Bima Journal of Science and Technology, Vol. 9(2B) Jul, 2025 ISSN: 2536-6041

E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1301

Comparative Phytochemical Screening and Antimicrobial Activities of *Acacia nilotica* (L.) Delile and *Morinda citrifolia* (L.) Extracts against selected Bacterial strains

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ABSTRACT

Plants have long been recognized as reservoir of bioactive compounds with therapeutic potentials, many of which possess antimicrobial properties. Among these, *Acacia nilotica* and *Morinda citrifolia* have attracted scientific interest due to their ethnomedicinal application and rich phytochemical profiles. This study investigated the phytochemical constituents and antibacterial efficacy of *Acacia nilotica* (L.) Delile and *Morinda citrifolia* L. extracts against five clinical bacterial strains: *Escherichia coli, Staphylococcus aureus, Proteus mirabilis, Salmonella typhi,* and *Klebsiella pneumoniae*. Ethanol extracts of stem bark and leaves of *A. nilotica*, as well as leaves and fruit of *M. citrifolia*, were evaluated using standard phytochemical screening, agar well diffusion assay, and MIC/MBC determinations. Phytochemical analysis revealed a rich presence of bioactive compounds. *A. nilotica* stem bark and leaves contained high levels of tannins (+), flavonoids (+), and saponins (+), while *M. citrifolia* fruit and leaves showed strong positivity for steroids (+), alkaloids (+), and flavonoids (+), though they lacked terpenoids and tannins. Antimicrobial results showed that all extracts exhibited concentration-dependent inhibition. At 100 mg/mL, A. nilotica leaf extract recorded the highest zone of inhibition (28.00 ± 0.70 mm) against *P. mirabilis*, followed closely by *A. nilotica* stem bark (27.65 ± 0.58 mm) and *M. citrifolia* fruit (23.93 ± 0.94 mm) against *S. aureus*. Streptomycin (100 µg/mL) served as control, producing inhibition zones ranging from 26.43 mm (*S. aureus*) to 27.82 mm (*P. mirabilis*). Minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) tests confirmed the potency of A. nilotica extracts. The lowest MICs were recorded by *A. nilotica* stem bark against *S. aureus* (6.81 mg/mL) and *P. mirabilis* (6.97 mg/mL), while *M. citrifolia* leaf and fruit showed higher MICs ranging from 12.01–15.46 mg/mL, with the highest MIC observed against *E. coli* (15.46 mg/mL). Corresponding MBCs followed a similar trend, with A. nilotica generally achieving bactericidal effects at half the concentration required by *M. citrifolia*. Overall, A. nilotica extracts demonstrated superior antibacterial activity compared to *M. citrifolia*, likely due to higher concentrations of polyphenolic compounds and tannins. These results support the traditional use of both plants in ethnomedicine and highlight the therapeutic potential of *A. nilotica* in combating bacterial infections, particularly those involving *P. mirabilis* and *S. aureus*.

Keywords: *Acacia nilotica, Morinda citrifolia*, phytochemicals, antimicrobial activity, raditional medicine.

INTRODUCTION

Medicinal plants have long served as primary healthcare remedies in many societies, particularly in Africa and Asia. Among the most widely recognized are *Acacia nilotica* (commonly known as Bagaruwa) and *Morinda citrifolia* (commonly known as Noni), both of which possess deep ethno-botanical significance due to their historical use in treating various diseases (Abubakar *et al*., 2022).

Bima Journal of Science and Technology, Vol. 9(2B) Jul, 2025 ISSN: 2536-6041
E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1301

A. nilotica, belongings to the family Fabaceae (formerly classified under Mimosaceae), a widespread species distributed across tropical and subtropical regions. It has been traditionally employed in the treatment of ailments such as bronchitis, dysentery, diarrhea, leprosy, tuberculosis, and hepatitis (El-Kamali and El-Khalifa, 2003; Gilani *et al*., 2009). Various parts of the plant—including bark, pods, leaves, and gum are utilized in decoctions, powders, and pastes by traditional (Kaur et al., 2022). In addition to its medicinal uses, *A. nilotica* serves as a multipurpose resource for fodder, fuelwood, tannin production, and soil enrichment (Shittu et al., 2020). In *A. nilotica*, tannins and flavonoids are especially abundant and have been linked to its strong antibacterial and astringent effects. Studies have shown that its leaves and bark contain catechins, gallic acid, and other polyphenolic compounds that are effective in neutralizing free radicals and microbial pathogens (Oyetayo *et al*., 2022).

