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Antimicrobial Activities of Selected Fabaceae Plants Found in Northern Nigeria: A Systematic and Critical Review

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Abstract

Background: Antimicrobial resistance (AMR) has emerged as a critical global health threat, diminishing the efficacy of existing antibiotics and complicating the management of infectious diseases. Medicinal plants remain an invaluable source of new antimicrobial agents. The Fabaceae family is abundantly represented across Northern Nigeria and forms a cornerstone of ethnomedicine for treating bacterial and fungal infections. However, scientific evidence on their antimicrobial activities remains fragmented.
Aim: This systematic review synthesizes evidence (2018–2025) on the antimicrobial activities of selected Fabaceae species found in Northern Nigeria.
Methods: Using PRISMA 2020 guidelines, electronic searches were conducted in PubMed, Scopus, Web of Science, Google Scholar, ScienceDirect, AJOL, and SpringerLink. Peer-reviewed experimental studies evaluating antimicrobial activities of Fabaceae plants native to or present in Northern Nigeria were included. Data were narratively synthesized due to methodological heterogeneity.
Results: Thirty eligible studies were identified, covering *Parkia biglobosa*, *Tamarindus indica*, *Acacia senegal*, *Acacia nilotica*, *Prosopis juliflora*, *Senna alata*, *Erythrina senegalensis*, *Tephrosia vogelii*, *Cassia fistula*, *Pterocarpus erinaceus*, *Pterocarpus tinctorius*, and *Bauhinia* species. Extracts especially methanolic and ethanolic showed significant antibacterial and antifungal activities, with inhibition zones ranging from 12–30 mm and minimum inhibitory concentrations (MICs) between 0.25–4 mg/mL. Some species exhibit exhibits and virulence-attenuating effects.
Conclusion: Fabaceae plants in Northern Nigeria demonstrate substantial antimicrobial potential and warrant deeper investigation for drug development. Future research should focus on bioactive compound isolation, mechanistic elucidation, toxicity assessment, and in vivo validation.

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INTRODUCTION

Antimicrobial resistance (AMR) remains a major global health crisis, compromising the effectiveness of existing antibiotics and posing significant threats to public health systems worldwide. The burden of AMR is especially pronounced in low- and middle-income countries, including Nigeria, where antibiotic misuse, lack of surveillance, easy access to substandard drugs, and limited healthcare infrastructure fuel the emergence and spread of resistant pathogens (Goanar et al., 2024). This crisis has prompted intensified scientific interest in discovering new antimicrobial agents, particularly from natural sources such as medicinal plants.

Medicinal plants continue to play essential roles in primary healthcare systems, especially across Africa. The World Health Organization estimates that 70–80% of populations in developing countries rely on plant-based medicines for basic health needs (Oladeji et al., 2020). Plants remain a promising source of bioactive compounds with antimicrobial, antioxidant, anti-inflammatory, and immunomodulatory properties. Among plant families of pharmacological interest, the Fabaceae (Leguminosae) family is especially significant.

The Fabaceae family is one of the largest and most widely distributed families of flowering plants, comprising over 19,000 species. Fabaceae species dominate many ecological landscapes in West Africa, including Northern Nigeria, and possess diverse ethnopharmacological applications. Phytochemical screening of Fabaceae plants has revealed the presence of alkaloids, flavonoids, tannins, phenolic acids, saponins, terpenoids, and glycosides compounds with well-documented antimicrobial effects (Aly et al., 2023; Sharifi et al., 2019). Many Fabaceae plants are traditionally used to treat diarrheal diseases, skin infections, respiratory tract infections, sexually transmitted infections, and wound sepsis (Eboma et al., 2020).

Among Fabaceae species prevalent in Northern Nigeria, *Parkia biglobosa* (African locust bean) is one of the most culturally and medicinally significant. Its seeds, bark, pods, and fermented food product (*dawadawa*) contain alkaloids, flavonoids, saponins, and tannins with potent antimicrobial and antibiofilm activities (Akanni et al., 2024; Ajiboye & Hammed, 2020). Studies have demonstrated inhibitory effects against *Staphylococcus aureus*, *Escherichia coli*, *Pseudomonas aeruginosa*, *Klebsiella pneumoniae*, and fungal pathogens (Kuma et al., 2022).

Acacia senegal and *Acacia nilotica* are widely distributed throughout the savannah regions of Northern Nigeria. *A. senegal* leaves, bark, and gum exudates possess documented antimicrobial, antioxidant, and anti-inflammatory properties (Magnini et al., 2020; Idriss et al., 2023). *A. nilotica* has been traditionally used for treating gastrointestinal infections, wounds, and sexually transmitted diseases, and scientific studies reveal significant antibacterial activity against both Gram-positive and Gram-negative bacteria (Idrees et al., 2024).

