antibiotics have accelerated the emergence of multidrug-resistant bacterial strains, rendering many conventional antibiotics increasingly ineffective (Ventola, 2015). Gram-positive pathogens such as methicillin-resistant *Staphylococcus aureus* (MRSA) and Gram-negative organisms including extended-spectrum beta-lactamase (ESBL)-producing *Escherichia coli* and *Klebsiella pneumoniae* pose particular challenges in clinical settings (De Oliveira et al., 2020). The World Health Organization has

identified AMR as a global health priority, emphasizing the urgent need for novel antimicrobial agents with diverse mechanisms of action (WHO, 2021). Medicinal plants have historically served as a rich source of antimicrobial compounds, and recent reviews have highlighted their potential in combating drug-resistant infections (Álvarez-Martínez et al., 2021; Egbuna et al., 2021).

Crateva adansonii DC. (family Capparaceae) is a medicinal plant widely distributed across tropical regions of Africa and Asia, where it has been traditionally employed for the management of various ailments including inflammatory conditions, infectious diseases, fever, malaria, rheumatic pains, and snakebites (Ahama-Esseh et al., 2017; Pervaiz et al., 2022). Phytochemical investigations have revealed the presence of diverse bioactive constituents including flavonoids, saponins, alkaloids, terpenoids, polyphenols, and cardiac glycosides in different parts of the plant (Pervaiz et al., 2022; Nounagnon et al., 2018). Notable isolated compounds include daucosterol, lupeol, phytol, and pyropheophorbide A, with lupeol demonstrating significant analgesic and anti-inflammatory potential (Rathinavel et al., 2021; Pervaiz et al., 2022). The leaves of *C. adansonii* have been reported to be rich in protein (26.09 g/100 g dry matter), lipids, minerals, and secondary metabolites with high antioxidant capacity (Roamba et al., 2025).

Previous pharmacological studies have documented various biological activities of *C. adansonii* extracts, including analgesic, antiarthritic, antibacterial, antifungal, antimalarial, antioxidant, and anticancer properties (Pervaiz et al., 2022). Ahama-Esseh et al. (2017) demonstrated that leaf extracts of *C. adansonii* exhibited potent anti-inflammatory effects on *S. aureus*-infected human keratinocytes by reducing the expression and production of pro-inflammatory cytokines IL-6, IL-8, and TNF-α. Additionally, antibacterial activity has been reported for leaf and stem bark extracts against various pathogenic bacteria, with stem extracts showing particularly high efficacy against *S. aureus* (Agboke et al., 2021; Ogunleye et al., 2024). Despite these promising findings, the fruit of *C. adansonii* remains relatively understudied compared to its leaves and bark.

The anti-inflammatory potential of natural products is commonly evaluated through *in vitro* assays targeting key inflammatory pathways. Protein denaturation inhibition assays are widely used to assess anti-inflammatory activity, as denaturation of tissue proteins is associated with inflammatory and arthritic conditions (Umapathy et al., 2020). Protease inhibitors play a crucial role in inflammation by preventing the breakdown of tissue proteins and the release of inflammatory mediators (Bhatt et al., 2022). Lipoxygenase (LOX) enzymes catalyze the formation of leukotrienes from arachidonic acid, which are potent mediators of inflammation, and their inhibition represents an important therapeutic strategy (Räder et al., 2023). Natural products that inhibit these pathways offer potential advantages over conventional NSAIDs by targeting multiple inflammatory mediators simultaneously (Dey et al., 2022).

Antibacterial activity assessment through agar well diffusion and broth microdilution methods remains the gold standard for evaluating the antimicrobial potential of plant extracts (Balouiri et al., 2016). The agar well diffusion method provides qualitative information on antibacterial activity through zones of inhibition, while minimum inhibitory concentration (MIC) determination offers quantitative data on the potency of extracts against specific bacterial strains (CLSI, 2018). The differential susceptibility of Gram-positive and Gram-negative bacteria to plant extracts is often attributed to structural differences in their cell walls, with the outer membrane of Gram-negative bacteria serving as an effective permeability barrier (Breijyeh et al., 2020).