Similarly, *M. citrifolia* (Rubiaceae), commonly called Noni, is native to Southeast Asia and has a long history of traditional use in Polynesian, Indian, and Caribbean herbal medicine. Traditionally, it has been used to manage infections, joint pain, and skin disorders. It is valued both as a health tonic and as a remedy for chronic illnesses such as diabetes, hypertension, and arthritis (Maharani *et al*., 2023). The plant's fruit, leaves, and roots are used in various formulations ranging from raw consumption to fermented juices and (Pandy et al., 2023). *M. citrifolia* is rich in scopoletin, damnacanthal, and iridoids, all of which contribute to its therapeutic efficacy. Phytochemical profiling of the fruit juice has shown a high presence of phenolic compounds and antioxidants, supporting its role as a nutraceutical product (Kamal *et al*., 2021). The increasing global threat posed by antibiotic-resistant pathogens has heightened interest in plant-based antimicrobial agents. Traditional medicinal plants like *A. nilotica* and *M. citrifolia* offer promising alternatives due to their potent and broad-spectrum antimicrobial effects (Adegboyega *et al*., 2023). Likewise, *M. citrifolia* fruit and leaf extracts have shown inhibitory effects against a variety of microorganisms, including drug-resistant strains of *Salmonella*, *Helicobacter pylori*, and *Candida albicans* (Zulkifli *et al*., 2022). These activities have been attributed to the presence of flavonoids and phenolic acids, which interfere with microbial DNA replication and protein synthesis (Zhang et al. 2025).

MATERIALS AND METHODS

Study Area

The research was conducted at the laboratory of the Department of Plant science, Gombe State University, Gombe State, Nigeria.

Sample collection and preparation

Fresh leaves and stem bark of *A. nilotica* were collected from the Botanical Garden of Gombe State University, while leaves and fruits of *M. citrifolia* were collected from Billiri, Gombe State. The samples were washed with distilled water, air-dried under shade to preserve active components, and then ground into fine powder using a mechanical grinder.

Preparation of Extracts

A. nilotica powder (25 g) was soaked in 250 mL of ethanol for 24 hours and agitated using a mechanical shaker. The mixture was filtered, and the filtrate was concentrated using a rotary evaporator. Similarly, 25 g of *M. citrifolia* powdered leaves was soaked in 250 mL of ethanol for 24 hours and agitated using a mechanical shaker. The mixture was filtered, and the filtrate was concentrated using a rotary evaporator, while fresh fruits were blended with a 500 mL of water, filtered, and stored. The extracts were evaporated under reduced

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pressure to obtain the crude extracts for testing reported by Julai *et al*. (2023).

Phytochemical Screening

Standard qualitative tests (Ogundare, 2007) were used to detect the presence of the following compounds: saponins, terpenoids, flavonoids, steroids, tannins, alkaloids, glycoside in both stem bark and leaf extracts of *A. nilotica* and *M. citrifolia* fruit and leaf extracts respectively.

Test for saponins

Approximately 0.5 g of plant extract was vigorously shaken with 10 mL distilled water in a test tube, then allowed to stand for 10 minutes. Formation of stable froth indicates the presence of saponins (Maheshwaran et al., 2023).

Test for terpenoid (FCl3 test)

A 0.2 g portion of extract was dissolved in 10 mL distilled water. A single drop (0.05 mL) of ferric chloride solution was added, and the mixture was observed for an immediate color change—suggestive of terpenoids (Maheshwaran et al., 2023)

Test for flavonoid (NaOH test)

0.2 g of extract was dissolved in 3 mL of 10% NaOH, followed by the addition of 2 mL dilute HCl dropwise. A yellow colour that fades or changes indicates the presence of flavonoids (Maheshwaran et al., 2023).

Test for steroid (H_2SO4 test)

A 0.2 g of the extract, 3 mL of distilled water was added. 0.05 mL of sulphuric acid was added to the solution and observed.

Test for tannins (FCl_3 test)

A mixture of 0.2 g extract in 3 mL distilled water received one drop (~0.05 mL) of $FeCl_3$ solution. A blue-black or greenish coloration indicates tannins (Maheshwaran et al., 2023).