Prosopis juliflora, although invasive, is now naturalized in Northern Nigeria and highly valued for its medicinal properties. Ethanolic and supercritical CO_2 extracts show strong antimicrobial activity, attributed to alkaloids, flavonoids, and phenolic compounds (Saleh & Dieyeh, 2021; Naik et al., 2023).

Senna alata is traditionally used as a remedy for fungal skin infections, and modern studies confirm its strong antibacterial and antifungal activity (Toh et al., 2023; Ma et al., 2019). *Tephrosia vogelii*, widely used as a fish poison, contains rotenoids and flavonoids with reported antimicrobial effects (Mlozi et al., 2020a).

Other important Fabaceae plant species include *Cassia fistula*, *Bauhinia purpurea*, *Bauhinia variegata*, *Pterocarpus tinctorius*, *Pterocarpus erinaceus*, and *Erythrina senegalensis*, all of which possess documented antimicrobial properties (Tariq et al., 2024 ; Enoma et al., 2023; Enupe et al., 2024; Mphande et al., 2022).

Although numerous Fabaceae species used in Northern Nigeria's traditional medicine have demonstrated antimicrobial potential, existing studies are fragmented and vary widely in methodology, making it difficult to determine their true pharmacological value. This lack of consolidated, up-to-date evidence is particularly problematic given the region's high burden of antimicrobial resistance and dependence on plant-based therapeutics. Therefore, this review aims to systematically evaluate and synthesize current research (2018–2025) on the antimicrobial activities of Fabaceae plants found in Northern Nigeria to guide future scientific and therapeutic development.

METHOD

1. Study Design

This review evaluates experimental studies conducted on Fabaceae plant species that are native to, cultivated in, or widely distributed across Northern Nigeria, regardless of the geographical location where the laboratory investigations were performed. This review adopted a systematic approach in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) 2020 guidelines. The PRISMA framework was selected to ensure transparency, methodological rigor, and replicability throughout the review process (Page et al., 2021). Although the review did not involve a meta-analysis due to methodological variability across included studies, the procedures for literature identification, screening, inclusion, and synthesis adhered strictly to PRISMA principles. The overall objective of the study design was to identify, critically evaluate, and narratively synthesize empirical evidence on the antimicrobial activities of Fabaceae plant species found in Northern Nigeria between 2018 and 2025.