Given the ethnomedicinal importance of *C. adansonii* and the limited scientific data on its fruit, the present study was undertaken to evaluate the *in vitro* anti-inflammatory and antibacterial activities of *C. adansonii* fruit extracts. Specifically, the study aimed to (i) assess the anti-inflammatory potential through protein denaturation inhibition, antiproteinase, and anti-lipoxygenase assays; (ii) evaluate antibacterial activity against clinically relevant Gram-positive and Gram-negative bacterial strains using agar well diffusion and MIC determination; and (iii) compare the efficacy of ethanolic and chloroform fruit extracts to provide a comprehensive understanding of the therapeutic potential of this underutilized plant part.

2. Materials and Methods

2.1 Chemicals, Drugs and Instruments

All chemicals and reagents used were of analytical grade. Bovine serum albumin, trypsin, casein, linoleic acid, lipoxidase, perchloric acid and borate buffer were used for the in vitro anti-inflammatory assays, with diclofenac, aspirin and indomethacin as reference standards. Nutrient agar and nutrient broth were used for bacterial culture, with dimethyl sulfoxide (DMSO) as the extract solvent and ciprofloxacin as the reference antibacterial standard; resazurin/2,3,5-triphenyltetrazolium chloride (INT) was used as a colorimetric growth indicator. Instrumentation included a UV-visible spectrophotometer, autoclave, incubator, hot-air oven, digital electronic balance, pH meter, cooling centrifuge and Soxhlet extraction apparatus.

2.2 Plant Material and Preparation of Extracts

Fruits of *Crateva adansonii* were collected from the Sonepat region of Haryana, India, and authenticated at the School of Science, Sonepat (Haryana). The fruit was dried, size-reduced to a coarse powder (sieve no. 36), and subjected to continuous hot extraction with solvents of increasing polarity — petroleum ether, chloroform and ethanol — in a Soxhlet apparatus, with intermediate drying of the marc at 50°C between solvents. The extracts were concentrated to dryness on a water bath, weighed and stored in an airtight container. The ethanolic extract of *Crateva adansonii* fruit (EECA/CAE) was used for the in vitro anti-inflammatory assays, and the ethanolic and chloroform fruit extracts were used for the antibacterial evaluation.

2.3 In Vitro Anti-Inflammatory Activity

2.3.1 Inhibition of Albumin (Protein) Denaturation

Inhibition of protein denaturation was assessed following Mizushima et al. and Sakat et al., with minor modifications. The reaction mixture consisted of the ethanolic extract of *Crateva adansonii* fruit (100-500 µg/mL) and 1% aqueous bovine albumin, with the pH adjusted using a small amount of 1 N HCl. Samples were incubated at 37°C for 20 minutes and then heated to 51°C for 20 minutes; after cooling, turbidity was measured at 660 nm. Diclofenac (100 µg/mL) served as the reference standard. Percentage inhibition of protein denaturation was calculated as: % inhibition = [(Abs control − Abs sample) × 100] / Abs control.

2.3.2 Antiproteinase Action

Antiproteinase activity was assessed by a modification of the method of Oyedepo et al. and Sakat et al. The 2 mL reaction mixture contained 0.06 mg trypsin, 1 mL of 20 mM Tris-HCl buffer (pH 7.4), and 1 mL of extract at concentrations of 100-500 µg/mL. The mixture was incubated at 37°C for 5 minutes, after which 1 mL of 0.8% (w/v) casein was added and incubation continued for a further 20 minutes. The reaction was arrested with 2 mL of 70% perchloric acid, the resulting cloudy suspension was centrifuged, and the absorbance of the supernatant was read at 210 nm against a buffer blank. Aspirin (100 µg/mL) served as the reference standard. Percentage inhibition was calculated as: % inhibition = [(Abs control − Abs sample) × 100] / Abs control.

2.3.3 Anti-Lipoxygenase Activity

Anti-lipoxygenase activity was determined using linoleic acid as substrate and lipoxidase as enzyme (Shinde et al.). Test samples (100-500 µg/mL) were dissolved in 0.25 mL of 2 M borate buffer (pH 9.0), combined with 0.25 mL of lipoxidase solution (20,000 U/mL), and incubated at 25°C for 5 minutes. Linoleic acid solution (1.0 mL, 0.6 mM) was then added and the absorbance measured at 234 nm. Indomethacin (100 µg/mL) served as the reference standard. Percentage inhibition was calculated as: % inhibition = [(Abs control − Abs sample) / Abs control] × 100.