Test for alkaloid (Wagner's test)

A 0.2 g sample of extract was mixed with 3 mL distilled water, then 0.25 mL Wagner's reagent was added. The formation of a reddish-brown precipitate confirms the presence of alkaloids (Maheshwaran et al., 2023).

Test for Glycoside

A 5 mL solution containing glacial acetic acid and approximately 0.15 mL of ferric chloride was mixed with 2 mL of the aqueous plant extract. Subsequently, 1 mL of concentrated sulfuric acid was carefully added along the inner wall of the test tube and the reaction was observed (Maheshwaran et al., 2023).

Antibacterial Assay

Preparation of Plant Extracts

Fresh stem bark of *Acacia nilotica* and the fruits and leaves of *Morinda citrifolia* were collected, washed, air-dried at room temperature, and pulverized into fine powder. One hundred grams (100 g) of each powdered sample was extracted separately with 70 % ethanol by cold maceration for 72 hours. The mixtures were filtered using Whatman No. 1 filter paper, and the filtrates were concentrated under reduced pressure using a rotary evaporator at 40 °C to obtain the crude extracts. The dried extracts were stored in airtight containers at 4 °C until use (Kaur et al., 2022; Elisha et al., 2017).

Preparation of Bacterial Strains

Standard strains of *Escherichia coli*, *Staphylococcus aureus*, *Salmonella typhi*, *Klebsiella pneumoniae*, and *Proteus mirabilis* were obtained from a microbiology laboratory. The bacterial inocula were prepared in sterile normal saline and adjusted to 0.5 McFarland standard (approximately 1.5×10^8 CFU/mL) (CLSI, 2021).

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Preparation of Extract Concentrations

A stock solution of 100 mg/mL of each extract was prepared using 10% DMSO. Two-fold serial dilutions were made with Mueller-Hinton broth to yield concentrations of 100, 50, 25, 12.5, 6.25, and 3.125 mg/mL for each extract (Zhang et al., 2025).

Determination of Minimum Inhibitory Concentration (MIC)

MIC was determined using the broth microdilution method in sterile 96-well microtiter plates according to CLSI guidelines (CLSI, 2021). Each well received 100 µL of Mueller-Hinton broth and 100 µL of the plant extract at varying concentrations. Then, 10 µL of standardized bacterial suspension was added to each well. Positive control wells contained broth and bacteria only, while negative controls contained extract and broth without bacteria. Ciprofloxacin was used as the antibiotic control. The plates were incubated at 37 °C for 24 hours. The MIC was recorded as the lowest concentration showing no visible bacterial growth.

Determination of Minimum Bactericidal Concentration (MBC)

From each well that showed no visible growth in the MIC assay, 10 µL was sub-cultured onto Mueller-Hinton agar and incubated at 37 °C for 24 hours. The MBC was determined as the lowest concentration at which no bacterial growth occurred on the agar surface, indicating a 99.9% bactericidal effect (Elisha et al., 2017; Zhang et al., 2025).

RESULTS

The results of the qualitative phytochemical screening of *A. nilotica* (bark and leaf) and *M. citrifolia* (fruit and leaf) extracts showed the presence secondary metabolites such as saponins, terpenoids, steroids, tannins, flavonoids, alkaloids, and glycosides as shown on Table 1 below. The phytochemical composition of *A. nilotica* and *M. citrifolia* revealed that the bark and leaf extracts of *A. nilotica* showed a rich profile of secondary metabolites. Notably, tannins (+++) and saponins (++ to +++) were present in high concentrations, especially in the bark extract. The comparative analysis indicates that *A. nilotica* especially its bark is superior in terms of tannin, saponin, and terpenoid content, making it a strong candidate for antimicrobial applications. Conversely, *M. citrifolia* contained higher alkaloid and flavonoid concentrations, supporting its traditional use for anti-inflammatory and antioxidant purposes.

Table 1: Phytochemical constituets of *A. nilotica* and *M. citrifolia* extracts.