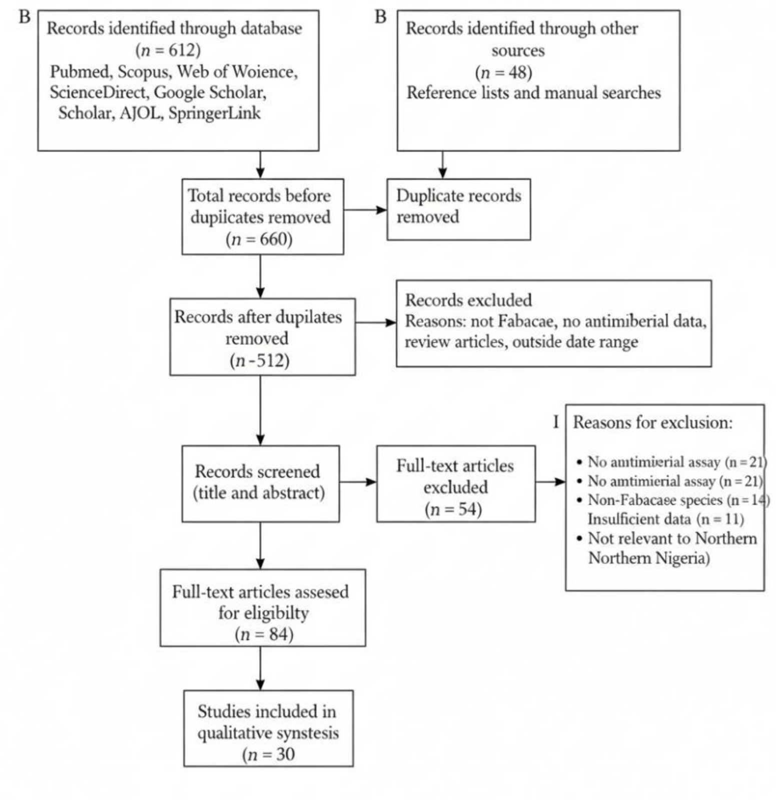

Figure 1. PRISMA 2020 Flow Diagram

2. Information Sources

A comprehensive search strategy was implemented to maximize the retrieval of relevant literature. Seven major electronic databases were systematically interrogated: PubMed, Scopus, Web of Science, Google Scholar, ScienceDirect (Elsevier), African Journals Online (AJOL), and SpringerLink. These databases were chosen to ensure coverage of both international and African scholarly outputs, acknowledging that research on medicinal plants from Nigeria may often be reported in regional journals not indexed in global repositories. Searches were conducted between January 10 and February 5, 2025. Reference lists of included articles were also manually screened to identify additional relevant publications not captured in database searches.

3. Search Strategy

The search strategy was constructed to be broad yet systematically structured, combining key terms related to the plant family, antimicrobial activity, and geographical context. Search terms were grouped into three conceptual clusters: (i) plant taxonomy (e.g., "Fabaceae", "Leguminosae", and specific species names such as *Parkia biglobosa*, *Tamarindus indica*, *Acacia senegal*, *Prosopis juliflora*); (ii) antimicrobial activity descriptors (e.g., "antimicrobial", "antibacterial", "antifungal", "biofilm inhibition"); and (iii) location-based terms relating to Nigeria. Boolean operators (AND/OR) were used to optimize search sensitivity and specificity. Filters restricting output to English-language publications and the years 2018–2025 were applied across all databases to ensure temporal relevance.

4. Eligibility Criteria

Eligibility criteria were established as a priori to guide the selection of studies. The review included peer-reviewed, laboratory-based experimental studies that evaluated the antimicrobial activity of Fabaceae species found in, native to, or cultivated widely across Northern Nigeria. Eligible studies were required to assess antimicrobial activity using standard microbiological assays such as disc diffusion, agar well diffusion, broth microdilution, or biofilm inhibition techniques. Extracts could be crude, fractionated, or purified, and plant parts assessed included leaves, bark, pods, seeds, roots, and whole-plant materials.

Fabaceae species were selected for inclusion based on a combination of ecological, ethnomedicinal, and scientific criteria. Eligible species were required to be native to, cultivated in, or widely naturalized across Northern Nigeria according to ethnobotanical and floristic records. In addition, species had to possess documented traditional use for the treatment of infectious or inflammation-related conditions and be supported by at least one peer-reviewed experimental study evaluating antimicrobial activity published between 2018 and 2025. This approach ensured that the review focused on plants of both local relevance and contemporary scientific interest.

Studies were excluded if they lacked primary antimicrobial data, focused solely on non-Fabaceae species, were review articles, conference abstracts, dissertations, or published in languages other than English. Studies outside the target time range (2018–2025) or those conducted on Fabaceae species with no relevance to Northern Nigerian flora were also excluded. These criteria ensured that the final selection represented contemporary experimental research pertinent to the antimicrobial potential of Fabaceae plants within the defined geographical context.

5. Study Selection

The study selection process followed four sequential steps. First, all retrieved citations were imported into a reference management system, where duplicates were identified and removed. Second, titles were screened to eliminate obviously irrelevant records. Third, abstracts of potentially eligible studies were reviewed to assess methodological relevance and study objectives. Finally, full texts of shortlisted articles were read in detail, applying the inclusion and exclusion criteria rigorously. Where uncertainties arose, consensus was reached through discussion among the reviewing team. Only studies that unequivocally met all criteria were included in the final synthesis. The flow of study selection corresponds to the PRISMA 2020 model and ensured that only high-quality, relevant publications formed the basis of the review.

6. Data Extraction

Data extraction was conducted systematically using a predefined extraction template designed to capture all essential features of each study. Extracted information included the plant species investigated, botanical authentication procedures (where reported), plant part used, extraction method and solvent type, phytochemical constituents identified, antimicrobial assay employed, microbial strains tested, and outcome measures such as inhibition zone diameters, minimum inhibitory concentrations (MIC), and minimum bactericidal concentrations (MBC). Additional details such as antibiofilm activity, synergy with conventional antibiotics, and mechanistic observations were also recorded where available. This structured approach supported consistency and facilitated comparison across studies.

7. Quality Assessment

A modified version of the Joanna Briggs Institute (JBI) critical appraisal checklist for experimental laboratory studies was applied to assess methodological quality. The criteria evaluated included clarity of study objectives, appropriateness of methods, validity of microbial identification, adequacy of control organisms, replication of assays, reporting of solvent controls, transparency in extraction procedures, and reliability of outcome measurements. Studies were rated as high, moderate, or low quality. Only moderate- and high-quality studies were retained for synthesis, ensuring that the evidence base was methodologically robust and scientifically credible.