2.4 Antibacterial Activity

2.4.1 Test Microorganisms

Antibacterial activity was evaluated against two Gram-positive strains (Staphylococcus aureus and Bacillus subtilis) and three Gram-negative strains (Escherichia coli, Pseudomonas aeruginosa and Klebsiella pneumoniae). Cultures were maintained and sub-cultured on nutrient agar slants prior to use.

2.4.2 Preparation of Inoculum

Each bacterial strain was inoculated into nutrient broth and incubated at 37°C for 18-24 hours. Turbidity of the resulting culture was adjusted to the 0.5 McFarland standard (~1.5×10^8 CFU/mL) with sterile normal saline immediately prior to inoculation of the test medium.

2.4.3 Agar Well Diffusion Method

Antibacterial activity was determined by the agar well diffusion method (Bauer et al., 1966). Sterile nutrient agar plates were uniformly seeded with the standardised bacterial suspension using a sterile cotton swab. Wells of 6 mm diameter were punched using a sterile cork borer, and the ethanolic and chloroform extracts (50, 100 and 200 mg/mL, dissolved in DMSO) were loaded into the wells. Ciprofloxacin (10 µg/well) served as the positive control and DMSO alone as the negative control. Plates were incubated at 37°C for 24 hours and the zone of inhibition around each well was measured in millimetres.

2.4.4 Determination of Minimum Inhibitory Concentration (MIC)

The MIC of the extract showing the most promising zone of inhibition was determined by the broth micro-dilution method. Serial two-fold dilutions of the extract were prepared in nutrient broth in a 96-well microtitre plate, inoculated with the standardised bacterial suspension, and incubated at 37°C for 24 hours. MIC was recorded as the lowest extract concentration showing no visible turbidity/bacterial growth, confirmed with resazurin/INT dye as a colorimetric growth indicator.

2.5 Statistical Analysis

All data are expressed as Mean ± SEM (n = 3 for the in vitro assays, performed in triplicate). Dose-response data were used to calculate percentage inhibition at each concentration relative to control. A probability value of $p < 0.05$ was considered statistically significant.

3. Results

3.1 In Vitro Anti-Inflammatory Activity

3.1.1 Inhibition of Albumin Denaturation

The ethanolic extract of *Crateva adansonii* fruit (CAE) produced a concentration-dependent inhibition of heat-induced albumin denaturation, increasing from 10.20% at 100 µg/mL to 62.24% at 500 µg/mL (Table

1). Diclofenac (100 µg/mL) produced 71.42% inhibition, higher than CAE at the equivalent concentration.

Table 1. Effect of *Crateva adansonii* Extract (CAE) on Heat-Induced Albumin Denaturation

Treatment	Concentration (µg/mL)	Absorbance at 660 nm	% Inhibition of Denaturation
Control	—	0.490	—
CAE	100	0.440	10.20
CAE	200	0.370	24.48
CAE	300	0.305	37.75
CAE	400	0.235	52.40
CAE	500	0.185	62.24
Diclofenac	100	0.140	71.42

3.1.2 Antiproteinase Action

CAE showed concentration-dependent inhibition of trypsin-induced proteinase activity, increasing from 14.13% at 100 µg/mL to 64.13% at 500 µg/mL (Table 2). Aspirin (100 µg/mL) produced 72.60% inhibition.

Table 2. Effect of *Crateva adansonii* Extract (CAE) on Proteinase Inhibitory Action

Treatment	Concentration (µg/mL)	Absorbance at 210 nm	% Inhibition of Proteinase Action
Control	—	0.460	—
CAE	100	0.395	14.13
CAE	200	0.364	20.46
CAE	300	0.325	29.34
CAE	400	0.225	51.08
CAE	500	0.165	64.13
Aspirin	100	0.126	72.60

3.1.3 Anti-Lipoxygenase Activity

CAE inhibited lipoxygenase activity in a concentration-dependent manner, from 14.63% at 100 µg/mL to 72.68% at 500 µg/mL, with no statistically significant difference from control at the two lowest concentrations tested (100 and 200 µg/mL, $p > 0.05$) (Table 3). Indomethacin (100 µg/mL) produced 83.65% inhibition.