	A. nilotica		***M. citrifolia***	
Compund Present	**Bark Extract**	**Leaf Extract**	**Fruit Extract**	**Leaf Extract**
Saponins	+	+	+	+
Terpenoids	+	+	-	-
Steriods	+	+	+	+
Tannins	+	+	-	-
Flavonoids	+	+	+	+
Alkaloids	+	+	+	+
Glycoside	+	-	-	-

The result of antibacterial activity at higher concentration (100 mg/mL) shows that *A. nilotica* stem bark exhibited high activity, with zone of inhibition ranging from 26.31 ± 1.54

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mm (*E. coli*) to 27.65 ± 0.58 mm (*P. mirabilis*). and *A. nilotica* leaf extract demonstrated even higher activity, particularly against *P. mirabilis* (28.00 ± 0.70 mm), and maintained potent effects across all pathogens (25.46–27.03 mm). While *M. citrifolia* fruit and leaf extracts showed moderate activity, with zone of inhibition values ranging from 21.31 to 23.93 mm presented in Table 2. At lower concentrations (50 mg/mL), the antibacterial activity also demonstrated that *A. nilotica* extracts remained effective (20.08–22.88 mm), maintaining activity across all test organisms. *M. citrifolia* extracts shifted towards intermediate activity (16.38–18.72 mm). At 25 mg/mL and 12.5 mg/mL, *M. citrifolia* extracts generally showed intermediate to resistant activity. For example, *M. citrifolia* fruit extract at 25 mg/mL ranged between 11.40 ± 1.48 mm and 13.75 ± 0.84 mm, indicating resistance indicated in Table 3 below.

Table 2: Inhibitory effect (mm) of Ethanol extract of stem bark and leaf extracts of *A. nilotica* and *M. citrifolia* fruit and leaf extracts against the test organisms.

Extract Type	Concentration	*E. coli*	*S. aureus*	*P. mirabilis*	*S. typhi*	*K. pneumoniae*
Acacia Stem Bark	100 mg/mL	26.31 ± 1.54	26.59 ± 1.82	27.65 ± 0.58	27.58 ± 0.89	27.52 ± 1.52
Acacia Stem Bark	50 mg/mL	20.27 ± 0.66	22.88 ± 0.83	21.69 ± 1.28	21.33 ± 1.72	21.76 ± 1.23
Acacia Stem Bark	25 mg/mL	15.96 ± 0.88	17.42 ± 1.28	16.37 ± 1.59	15.19 ± 0.69	16.59 ± 0.64
Acacia Stem Bark	12.5 mg/ml	10.78 ± 1.15	11.97 ± 0.97	12.86 ± 1.24	10.87 ± 0.97	11.24 ± 1.92
Acacia Leaf	100 mg/ml	27.03 ± 1.18	26.27 ± 1.10	28.00 ± 0.70	25.83 ± 1.70	25.46 ± 1.47
Acacia Leaf	50 mg/ml	22.10 ± 1.97	20.97 ± 1.05	20.89 ± 0.66	20.08 ± 1.88	20.57 ± 1.44
Acacia Leaf	25 mg/ml	16.05 ± 1.07	16.71 ± 0.63	17.37 ± 1.98	17.62 ± 0.71	15.24 ± 1.48
Acacia Leaf	12.5 mg/ml	12.67 ± 1.99	11.32 ± 1.08	11.75 ± 0.76	11.85 ± 0.92	10.44 ± 1.32
Morinda Leaf	100 mg/ml	23.50 ± 0.85	21.86 ± 1.28	21.31 ± 1.17	21.39 ± 0.69	23.70 ± 1.46
Morinda Leaf	50 mg/ml	16.43 ± 0.77	18.50 ± 1.23	18.09 ± 1.94	17.59 ± 1.20	17.72 ± 1.04
Morinda Leaf	25 mg/ml	12.03 ± 1.54	11.61 ± 1.96	11.56 ± 1.74	11.78 ± 1.14	12.97 ± 0.61
Morinda Leaf	12.5 mg/ml	7.61 ± 1.09	7.17 ± 0.77	7.25 ± 0.72	8.30 ± 1.20	6.60 ± 1.43
Morinda Fruit	100 mg/ml	23.22 ± 0.89	23.93 ± 0.94	23.22 ± 1.28	22.91 ± 0.71	22.83 ± 1.98
Morinda Fruit	50 mg/ml	17.38 ± 1.35	17.84 ± 1.45	16.38 ± 0.93	18.72 ± 0.61	17.34 ± 1.87
Morinda Fruit	25 mg/ml	11.40 ± 1.48	12.32 ± 1.93	13.00 ± 0.75	13.75 ± 0.84	12.36 ± 1.33
Morinda Fruit	12.5 mg/ml	6.62 ± 1.30	6.81 ± 0.56	8.68 ± 1.98	7.76 ± 1.51	7.12 ± 0.78
Streptomycin (Control)	100 µg/ml	26.67	26.43	27.82	26.7	26.49

Values above 19 are susceptible. 15-19 is intermediate, while values less than 15 are resistant.