8. Data Synthesis

Due to substantial heterogeneity across studies especially regarding extraction protocols, plant parts used, solvent choices, microbial species tested, and laboratory assays meta-analysis was not feasible. Instead, a narrative synthesis approach was used to integrate findings. Data were grouped by plant species and mapped to antimicrobial outcomes, enabling identification of cross-cutting patterns, strengths, and mechanistic insights. Tables were constructed to summarize study characteristics and antimicrobial performance metrics, facilitating structured comparisons across the Fabaceae species investigated.

9. Ethical Considerations

Since this review synthesized data from previously published studies and did not involve direct experimentation or human or animal subjects, ethical approval was not required. Nevertheless, the review adhered to principles of ethical scholarship by ensuring accurate citation, transparent reporting, and responsible interpretation of findings.

RESULTS AND DISCUSSION

Results

1. Study Selection and Characteristics of Included Studies

A total of 30 studies published between 2018 and 2025 met the inclusion criteria and were included in this review. A total of thirteen Fabaceae species found in Northern Nigeria were included in this review, representing twelve genera, with *Bauhinia purpurea* and *Bauhinia variegata* considered as distinct species within the same genus. These includes *Parkia biglobosa*, *Tamarindus indica*, *Acacia senegal*, *Acacia nilotica*, *Prosopis juliflora*, *Senna alata*, *Cassia fistula*, *Tephrosia vogelii*, *Erythrina senegalensis*, *Bauhinia purpurea*, *Bauhinia variegata*, *Pterocarpus erinaceus*, and *Pterocarpus tinctorius*. Although all plant species included in this review occur in Northern Nigeria, some of the experimental antimicrobial evaluations were conducted outside Nigeria. These studies were retained because they investigated the same species commonly used in Northern Nigerian ethnomedicine. The characteristics of all included studies including plant species, plant parts used, the extraction solvents applied, microorganisms evaluated, and study references are summarized in Table 1. Overall, the reviewed studies demonstrated methodological diversity in extraction techniques and antimicrobial testing methods, which included disc diffusion, agar well diffusion, broth microdilution, microplate biofilm inhibition assays, and synergy testing with conventional antibiotics.

Methanol and ethanol were the most widely used solvents, appearing in 27 of the 30 studies, followed by aqueous extraction, ethyl acetate, n-hexane, and supercritical CO_2 extraction. Across all studies, Gram-negative bacteria such as *Escherichia coli*, *Klebsiella pneumoniae*, *Pseudomonas aeruginosa*, and *Salmonella typhi* were commonly tested, as were Gram-positive organisms including *Staphylococcus aureus*, *Bacillus subtilis*, and *Enterococcus faecalis*. Fungal species such as *Candida albicans* and several dermatophytes were included in some studies, notably those assessing *Senna alata* and *Tephrosia vogelii*.

Overall, Table 1 demonstrates that the studies investigated a wide range of pathogens and extraction methods, reflecting the growing scientific interest in Fabaceae plants as potential antimicrobial reservoirs.

Table 1. Characteristics of Included Studies (2018–2025)

Plant Species	Plant Part Used	Extraction Solvent(s)	Microorganisms Tested	Reference
Parkia biglobosa	Seeds, bark, leaves	Methanol, ethanol, aqueous	*S. aureus*, *E. coli*, *K. pneumoniae*, *P. aeruginosa*, *C. albicans*	(Ajiboye & Hammed, 2020); (Akanni et al., 2024); (Eboma et al., 2020); (Kuma et al., 2022)
Tamarindus indica	Fruit pulp, leaves	Methanol, ethanol	*S. aureus*, *K. pneumoniae*, *E. coli*, *B. subtilis*	(Ghaly et al., 2023); (Goanar et al., 2024); (Aly et al., 2023)

