IJARSCT
International Journal of Advanced Research in Science, Communication and Technology
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
ISSN: 2581-9429
Volume 6, Issue 2, November 2026
Impact Factor: 8.2

Phytochemical Profiles and Antimicrobial Potential of Selected Medicinal Plants from Jalgaon District, Maharashtra: A Review

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Abstract: *Antimicrobial resistance (AMR) is a major global health threat, and plant-derived compounds remain an important source of leads for new anti-infective agents. Jalgaon District, in the Khandesh region of northern Maharashtra, includes the Satpuda foothills and has a long tradition of ethnomedicinal plant use among the Pawara, Bhil and Pardhi communities. This review brings together (i) regional ethnobotanical and laboratory studies from Jalgaon and neighbouring North Maharashtra, and (ii) recent (2021–2026) international evidence on the phytochemistry and antimicrobial activity of nine plants documented in the district: Azadirachta indica, Ocimum tenuiflorum (syn. O. sanctum), Curcuma longa, Moringa oleifera, Cassia fistula, Phyllanthus niruri, Eclipta alba (syn. E. prostrata), Enicostemma littorale and Aloe vera. Across these species the recurrent antimicrobial-associated metabolite classes are phenolics, flavonoids, tannins, terpenoids (including limonoids), alkaloids, saponins and anthraquinones. Recent district-specific antimicrobial studies are, however, few, mostly qualitative (disc/well diffusion), and rarely report minimum inhibitory concentrations, chemical fingerprints (GC-MS, LC-MS/HPLC), toxicity or voucher-based authentication. We summarise what is known, critically appraise the evidence, and propose priorities for standardised, Jalgaon-sourced research.*

Keywords: Jalgaon; Khandesh; medicinal plants; phytochemistry; antimicrobial activity; antimicrobial resistance; ethnobotany.

I. INTRODUCTION

Bacterial antimicrobial resistance was directly responsible for an estimated 1.27 million deaths in 2019 and was associated with 4.95 million, according to the Global Burden of Disease analysis of 204 countries and territories [1]. This burden has renewed interest in medicinal plants, which contain thousands of antimicrobial secondary metabolites and are used as alternatives or adjuncts to conventional drugs; recent reviews stress, however, that translating plant extracts into dependable therapeutics requires standardisation, mechanism-of-action work and toxicity data [2]. Screening of locally used plants against multidrug-resistant pathogens is a widely adopted first step [3].

Jalgaon District (20°–21° N, 74°55′–76°28′ E) lies in the northern part of Maharashtra, with a largely rural population and forest-dwelling communities in the Satpuda ranges [5]. Early surveys documented dozens of folk-medicinal species from the district [4,5], yet systematic phytochemical and antimicrobial characterisation of these plants has progressed slowly. The aim of this review is to consolidate available information, separating clearly what has been demonstrated in Jalgaon-sourced material from what has been shown only for the same species elsewhere.

II. SCOPE AND METHOD OF THE REVIEW

Literature on Jalgaon, Khandesh and North Maharashtra medicinal plants was searched using combinations of the terms Jalgaon, Khandesh, Satpuda, ethnomedicinal, phytochemical and antimicrobial. Plant-wise searches (species name with antimicrobial, phytochemistry and review) were then run for 2021–2026 publications. Preference was given to peer-

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DOI: 10.48175/IJARSCT-40758

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reviewed reviews and original studies with verifiable bibliographic details. Because recent Jalgaon-specific papers are scarce, a small number of older regional studies (pre-2021) are cited as a foundational baseline and are marked as such. This is a narrative review, not a PRISMA systematic review, and the search was not exhaustive; relevant work in regional journals not indexed in major databases may have been missed.

III. REGIONAL ETHNOBOTANICAL AND LABORATORY BACKGROUND

3.1 Ethnomedicinal documentation

A survey of herbal folk medicines from Jalgaon reported fifty plants in 33 angiosperm families used by tribal and rural people and called for pharmacological and clinical validation [5]. Work on wound-healing plants of the district noted that about 133 plants were routinely used by the local Satpuda tribal community, of which 11 were selected for wound-healing screening [4]. These baseline studies (pre-2021) set the ethnobotanical context for the species discussed below.