Table 3. Effect of *Crateva adansonii* Extract (CAE) on Lipoxygenase Inhibitory Action

Treatment	Concentration (µg/mL)	Absorbance at 234 nm	% Inhibition of Lipoxygenase Activity
Control	—	0.410	—
CAE	100	0.350	14.63
CAE	200	0.310	24.39
CAE	300	0.255	37.85
CAE	400	0.190	53.66
CAE	500	0.112	72.68
Indomethacin	100	0.067	83.65

3.2 Antibacterial Activity

3.2.1 Zone of Inhibition (Agar Well Diffusion Method)

Both the ethanolic and chloroform extracts of *Crateva adansonii* fruit exhibited concentration-dependent antibacterial activity against all five tested strains, with the ethanolic extract consistently more potent than the chloroform extract at every concentration tested (Table 4). The largest zone of inhibition (18.7 ± 0.7 mm) was produced by the ethanolic extract at 200 mg/mL against Bacillus subtilis. Gram-positive strains (S. aureus, B. subtilis) were more susceptible than Gram-negative strains, with Pseudomonas aeruginosa the least susceptible overall (no measurable zone for the chloroform extract at 50 mg/mL). Ciprofloxacin (10 µg/well) produced substantially larger zones (20.4-26.2 mm) than either extract at any concentration tested.

Table 4. Antibacterial Activity of *Crateva adansonii* Fruit Extracts by Agar Well Diffusion Method

S. No.	Bacterial Strain	Gram Type	Ethanolic 50 mg/mL	Ethanolic 100 mg/mL	Ethanolic 200 mg/mL	Chloroform 50 mg/mL	Chloroform 100 mg/mL	Chloroform 200 mg/mL	Ciprofloxacin (10 µg/well)

1	Staphylococcus aureus	Gram-positive	8.2 ± 0.4	12.5 ± 0.5	17.3 ± 0.6	7.0 ± 0.3	10.8 ± 0.5	14.6 ± 0.5	24.5 ± 0.7
2	Bacillus subtilis	Gram-positive	9.4 ± 0.5	13.8 ± 0.6	18.7 ± 0.7	7.8 ± 0.4	11.6 ± 0.5	15.8 ± 0.6	26.2 ± 0.8
3	Escherichia coli	Gram-negative	6.8 ± 0.3	10.2 ± 0.4	14.5 ± 0.5	5.5 ± 0.3	8.4 ± 0.4	11.2 ± 0.4	22.8 ± 0.6
4	Pseudomonas aeruginosa	Gram-negative	5.2 ± 0.3	7.8 ± 0.4	10.6 ± 0.4	—	6.2 ± 0.3	8.4 ± 0.3	20.4 ± 0.5
5	Klebsiella pneumoniae	Gram-negative	7.4 ± 0.4	11.0 ± 0.5	15.2 ± 0.6	6.2 ± 0.3	9.4 ± 0.4	12.8 ± 0.5	23.6 ± 0.7

Values are zone of inhibition in mm, expressed as Mean ± SEM; (—) indicates no detectable zone of inhibition; DMSO (negative control) showed no zone of inhibition against any organism.

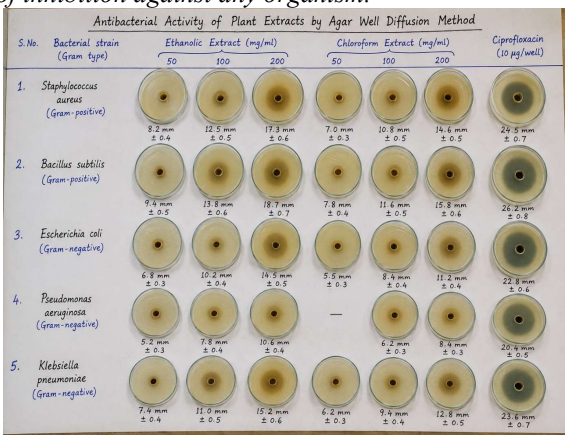

Figure 1: Antibacterial Activity of *Crateva adansonii* Fruit Extracts by Agar Well Diffusion Method

3.2.2 Minimum Inhibitory Concentration (MIC)

MIC was determined for the ethanolic extract, which showed the more promising zones of inhibition in the diffusion assay (Table 5). The lowest MIC (6.25 mg/mL) was recorded against Bacillus subtilis, indicating this strain was the most susceptible, while Pseudomonas aeruginosa showed the highest MIC (50.0 mg/mL), confirming its relative resistance. These findings were consistent with the zone-of-inhibition data and indicate that the ethanolic extract of *Crateva adansonii* fruit possesses antibacterial activity, particularly against Gram-positive organisms.