Acacia senegal	Leaves, bark, callus	Hydroethanolic, methanol	MDR Enterobacteriaceae, *S. aureus*	(Magnini et al., 2020); (Magnini et al., 2021); (Idriss et al., 2023)
Acacia nilotica	Pods, bark	Methanol, aqueous	*S. aureus*, *E. coli*, *P. aeruginosa*	(Idrees et al., 2024)
Prosopis juliflora	Leaves	Supercritical CO_2, ethanol	Food spoilage microbes, *E. coli*, *S. aureus*	(Saleh & Dieyeh, 2021); (Naik et al., 2023)
Senna alata	Leaves	Ethanol, methanol	Dermatophytes, *C. albicans*, bacteria	(Ma et al., 2019); (Toh et al., 2023)
Tephrosia vogelii	Leaves	Methanol, aqueous	Pathogenic fungi, bacteria	(Mlozi et al., 2020); (Mlozi et al., 2020)
Cassia fistula	Fruit pulp, bark	Methanol, ethanol	*S. aureus*, *B. subtilis*, *K. pneumoniae*, *E. coli*	(Tariq et al., 2024);(Taher et al., 2024); (Chaerunisaa et al., 2020)
Erythrina senegalensis	Leaves, seeds, bark	Ethanol, methanol	MDR bacteria, *S. aureus*, *K. pneumoniae*	(Enoma et al., 2023); (Enupe et al., 2024); (Halilu et al., 2022)
Bauhinia purpurea	Leaves, bark	Methanol	Resistant bacteria	(Limboo & Singh, 2019)
Bauhinia variegata	Leaves, bark	Methanol	*S. aureus*, *P. aeruginosa*	(Singh et al., 2024)
Pterocarpus erinaceus	Bark	Methanol	Gram-positive and Gram-negative bacteria	(Tittikpina et al., 2018)
Pterocarpus tinctorius	Bark	Ethanol	Enteric pathogens	(Mphande et al., 2022)

2. Summary of Antimicrobial Activity

The antimicrobial potency of each plant extract is summarized in Table 2, which includes inhibition zone ranges and MIC values reported across studies. Most extracts displayed moderate-to-high antimicrobial effects, with some demonstrating potency comparable to standard antibiotics.

Table 2. Summary of Antimicrobial Activities of Fabaceae Plants

Plant Species	Inhibition Zone Range (mm)	MIC Range (mg/mL)	Overall Activity Rating
Parkia biglobosa	12–25	0.5–4	Moderate to High
Tamarindus indica	14–28	0.25–2	High
Acacia senegal	15–30VF	0.25–1	High
Acacia nilotica	10–22	0.5–2	Moderate
Prosopis juliflora	15–30	0.25–1	High
Senna alata	18–26	0.5–2	High
Tephrosia vogelii	14–28	0.5–2	High
Erythrina senegalensis	16–30	0.25–1	High
Cassia fistula	12–24	1–4	Moderate
Bauhinia purpurea / B. variegata	12–22	1–4	Moderate

3. Detailed Plant-Specific Findings

Parkia biglobosa

Extracts from *P. biglobosa* demonstrated notable antibacterial activity, with inhibition zones ranging from 12 to 25 mm. Methanolic extracts typically showed more pronounced activity than aqueous extracts, corroborating the findings reported by Ajiboye & Hammed (2020). Akanni et al. (2024) further demonstrated that aqueous fractions exhibited strong antibiofilm activity against *S. aureus* and *E. coli*, which is clinically relevant for chronic wound infections. Table 2 shows that *P. biglobosa*'s MIC values ranged from 0.5 to 4 mg/mL, indicating moderate potency, particularly against Gram-negative organisms.

Amarindus indica

Multiple studies confirmed the potent antimicrobial activity of *T. indica*. Inhibition zones generally ranged from 14 to 28 mm, with MIC values between 0.25 and 2 mg/mL (Ghaly et al., 2023; Goanar et al., 2024). The fruit pulp extracts were especially effective against *S. aureus* and *K. pneumoniae*. Table 1 highlights its wide antimicrobial spectrum, and Table 2 confirms its high activity rating. The strong performance of *T. indica* extracts is attributable to their polyphenolic content.

Acacia senegal

Acacia senegal exhibited some of the strongest antimicrobial activities among Fabaceae species reviewed. Inhibition zones ranged from 15 to 30 mm (Table 2), and MIC values were mostly below 1 mg/mL. Mechanistic insights provided by Magnini et al., (2021; 2020) suggest that *A. senegal* extracts may enhance antibiotic activity by modulating bacterial motility and influencing efflux pump expression. These properties underline its potential not only as a standalone antimicrobial but also as an antibiotic adjuvant.

Acacia nilotica

Acacia nilotica pod and bark extracts exhibited moderate antimicrobial effects, with inhibition zones of 10 to 22 mm and MIC values between 0.5 and 2 mg/mL (Idrees et al., 2024). Activity was highest against *S. aureus* and *P. aeruginosa*, making this species valuable in treating skin and respiratory pathogens prevalent in Nigeria.