3.2 Laboratory studies using Jalgaon or North Maharashtra material

Endophytes (baseline, 2010). Seventy-eight bacterial and 142 fungal endophytes were isolated from roots, stems and leaves of seven medicinal plants used in Jalgaon, including *A. indica, C. longa, Aloe vera, Moringa and Ocimum sanctum*; 15 bacterial and 14 fungal isolates showed antimicrobial activity, and some isolates from *Aloe vera* roots strongly inhibited Salmonella typhi in dual-culture assays [6].

Enicostemma littorale (baseline, 2010). Plants collected from the Satpuda range and identified at North Maharashtra University were extracted with ethanol and water, screened for alkaloids, terpenoids and tannins, and tested by agar disc diffusion [7].

Cassia fistula (2019). Leaflets collected in Jalgaon were subjected to pharmacognostic evaluation, physicochemical standardisation (ash values) and preliminary phytochemical screening with ethyl acetate, chloroform, acetone, methanol and aqueous extracts [8].

Northern Maharashtra bioactive plants (2022). Ethanol and methanol extracts of three plants from different families, including Diplocyclos palmatus, showed antibacterial activity against the tested bacteria, with the magnitude of activity dependent on the plant species and extract [9].

Meta-analytical overview (2024). A review of Dhule–Jalgaon–Nandurbar ethnomedicinal plants reported 60 species in 20 families (most frequently Fabaceae, Asteraceae, Euphorbiaceae and Apocynaceae) and alkaloids in about 80% of reviewed plants [10]. As this is a secondary compilation from a regional journal, its figures should be verified against primary sources before being relied upon.

IV. SELECTED PLANTS: PHYTOCHEMISTRY AND ANTIMICROBIAL EVIDENCE

Plant (family)	Main reported constituents	Antimicrobial relevance	Refs
Azadirachta indica (Meliaceae)	Limonoids, flavonoids, phenolics, tannins, saponins	Antibacterial, antifungal, antiviral, antibiofilm reports; clinical evidence limited	[11,12]
Ocimum tenuiflorum (Lamiaceae)	Eugenol, ursolic acid, rosmarinic acid, apigenin, luteolin, linalool	Broad-spectrum antibacterial and antifungal reports	[13,14]
Curcuma longa (Zingiberaceae)	Curcuminoids (curcumin and analogues)	Antibacterial, antifungal, antiviral; poor bioavailability	[15,16]
Moringa oleifera (Moringaceae)	Flavonoids, phenolics, alkaloids, carotenoids, isothiocyanates	Antibacterial activity of leaf and seed extracts	[17–19]
Cassia fistula (Fabaceae)	Anthraquinones (e.g. rhein, emodin), flavonoids, tannins, glycosides	Antibacterial and antifungal reports	[8,20,21]
Phyllanthus niruri (Phyllanthaceae)	Lignans, flavonoids, tannins, alkaloids, saponins	Antimicrobial reports among many bioactivities	[22]

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Plant (family)	Main reported constituents	Antimicrobial relevance	Refs
Eclipta alba (Asteraceae)	Wedelolactone, saponins, flavonoids (apigenin, luteolin)	Antimicrobial activity among many bioactivities	[23]
Enicostemma littorale (Gentianaceae)	Alkaloids, terpenoids, tannins	Disc-diffusion activity of extracts (baseline)	[7]

4.1 *Azadirachta indica* A. Juss. (neem)

Almost every part of neem is used in household remedies, and its antimicrobial activity has been explored in dentistry, food safety, bacteriology, mycology, virology and parasitology; the authors of a 2022 review conclude that mechanisms of action, clinical efficacy and in vivo safety still need to be established [11]. A narrative review of crude extracts summarises antibacterial and antifungal effects measured mainly by disc diffusion and inhibition-zone methods [12]. For Jalgaon, neem was among the plants whose endophytes showed antimicrobial activity [6], but no recent, standardised antimicrobial characterisation of Jalgaon neem populations was retrieved.

4.2 *Ocimum tenuiflorum* L. (tulsi)

Comprehensive reviews attribute tulsi's bioactivity to eugenol, ursolic acid, rosmarinic acid, apigenin and linalool, with extensively reported antioxidant, antimicrobial and anti-inflammatory effects [13,14]. Chemotype, cultivar (for example purple versus green tulsi) and extraction solvent can alter composition, so Jalgaon-grown material should be chemically profiled rather than assumed equivalent to published samples [13].

4.3 *Curcuma longa* L. (turmeric)

Curcumin, the principal curcuminoid, shows antibacterial, antifungal (including activity against dermatophytes and Candida) and antiviral effects in reviewed studies, but poor solubility and bioavailability are significant obstacles to clinical translation, motivating nanoformulations and analogues [15]. A systematic review of 32 publications selected from 671 records reached a broadly similar conclusion about its antibacterial promise [16].