Table 5. Minimum Inhibitory Concentration (MIC) of Ethanolic Extract of *Crateva adansonii* Fruit

S. No.	Bacterial Strain	MIC (mg/mL)
1	Staphylococcus aureus	12.5
2	Bacillus subtilis	6.25
3	Escherichia coli	25.0
4	Pseudomonas aeruginosa	50.0
5	Klebsiella pneumoniae	25.0

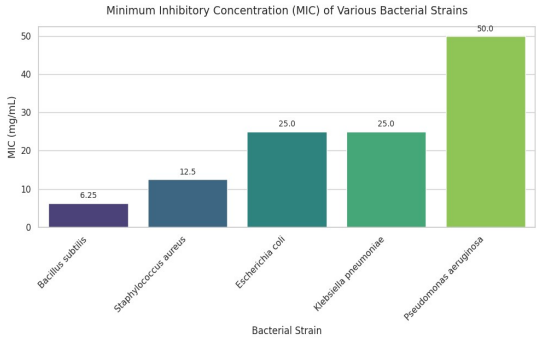

Figure 2: Minimum Inhibitory Concentration (MIC) of Ethanolic Extract of *Crateva adansonii* Fruit

Discussion

The present study demonstrates that the ethanolic extract of *Crateva adansonii* fruit (CAE) exhibits significant concentration-dependent anti-inflammatory activity across three mechanistically distinct *in vitro* assays, alongside promising antibacterial activity against clinically relevant bacterial pathogens. These findings provide scientific validation for the traditional medicinal use of this plant and highlight the therapeutic potential of its fruit, a plant part that has received comparatively less attention than its leaves and bark.

The anti-inflammatory activity of CAE was evidenced through inhibition of protein denaturation (62.24% at 500 µg/mL), antiproteinase activity (64.13% at 500 µg/mL), and anti-lipoxygenase activity (72.68% at 500 µg/mL). Protein denaturation is a well-established marker of inflammation, as denatured proteins can trigger autoimmune responses and contribute to the pathogenesis of inflammatory conditions such as rheumatoid arthritis (Umapathy et al., 2020). The observed inhibition of heat-induced albumin denaturation suggests that CAE contains bioactive compounds capable of stabilizing protein structure, a mechanism shared by many NSAIDs (Gunathilake et al., 2018). Similarly, the antiproteinase activity indicates that CAE can inhibit proteolytic enzymes that mediate tissue damage during inflammatory responses, consistent with findings from other medicinal plants (Bhatt et al., 2022; Oyedepo & Femurewa, 1995).

The most notable anti-inflammatory effect was observed in the lipoxygenase inhibition assay, with CAE achieving 72.68% inhibition at 500 µg/mL, approaching the efficacy of the reference standard indomethacin (83.65% at 100 µg/mL). Lipoxygenase enzymes play a critical role in the biosynthesis of leukotrienes, which are potent pro-inflammatory mediators involved in asthma, allergic reactions, and inflammatory bowel disease (Räder et al., 2023). The ability of CAE to inhibit LOX activity suggests that its anti-inflammatory action may involve modulation of the arachidonic acid cascade, a pathway targeted by conventional anti-inflammatory drugs. The concentration-dependent nature of this inhibition, with statistically significant effects observed at higher concentrations, supports the presence of dose-responsive bioactive constituents in the extract.

Previous studies have reported that *C. adansonii* leaf extracts reduce the expression of pro-inflammatory cytokines IL-6, IL-8, and TNF-α in *S. aureus*-infected keratinocytes (Ahama-Esseh et al., 2017). The present findings extend this understanding by demonstrating that fruit extracts also possess anti-inflammatory properties, likely through inhibition of enzymatic pathways rather than cytokine modulation alone. Phytochemical constituents such as flavonoids and triterpenoids, which have been identified in *C. adansonii* (Pervaiz et al., 2022; Roamba et al., 2025), are known to exert anti-inflammatory effects through multiple mechanisms including LOX inhibition, antioxidant activity, and suppression of NF-κB signaling (Dey et al., 2022; Khan et al., 2021). The presence of lupeol, a pentacyclic triterpenoid isolated from *C. adansonii* leaves with demonstrated analgesic and anti-inflammatory properties (Rathinavel et al., 2021), may contribute to the observed activity, though further phytochemical characterization of the fruit extract is warranted.

