



ANTIOXIDANT AND ANTIMICROBIAL ACTIVITIES OF *CAPPARIS FASCICULARIS* LEAF EXTRACTS

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ABSTRACT:

Rising microbial resistance to synthetic antibiotics and growing interest in natural antioxidants have renewed attention on underexplored medicinal plants such as *Capparis fascicularis*. This study evaluated the antioxidant and antimicrobial activities of leaf extracts of *C. fascicularis* obtained using *n*-hexane, ethyl acetate, acetone and methanol. Antioxidant activity was assessed by hydrogen peroxide (H_2O_2), 2,2-diphenyl-1-picrylhydrazyl (DPPH) and ferric chloride ($FeCl_3$) assays at concentrations of 200–1000 ppm. All extracts showed concentration-dependent antioxidant activity, with the methanol extract consistently the most active (31.3–64.0% in the H_2O_2 assay, 36.9–75.2% in the DPPH assay and 36.7–65.9% in the $FeCl_3$ assay). Antimicrobial activity, assessed by agar disc diffusion and broth microdilution against *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Escherichia coli*, *Salmonella Typhi*, *Candida albicans* and *Aspergillus flavus*, showed the methanol extract to have the broadest spectrum of activity, with zones of inhibition of 8.5–31 mm against bacteria and 10–20 mm against fungi and minimum inhibitory concentrations (MIC) of 100–200 mg/mL against most organisms. The acetone extract produced the lowest MIC against *S. aureus* (20 mg/mL). Minimum bactericidal concentrations (MBC) ranged from 200–400 mg/mL. None of the extracts showed activity against *A. flavus*. These findings indicate that *C. fascicularis* leaf extracts, particularly the methanol fraction, possess appreciable antioxidant and broad-spectrum antibacterial potential warranting further isolation and mechanistic study of the responsible bioactive compounds.

Keywords: *Capparis fascicularis*; antioxidant activity; DPPH; antimicrobial activity; minimum inhibitory concentration

Introduction

The rise of antibiotic-resistant pathogens alongside the adverse effects associated with many synthetic drugs has renewed scientific interest in plant-derived antimicrobial and antioxidant agents (Murray *et al.*, 2022). Reactive oxygen species generated during normal metabolism are implicated in the pathogenesis of numerous chronic and degenerative diseases and phytochemicals such as flavonoids, phenolics and terpenoids are widely reported to neutralize these species through radical scavenging and metal-chelating mechanisms (Jomova *et al.*, 2023). In parallel, plant secondary metabolites including flavonoids and tannins have been shown to disrupt microbial membranes, inhibit key enzymes and interfere with biofilm formation, making them promising candidates for combating drug-resistant pathogens (Khare *et al.*, 2021; Álvarez-Martínez *et al.*, 2021).

Within the genus *Capparis*, several species notably *C. spinosa* and *C. decidua* have been shown to possess antioxidant, antibacterial, antifungal and anti-inflammatory properties attributable to their flavonoid and phenolic content (Annaz *et al.*, 2022; Sun *et al.*, 2023; Oraibi *et al.*, 2025). However, comparable data for *C. fascicularis*, a related species native to Africa, remain limited, particularly for populations found in Bauchi State, Nigeria. Standardized evaluation of its antioxidant capacity and antimicrobial spectrum is needed to validate its traditional use and assess its potential as a source of novel therapeutic agents.

This study therefore evaluated the antioxidant activity of *C. fascicularis* leaf extracts using three complementary assays (H_2O_2 , DPPH and $FeCl_3$ reducing power) and determined their antimicrobial activity, including MIC and MBC values, against a panel of clinically relevant bacterial and fungal pathogens, benchmarked against standard antibiotics.

Materials and Methods

Antioxidant Activity Assays

DPPH radical scavenging activity was determined by incubating extracts with a DPPH solution and measuring absorbance spectrophotometrically, with ascorbic acid as positive control. Ferric reducing antioxidant power was assessed following Gulcin (2025): extracts at concentrations of 200–1200 μ g/mL were mixed with phosphate buffer and potassium ferricyanide, incubated at 50°C and treated with trichloroacetic acid and ferric chloride, with absorbance read at 700 nm and catechin used as positive control. Hydrogen peroxide scavenging activity was assessed following Gulcin (2025) as modified by

Munteanu and Apetrei (2021), with absorbance read at 695 nm and ascorbic acid as reference standard; percentage inhibition was calculated as $(Ab - As)/Ab \times 100$, where Ab and As are the absorbances of the blank and sample, respectively.