Minimum Inhibitory Concentration and Minimum Bactericidal Concentration

Acacia stem bark extract demonstrated notable antibacterial effects across all the tested bacteria. Among the pathogens, *S. aureus* and *P. mirabilis* were particularly sensitive to this extract, which suggests that the stem bark contains potent antimicrobial compounds. Its performance indicates both inhibitory and bactericidal action, supporting its traditional usage in treating bacterial infections. The leaf extract of Acacia also showed good antibacterial activity, although slightly less

E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1301

potent than the stem bark. It was especially effective against *S. typhi* and *P. mirabilis*, suggesting that the leaves also possess bioactive components with considerable antimicrobial properties. These results validate the ethno-pharmacological relevance of Acacia leaves as a therapeutic agent.

In contrast, the leaf extract of Morinda exhibited moderate antibacterial activity. The results suggested that while it has some inhibitory effects, particularly against *S. typhi*, it was less effective against more resistant strains such as *K. pneumoniae* and *E. coli*. This reflects the possibility that the active compounds in the Morinda leaf are present in lower concentrations or are less effective against gram-negative organisms. The Morinda fruit extract showed the weakest antibacterial properties in this study. Its activity was minimal across all tested bacteria, particularly against *E. coli* and *K. pneumoniae*, which were largely resistant.

Table 3: The MIC and MBC of *A. nilotica* and *M. citrifolia* extracts.

Extract Source	Bacteria	MIC (mg/mL)	MBC (mg/mL)
Acacia Stem Bark	*E. coli*	8.66	17.32
Acacia Stem Bark	*S. aureus*	6.81	13.63
Acacia Stem Bark	*P. mirabilis*	6.97	13.94
Acacia Stem Bark	*S. typhi*	9.41	18.83
Acacia Stem Bark	*K. pneumoniae*	8.32	16.63
Acacia Leaf	*E. coli*	7.02	14.03
Acacia Leaf	*S. aureus*	7.68	15.36
Acacia Leaf	*P. mirabilis*	7.69	15.38
Acacia Leaf	*S. typhi*	6.5	13.01
Acacia Leaf	*K. pneumoniae*	9.02	18.05
Morinda Leaf	*E. coli*	14.12	28.25
Morinda Leaf	*S. aureus*	14.05	28.1
Morinda Leaf	*P. mirabilis*	13.92	27.83
Morinda Leaf	*S. typhi*	12.49	24.99
Morinda Leaf	*K. pneumoniae*	14.43	28.86
Morinda Fruit	*E. coli*	15.46	30.93
Morinda Fruit	*S. aureus*	14.66	29.32
Morinda Fruit	*P. mirabilis*	12.01	24.02
Morinda Fruit	*S. typhi*	12.12	24.25
Morinda Fruit	*K. pneumoniae*	14.1	28.19

DISCUSSION

The findings of this study validate the uses of *A. nilotica* and *M. citrifolia* and which a phytochemical basis for their ethnomedicinal and pharmacological activities. Moreover, the presence of multiple bioactive compounds in these extracts suggests synergistic effects that may enhance their therapeutic potential. This supports previous findings by Kumar et al. (2021), who reported a high concentration of tannins in *A. nilotica* bark, contributing to its antimicrobial and astringent properties. Additionally, terpenoids, steroids, and flavonoids were moderately present in both plant parts, which are compounds well known for their antioxidant, anti-inflammatory, and antibacterial activities. Alkaloids and glycosides were detected at lower levels,

E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1301

consistent with observations made by Owolabi et al. (2021), who noted that glycoside content in *A. nilotica* varies depending on plant part and extraction method. Cite more relevant literature to supports your results

The phytochemical analysis of *M. citrifolia* revealed consistent presence of flavonoids and steroids in both fruit and leaf extracts, aligning with earlier studies by Singh et al. (2020) that attributed the antioxidant and cytoprotective effects of *M. citrifolia* to its rich flavonoid content. Alkaloids were more abundant in the fruit and leaf extracts (++) compared to *A. nilotica*, supporting their reported analgesic and anticancer properties (Arvind et al., 2022).