The antibacterial evaluation revealed that both ethanolic and chloroform fruit extracts exhibited concentration-dependent activity against all five tested bacterial strains, with the ethanolic extract consistently outperforming the chloroform extract. This differential activity likely reflects variations in the solubility and extraction efficiency of bioactive compounds, with ethanol being a more effective solvent for extracting a broader range of polar and moderately polar antimicrobial phytochemicals (Tiwari et al., 2021). The largest zone of inhibition was observed against *B. subtilis* (18.7 ± 0.7 mm at 200 mg/mL), while the lowest MIC was also recorded against this strain (6.25 mg/mL), indicating that Gram-positive bacteria are more susceptible to CAE than Gram-negative organisms. This pattern is consistent with previous reports on *C. adansonii* leaf and stem extracts (Ogunleye et al., 2024; Agboke et al., 2021) and is commonly observed with plant extracts, attributable to the protective outer membrane of Gram-negative bacteria that restricts the penetration of hydrophobic compounds (Breijyeh et al., 2020).

Pseudomonas aeruginosa was the least susceptible strain, with no detectable zone of inhibition for the chloroform extract at 50 mg/mL and the highest MIC (50.0 mg/mL) for the ethanolic extract. The intrinsic resistance of *P. aeruginosa* to many antimicrobial agents is well-documented and is mediated by efflux

pumps, low outer membrane permeability, and the production of biofilm (Pang et al., 2019). The moderate activity against *E. coli* and *K. pneumoniae* (MIC 25.0 mg/mL for both) suggests that CAE may have limited utility against these pathogens as a standalone agent but could potentially be explored in combination therapies.

The findings of this study have several important implications. First, the demonstration of significant anti-inflammatory activity through multiple mechanistic pathways supports the ethnomedicinal use of *C. adansonii* for inflammatory conditions and suggests that the fruit may be a valuable source of anti-inflammatory compounds. Second, the antibacterial activity, particularly against Gram-positive pathogens, positions *C. adansonii* fruit as a potential candidate for the development of botanical antimicrobial agents, especially in the context of rising antibiotic resistance. Third, the superior activity of the ethanolic extract over the chloroform extract provides guidance for future phytochemical isolation studies aimed at identifying the specific bioactive constituents responsible for the observed activities.

However, several limitations should be acknowledged. The study was conducted exclusively *in vitro*, and the results may not fully reflect the *in vivo* efficacy of the extracts due to issues of bioavailability, metabolism, and pharmacokinetics. The use of relatively high extract concentrations in the antibacterial assays (up to 200 mg/mL) suggests moderate potency compared to conventional antibiotics, and further fractionation and isolation of active compounds may be necessary to enhance activity. Additionally, the study did not investigate the cytotoxicity or safety profile of the extracts, which is essential for any potential therapeutic application.

Future research should focus on the isolation and characterization of the bioactive compounds responsible for the observed anti-inflammatory and antibacterial activities, using bioassay-guided fractionation approaches. *In vivo* studies using appropriate animal models are needed to confirm the efficacy and safety of the extracts. Furthermore, investigation of the molecular mechanisms underlying the anti-inflammatory activity, such as the modulation of specific inflammatory signaling pathways, would provide deeper insights into the therapeutic potential of *C. adansonii* fruit. The potential for synergistic effects when combined with conventional antibiotics also warrants exploration, particularly given the growing interest in natural product-antibiotic combinations for combating antimicrobial resistance (Ayaz et al., 2019).

In conclusion, the ethanolic extract of *Crateva adansonii* fruit demonstrates significant anti-inflammatory activity through inhibition of protein denaturation, protease activity, and lipoxygenase enzyme, as well as promising antibacterial activity against clinically relevant bacterial strains. These findings support the traditional medicinal use of this plant and provide a scientific basis for further investigation into its therapeutic potential. The fruit of *C. adansonii* represents an underexplored resource that may yield novel bioactive compounds for the management of inflammatory and infectious diseases.

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