Antimicrobial Activity Assays

Antibacterial activity was evaluated by the agar well diffusion (Kirby-Bauer-type) method against *Staphylococcus aureus*, *Streptococcus pneumoniae*, *Escherichia coli* and *Salmonella Typhi*, using streptomycin as the reference antibiotic. Antifungal activity was similarly evaluated on Sabouraud dextrose agar against *Candida albicans* and *Aspergillus flavus*, using ketoconazole as reference. Zones of inhibition were measured and categorized as susceptible (>20 mm), intermediate (15–19 mm), or resistant (<14 mm). Minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) were determined by the broth microdilution method, with MIC defined as the lowest extract concentration producing no visible microbial growth and MBC as the lowest concentration causing no viable growth on subculture.

Results and Discussion

Antioxidant Activity; Hydrogen Peroxide Scavenging

All four extracts exhibited concentration-dependent H_2O_2 scavenging activity between 200 and 1000 ppm (Table 1). The methanol extract showed the highest activity overall (31.3–64.0%), followed by acetone (35.5–59.8%), ethyl acetate (32.5–54.7%) and n-hexane, which was consistently the weakest (21.9–56.2%).

Table 1: Hydrogen peroxide (H_2O_2) scavenging activity (% inhibition) of *Capparis fascicularis* extracts

Conc. (ppm)	Acetone (%)	Ethyl acetate (%)	n-Hexane (%)	MeOH (%)
200	35.506	32.491	21.919	31.295
400	43.859	40.395	29.544	40.725
600	51.900	46.572	36.648	49.948
800	57.309	51.920	44.619	60.725
1000	59.799	54.664	56.229	64.041

Antioxidant Activity; DPPH Radical Scavenging

DPPH scavenging activity likewise increased with concentration across all solvents (Table 2), ranging from 32.4–75.2%. At the highest concentration tested (1000 ppm), methanol gave the strongest inhibition (75.2%), followed by n-hexane (69.6%), acetone (67.0%) and ethyl acetate (61.5%).

Table 2: DPPH radical scavenging activity (% inhibition) of *Capparis fascicularis* extracts

Conc. (ppm)	Acetone (%)	Ethyl acetate (%)	n-Hexane (%)	MeOH (%)
200	37.691	35.064	32.408	36.869
400	47.520	42.475	43.516	46.323
600	53.742	44.822	34.937	57.037
800	59.693	54.781	62.967	63.760
1000	66.997	61.511	69.576	75.210

The consistently superior performance of the methanol extract across assays is in line with reports on *C. decidua* and *C. spinosa*, where polar solvents were similarly found to yield extracts with the highest antioxidant capacity, attributable to more efficient recovery of phenolic and flavonoid compounds (Rajhi *et al.*, 2021; AlMousa *et al.*, 2022).

Antioxidant Activity; Ferric Chloride Reducing Power

The $FeCl_3$ reducing power assay (Table 3) confirmed the same solvent ranking, with methanol showing the highest inhibition (36.7–65.9%) at all concentrations tested, followed by acetone, ethyl acetate and n-hexane.

Table 3: Ferric chloride (FeCl₃) reducing antioxidant activity (% inhibition) of *Capparis fascicularis* extracts

Conc. (ppm)	Acetone (%)	Ethyl acetate (%)	n-Hexane (%)	MeOH (%)
200	32.423	28.767	27.44	36.704
400	39.727	36.986	36.216	44.725
600	48.715	41.666	46.863	54.054
800	53.130	46.232	52.091	61.203
1000	56.741	50.288	58.460	65.962

Taken together, the three assays consistently identify the methanol extract as the most antioxidant-active fraction of *C. fascicularis* leaves, mirroring the trend reported for related *Capparis* species in which polar solvents best recover the phenolic and flavonoid constituents responsible for radical-scavenging and metal-reducing activity (Oraibi *et al.*, 2025; Bacchetti *et al.*, 2022).