In contrast, terpenoids, tannins, and glycosides were absent in both the fruit and leaf extracts. The lack of tannins and glycosides may explain the comparatively lower antimicrobial potential of *M. citrifolia* extracts relative to *A. nilotica*, as previously noted by Owolabi et al. (2021). The current study evaluated the antibacterial activity of *A. nilotica* leaf and stem bark and *M. citrifolia* (Noni) fruit and leaf extracts against five pathogenic bacterial strains: *E. coli, S. aureus, Proteus mirabilis, S.typhi,* and *K. pneumoniae*. The efficacy was assessed using both zone of inhibition (ZOI) measurements and MIC/MBC assays.

The findings revealed that *M. citrifolia* fruit extract demonstrated moderate antibacterial activity, with *P. mirabilis* and *S. typhi* showing the greatest sensitivity, as reflected by the lowest MIC values (12.01 mg/mL and 12.12 mg/mL, respectively). In contrast, *E. coli* and *K. pneumoniae* exhibited the highest MIC and MBC values (*E. coli*: 15.46 mg/mL and 30.93 mg/mL), indicating relatively poor susceptibility to the fruit extract.

These results are consistent with existing literature suggesting that the bioactive components in *M. citrifolia* such as scopoletin, damnacanthal, and anthraquinones—exhibit selective activity depending on the bacterial envelope structure (Sunderam *et al*., 2019). Gram-negative bacteria like *E. coli* and *K. pneumoniae* possess an outer membrane rich in lipopolysaccharides, which can act as a permeability barrier, thus reducing the efficacy of hydrophilic plant-derived compounds (Silhavy *et al*., 2010).

Furthermore, the zone of inhibition data revealed that Acacia stem bark extract produced larger zones against nearly all bacterial strains, particularly *P. mirabilis* and *S. typhi* at 100 mg/mL concentration (27.65 mm and 27.58 mm, respectively), suggesting stronger antibacterial potency. These results correlate with other studies reporting the presence of tannins, flavonoids, and saponins in *A. nilotica*, which exhibit broad-spectrum antibacterial effects (Bakare *et al*., 2021).

Interestingly, *Acacia* extracts were consistently more effective than Morinda extracts, both in inhibition zones and MIC values. This suggests that *Acacia* might have a higher concentration or broader spectrum of active phytochemicals. However, Morinda still holds promise, especially in targeting *P. mirabilis* and *S. typhi*, which aligns with prior reports on its traditional use in treating gastrointestinal and urinary tract infections (Kumar *et al*., 2018).

The comparatively weak activity against *E. coli* and *K. pneumoniae* observed in this study reflects a growing concern of multidrug resistance in these strains. The elevated MICs could reflect efflux pump overexpression or enzymatic degradation of bioactive compounds, as previously documented in studies on phytochemical resistance mechanisms (Poole, 2007).

The potent antibacterial activity of *A. nilotica* can be attributed to its rich phytochemical composition, including tannins, flavonoids, saponins, and terpenoids, which are known to

E-ISSN: 3115-4662 DOI: 10.64290/bima.v9i2B.1301

disrupt microbial membranes, inhibit DNA synthesis, and impair cell wall formation (Kumar et al., 2021; Bakare et al., 2021). *M. citrifolia*, although less potent, still demonstrated notable antibacterial effects at higher concentrations. Its moderate efficacy is likely due to its content of alkaloids, anthraquinones, and flavonoids (Sunderam et al., 2019; Arvind et al., 2022). The reduced effectiveness against gram-negative bacteria such as *E. coli* and *K. pneumoniae* may stem from their outer membrane, which acts as a barrier to many phytochemicals (Silhavy et al., 2010).

CONCLUSION

This qualitative screening indicates that both *A. nilotica* and *M. citrifolia* are rich sources of diverse phytochemicals, although their distribution varies by species and plant part. The pronounced presence of tannins and saponins in *A. nilotica* and alkaloids and flavonoids in *M. citrifolia* validates their traditional medicinal use and highlights their potential for future drug development. Further quantitative and bioassay-guided fractionation studies are recommended to isolate and characterize the active constituents. The current findings support the potential of *A. nilotica* as a more potent antibacterial candidate, while *M. citrifolia* may serve complementary roles, particularly in mixed infections involving *P. mirabilis* and *S. typhi*. Overall, the differential susceptibility among bacterial strains highlights the importance of target-specific screening when evaluating plant extracts for antibacterial applications.

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