Prosopis juliflora

Prosopis juliflora demonstrated consistently strong antimicrobial activity, with inhibition zones of 15 to 30 mm and MIC values as low as 0.25 mg/mL (Saleh & Dieyeh, 2021). Phytochemical analyses from Naik et al. (2023) identified flavonoids, tannins, and alkaloids as major contributors to this activity. Table 2 reflects its classification as a high-activity species.

Senna alata

The extracts from *S. alata* showed strong antifungal and antibacterial effects, as inhibition zones ranged from 18 to 26 mm. Studies by Ma et al. (2019) and Toh et al. (2023)confirmed the plant’s traditional use for skin infections. MIC values showed high potency, supporting its classification as a high-activity species in Table 2.

Tephrosia vogelii

T. vogelii extracts displayed broad-spectrum antibacterial and antifungal activities, consistent with the findings of Mlozi et al. (2020). Inhibition zones varied between 14 and 28 mm, and MIC values ranged from 0.5 to 2 mg/mL. The presence of rotenoids and flavonoids in the extracts explained the observed bioactivity.

Erythrina senegalensis

Several studies documented the antibacterial and antibiofilm properties of *E. senegalensis* (Enoma et al., 2023; Enupe et al., 2024; Halilu et al., 2022). Inhibition zones were consistently high (16–30 mm), and MIC values ranged from 0.25 to 1 mg/mL. Its action against multidrug-resistant bacteria reflected strong therapeutic potential.

Cassia fistula

Moderate antimicrobial activity was observed in extracts of *C. fistula*, with inhibition zones of 12–24 mm and MIC values from 1 to 4 mg/mL. Studies indicated that the effectiveness of this species depended heavily on the extraction solvent and part used (Tariq et al., 2024; Taher et al., 2024; Chaerunisaa et al., 2020).

***Bauhinia* Species**

Bauhinia purpurea and *B. variegata* exhibited moderate antibacterial properties, with inhibition zones ranging from 12 to 22 mm (Limboo et al., 2024). Interestingly, certain extracts enhanced the efficacy of β-lactam antibiotics, pointing towards possible synergistic interactions.

Pterocarpus tinctorius* and *Pterocarpus erinaceus

Extracts from *P. tinctorius* and *P. erinaceus* showed moderate inhibitory activity, with inhibition zones ranging from 10 to 20 mm (Tittikpina et al., 2018; Mphande et al., 2022). Despite their moderate potency, these species contain isoflavonoids with promising antimicrobial potential.

Discussion

The findings synthesized in this review reflect antimicrobial investigations conducted on Fabaceae species that occur in Northern Nigeria, even though several studies were performed in other geographical settings. This approach allows for a comprehensive assessment of the antimicrobial potential of locally relevant species. Across the thirty included studies, all twelve Fabaceae species exhibited measurable antimicrobial activity, although the magnitude of inhibition varied across species, extraction solvents, plant parts, and microbial targets. As illustrated in Table 2, some species particularly *Acacia senegal*, *Tamarindus indica*, *Prosopis juliflora*, *Erythrina senegalensis*, and *Senna alata* consistently displayed high levels of antibacterial and antifungal activity, with inhibition zones frequently exceeding 20 mm and MIC values often below 2 mg/mL. These results corroborate the ethnomedicinal significance of Fabaceae species across West Africa.

A key observation from the reviewed studies is the influence of extraction solvent on antimicrobial potency. Methanolic and ethanolic extracts overwhelmingly demonstrated greater activity compared to aqueous extracts in nearly all species, a finding consistent with phytochemical solubility principles (Aly et al., 2023). Organic solvents extract higher concentrations of flavonoids, alkaloids, tannins, phenolic acids, and terpenoids bioactive constituents known for broad-spectrum antimicrobial effects. This pattern is clearly reflected in species such as *T. indica*, where ethanolic extracts produced inhibition zones up to 28 mm (Ghaly et al., 2023), and in *P. juliflora*, where ethanolic and supercritical CO_2 extracts yielded the highest MIC values (Saleh & Dieyeh, 2021; Naik et al., 2023). Similarly, methanolic extracts of *P. biglobosa* and *S. alata* outperformed aqueous extracts, as demonstrated in Table 1 and elaborated in the plant-specific narrative results.