In Vitro Antimicrobial Activity Compared to Standard Antibiotics

Zone of inhibition data (Table 4) show that the methanol extract had the broadest antimicrobial spectrum, with zones ranging from 8.5–31 mm against the bacterial isolates tested and 10–20 mm against *C. albicans*, approaching or exceeding intermediate susceptibility thresholds at the higher test concentrations. The n-hexane extract was the weakest, showing largely resistant-range or no activity except at the highest concentration. Ethyl acetate and acetone extracts showed intermediate activity. None of the plant extracts showed any activity against *A. flavus*, whereas the reference antifungal ketoconazole was active against both *C. albicans* and *A. flavus*.

Table 4: Zone of inhibition (mm) of *Capparis fascicularis* extracts and reference antibiotics against tested organisms (highest and lowest extract concentrations shown)

Extract (mg/mL)	<i>S. aureus</i>	<i>Strep. pneumoniae</i>	<i>E. coli</i>	<i>S. Typhi</i>	<i>C. albicans</i>	<i>A. flavus</i>
Methanol (400)	24–26	18	31–29	21–23	20–19.5	3–4
Methanol (50)	8.5–9	8	10	9	10–11	0
n-Hexane (400)	7–6	0	10–8	6	8–9	0
Ethyl acetate (400)	20–21	12.5–14	16–14	12–11	10–8	0
Acetone (400)	17–15	14–13	18–17.5	12	10–12	0
Streptomycin (50)	36	33	39–38	33	–	–
Ketoconazole (50)	–	–	–	–	29	24–23

The broader spectrum of the methanol extract relative to n-hexane is consistent with the greater polarity of methanol enabling extraction of a wider range of antimicrobial phytoconstituents, as similarly observed for other *Capparis* species (AlMousa *et al.*, 2022; Sun *et al.*, 2023).

Minimum Inhibitory Concentration (MIC)

MIC values (Table 5) confirmed the acetone extract as most potent against *S. aureus* (20 mg/mL), while the methanol extract showed the broadest activity profile, with MIC values of 100–200 mg/mL against *S. aureus*, *E. coli*, *S. Typhi* and *C. albicans*. The n-hexane extract showed the weakest activity (400 mg/mL against *S. aureus* and *E. coli* only) and no extract inhibited *A. flavus* at the concentrations tested.

Table 5: Minimum inhibitory concentration (MIC, mg/mL) of Capparis fascicularis extracts

Extract	S. aureus	Strep.	E. coli	S. Typhi	S. albicans	A. flavus
Absolute methanol	100	–	100	200	200	–
n-Hexane	400	–	400	–	–	–
Ethyl acetate	200	200	200	200	200	–
Acetone	20	200	100	–	–	–

Minimum Bactericidal Concentration (MBC)

MBC values (Table 6) ranged from 200–400 mg/mL across extracts and organisms. The methanol extract was bactericidal against *S. aureus* and *E. coli* at 200 mg/mL and against the remaining susceptible organisms at 400 mg/mL. The acetone extract showed comparable bactericidal activity to methanol, while the n-hexane extract showed no bactericidal activity against any organism tested.

Table 6: Minimum bactericidal concentration (MBC, mg/mL) of Capparis fascicularis extracts

Extract	S. aureus	Strep.	E. coli	S. Typhi	S. albicans	A. flavus
Absolute methanol	200	400	200	400	400	–
n-Hexane	–	–	–	–	–	–
Ethyl acetate	400	400	400	400	400	–
Acetone	400	400	200	400	400	–

The proximity of MIC and MBC values for the methanol and acetone extracts suggests a predominantly bactericidal, rather than merely bacteriostatic, mode of action against the susceptible organisms, consistent with mechanisms proposed for flavonoid- and tannin-rich plant extracts, which act by disrupting microbial membranes and inactivating cell-wall adhesion proteins (Álvarez-Martínez *et al.*, 2021; Khare *et al.*, 2021).

Conclusion

This study demonstrated that *C. fascicularis* leaf extracts possess concentration-dependent antioxidant activity across three independent assays and broad-spectrum antimicrobial activity against clinically relevant bacterial and fungal pathogens, with the methanol extract consistently the most active across all parameters measured. The comparable potency of the acetone extract against *S. aureus* (MIC 20 mg/mL) further highlights solvent choice as a key determinant of bioactivity. These findings support the traditional therapeutic use of *C. fascicularis* and identify the methanol extract as the most promising candidate for further bioassay-guided isolation of its active antioxidant and antimicrobial constituents.

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