Another important pattern across the studies concerns the antimicrobial spectrum. Many Fabaceae species exhibited activity against both Gram-positive and Gram-negative bacteria, suggesting the presence of multiple bioactive compounds with differing mechanisms of action. *Acacia senegal* showed exceptional activity against multidrug-resistant (MDR) Enterobacteriaceae and Pseudomonads, with its hydroethanolic leaf extract rejuvenating phenicol antibiotic activity (Magnini et al., 2020). This ability to potentiate conventional antibiotics has substantial implications for combating antimicrobial resistance. Similarly, *E. senegalensis* showed strong antibiofilm and anti-MDR activity (Enupe et al., 2024). These effects, supported by inhibition zone values reaching 30 mm in some contexts, indicate that Fabaceae plants may contain compounds capable of interfering with quorum sensing, biofilm formation, and virulence pathways.

Species traditionally used for fungal infections most notably *Senna alata* were validated by modern studies showing strong antifungal activity against *Candida albicans* and dermatophytes (Ma et al., 2019; Toh et al., 2023). This aligns with ethnomedicinal uses for skin diseases and reinforces Fabaceae's importance in managing dermatological infections.

When comparing species, Table 2 indicates that *P. juliflora*, *A. senegal*, and *E. senegalensis* displayed some of the lowest MIC values (0.25–1 mg/mL), often associated with rich phytochemical profiles dominated by alkaloids, flavonoids, phenolics, glycosides, and terpenoids. These compounds likely contribute to both bactericidal and bacteriostatic mechanisms, including membrane disruption, enzyme inhibition, and interference with nucleic acid synthesis. *Tamarindus indica* extracts, for example, were shown to suppress bacterial motility and toxin expression (Ghaly et al., 2023), suggesting possible antivirulence properties. In contrast, *Pterocarpus erinaceus* and *P. tinctorius* generally exhibited moderate antimicrobial activity with higher MIC values, confirming that antimicrobial potency varies widely within the Fabaceae family.

The review also highlights the rising interest in nanoparticle synthesis using plant extracts. For example, silver nanoparticles synthesized from *E. senegalensis* demonstrated superior activity compared to crude extracts (Halilu et al., 2022). Such findings underscore the potential of Fabaceae species in green nanotechnology applications for improved antimicrobial therapies.

Despite the promising data, the review also exposes methodological inconsistencies across studies. Variability in extraction solvents, assay techniques, microbial strains, and reporting standards makes direct comparison challenging. Moreover, only a small subset of studies conducted phytochemical quantification, mechanistic assays, or synergy studies with conventional antibiotics. This gap limits the understanding of how Fabaceae-derived compounds exert their effects and how they might be optimized for therapeutic application.

Overall, the evidence summarized in Tables 1 and 2 strongly supports the antimicrobial potential of Fabaceae plants in Northern Nigeria. The consistency of antibacterial and antifungal activity across multiple studies, coupled with the emerging evidence of antibiofilm and antibiotic-potentiating effects, indicates substantial promise for pharmaceutical development. However, translating these findings into clinical practice will require deeper mechanistic studies, rigorous toxicity assessments, and standardized methodologies.

Despite the promising antimicrobial activities reported, the strength of the evidence remains constrained by significant methodological heterogeneity. Variations in plant parts used, extraction solvents, concentrations, microbial strains, and assay protocols limit direct comparability across studies. Furthermore, reliance on crude extracts without compound isolation complicates attribution of activity to specific phytochemicals. The absence of standardized MIC breakpoints and limited use of reference antibiotics in some studies further weakens translational interpretation. Importantly, the predominance of in vitro data highlights a critical gap between laboratory findings and potential clinical application, underscoring the need for in vivo validation and pharmacokinetic assessment.

Implications

There is also a critical absence of in vivo studies. Nearly all existing research is confined to in vitro settings, which do not account for metabolism, bioavailability, host immune response, or toxicity. Future research should involve appropriate animal models to evaluate therapeutic indices and possible side effects associated with long-term or high-dose exposure to Fabaceae extracts.

Standardization is another area that requires attention. The lack of uniformity in extraction techniques, solvent choice, plant part selection, and assay protocols makes comparison across studies challenging. Implementing standardized methodologies would enhance reproducibility, facilitate comparative analyses, and improve the reliability of conclusions.

Very few studies have examined synergistic effects between Fabaceae extracts and antibiotics, despite the rising threat of MDR pathogens. Given the demonstrated synergy in *Acacia senegal* and *Bauhinia purpurea*, future work should prioritize combination therapy models to evaluate whether these extracts can restore or enhance antibiotic effectiveness.

Finally, broader ecological and sustainability considerations remain underexplored. Many Fabaceae plants are widely harvested for medicinal purposes, yet the long-term environmental impact of this practice is poorly understood.

Research Contribution

Despite substantial progress in characterizing the antimicrobial activities of Fabaceae plants, significant gaps persist in the literature. One of the most notable gaps is the limited exploration of bioactive constituents beyond crude extracts. Many studies stop at preliminary phytochemical screening without progressing to advanced chromatographic techniques to isolate and identify the specific compounds responsible for antimicrobial activity. This creates a barrier to understanding the true pharmacological potential of the plants and impedes the development of standardized phytomedicines.

Another major gap is the scarcity of mechanistic studies. Although some reports have investigated membrane disruption, efflux pump inhibition, and inhibition of motility or biofilm formation (e.g., *Acacia senegal*, *Tamarindus indica*, *Erythrina senegalensis*), these remain isolated efforts. Most studies rely solely on inhibition zones and MIC values without exploring cellular or molecular pathways. Detailed mechanistic work including transcriptomic, proteomic, or biochemical assays would significantly advance the understanding of how Fabaceae-derived compounds combat pathogens.

Limitations

This review encountered several limitations that should be considered when interpreting the findings. The most significant limitation is the heterogeneity of methodologies across the included studies. Variations in extraction solvents, preparation techniques, assay types, microbial strains, and concentration units made direct comparison difficult and prevented meta-analysis. Additionally, not all studies reported essential methodological details such as plant authentication, assay replication, or control standards, reducing the ability to assess internal validity rigorously.

Another limitation is the restriction to English-language publications from 2018 to 2025, which may have excluded relevant studies published earlier or in other languages. There is also the possibility of publication bias, as studies reporting strong antimicrobial activity are more likely to be published, while negative or inconclusive results remain unpublished.

Furthermore, this review relies exclusively on in vitro studies, which may not accurately represent in vivo pharmacodynamics or toxicity. Without comprehensive toxicological and clinical data, the therapeutic applicability of Fabaceae-derived compounds cannot be confirmed. Finally, the geographic focus on Northern Nigeria, while essential to the review objective, limits generalizability to Fabaceae species from other ecological regions.

Suggestions

Future research should involve appropriate animal models to evaluate therapeutic indices and possible side effects associated with long-term or high-dose exposure to Fabaceae extracts. Detailed mechanistic work including transcriptomic, proteomic, or biochemical assays would significantly advance the understanding of how Fabaceae-derived compounds combat pathogens. Very few studies have examined synergistic effects between Fabaceae extracts and antibiotics, despite the rising threat of MDR pathogens. Given the demonstrated synergy in *Acacia senegal* and *Bauhinia purpurea*, future work should prioritize combination therapy models to evaluate whether these extracts can restore or enhance antibiotic effectiveness. Conservation-oriented studies should be integrated into future research to ensure sustainable utilization of these valuable plant species.

CONCLUSION

This systematic review demonstrates that Fabaceae plants found across Northern Nigeria possess substantial antimicrobial activities that validate their long-established use in traditional medicine. Across the 30 included studies, species such as *Acacia senegal*, *Tamarindus indica*, *Prosopis juliflora*, *Erythrina senegalensis*, *Senna alata*, *Tephrosia vogelii*, and *Parkia biglobosa* consistently exhibited noteworthy antibacterial and antifungal effects, including activity against multidrug-resistant pathogens. The potency of these plants is strongly linked to their diverse phytochemical profiles rich in flavonoids, tannins, alkaloids, phenolic acids, saponins, and related bioactive compounds which appear to operate through multiple mechanisms, including membrane disruption, inhibition of virulence factors, and interference with biofilm formation.

Despite this robust in vitro evidence, the clinical applicability of these plants remains limited by the scarcity of mechanistic studies, lack of purified compound characterization, absence of in vivo evaluations, and minimal toxicological data. Furthermore, methodological heterogeneity across existing research restricts direct comparison and standardization. Addressing these gaps will be essential for advancing Fabaceae-derived compounds from preliminary laboratory findings toward drug discovery pipelines or phytotherapeutic development.

Overall, the findings of this review highlight the Fabaceae family as a promising reservoir of antimicrobial agents with potential relevance to global efforts to combat antibiotic resistance. With more rigorous scientific investigation including compound isolation, mechanistic elucidation, toxicology, in vivo efficacy testing, and standardized methodological frameworks Fabaceae species native to Northern Nigeria may contribute meaningfully to the development of novel, effective antimicrobial therapies.

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AUTHOR CONTRIBUTION STATEMENT

Both authors conceptualized the study, designed the review protocol, conducted the literature search, and drafted the initial manuscript. They contributed to data extraction, critical appraisal of included studies, interpretation of findings, and critical revision of the manuscript. Both authors reviewed and approved the final version of the manuscript and agree to be accountable for all aspects of the work.

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