4.4 *Moringa oleifera* Lam.

Reviews describe flavonoids, alkaloids, carotenoids and other phytochemicals in M. oleifera and note that composition varies with plant part and environmental factors [17,19]. Chemical analysis of leaves and seeds has been paired with antimicrobial testing [18]. Because Moringa is widely cultivated in Maharashtra, regional chemotype and soil-related variability are worth testing directly.

4.5 *Cassia fistula* L. (amaltas)

Pharmacological reviews report antioxidant, antimicrobial, anti-inflammatory, antidiabetic, antitumour and hepatoprotective activities for C. fistula, and describe it as a source of glycosides, tannins and flavonoids [20]; a mini review further highlights antioxidant, antidiabetic and antimicrobial properties [21]. For Jalgaon specifically, leaflet standardisation and solvent-wise phytochemical screening have been reported [8], but compound-level identification and MIC-based antimicrobial data from the district remain to be done.

4.6 *Phyllanthus niruri* L.

A 2022 review lists flavonoids (e.g. rutin), tannins and ellagitannins (e.g. geraniin, corilagin), lignans (phyllanthin, hypophyllanthin, phyltetralin), saponins and alkaloids, and attributes anticancer, antidiabetic, antihypertensive, anti-inflammatory, antimicrobial and antioxidant effects to the species [22]. The Khandesh region has also been targeted by antimicrobial screening of P. niruri together with Acalypha indica, Cassia auriculata and *Eclipta alba* (older regional report; full bibliographic details were not retrievable and it is therefore not cited).

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4.7 *Eclipta alba* (L.) Hassk.

A 2023 review describes hepatoprotective, antioxidant, antimicrobial, anti-inflammatory and many other activities of E. alba and links these to constituents such as wedelolactone and related compounds [23]. Jalgaon-specific antimicrobial and chemical-fingerprint data are limited.

4.8 *Enicostemma littorale* and *Aloe vera*

E. littorale from Satpuda was among the earliest North Maharashtra species screened for alkaloids, terpenoids and tannins with antimicrobial testing [7]. *Aloe vera* appears in district endophyte work, where root-derived isolates inhibited S. typhi [6]. Both species would benefit from modern, quantified re-evaluation using current methods.

V. PHYTOCHEMICAL CLASSES AND ANTIMICROBIAL MECHANISMS

Across the species above, the same broad metabolite groups recur and are most often linked to antimicrobial effects in the reviewed literature:

Phenolics and flavonoids (e.g. apigenin, luteolin, rosmarinic acid): linked to antibacterial and antioxidant activity [13,14].

Terpenoids and limonoids (e.g. ursolic acid, neem limonoids): reported as antimicrobial, with biofilm effects discussed for neem [11,13].

Curcuminoids: membrane and cellular-process effects, plus antifungal action [15].

Anthraquinones and tannins (e.g. C. fistula): associated with antibacterial and antifungal activity [20].

Alkaloids and saponins: frequently detected in preliminary screens of North Maharashtra plants [7,10].

Most regional studies use qualitative tests (e.g. Mayer's, Shinoda, ferric chloride) with extracts prepared by solvent maceration or Soxhlet extraction. More recent international studies pair such screening with agar-well or disc diffusion, MIC determination and GC-MS or LC-MS profiling [24]. Phytochemical screening alone does not identify the active compounds, and an inhibition zone is not equivalent to a therapeutically meaningful MIC.

VI. CRITICAL APPRAISAL OF THE EVIDENCE

Few recent Jalgaon-specific studies. Most district-sourced laboratory work retrieved here predates 2021 [6,7,8], with a limited number of recent regional contributions [9,10].

Methodological heterogeneity. Different solvents, plant parts, inocula and concentrations prevent quantitative comparison between studies.

Qualitative endpoints. Zone-of-inhibition data dominate; MIC/MBC, time–kill, cytotoxicity and synergy with antibiotics are rarely reported.

Geographic extrapolation. Phytochemical composition varies with part, season, soil and environment [17,19]; international findings should not be assumed to hold for Jalgaon populations.

Authentication and reproducibility. Voucher specimens and deposition details are not always reported.

Translation gap. For curcumin and neem in particular, bioavailability, mechanism and in vivo safety remain limiting factors [11,15].

VII. FUTURE DIRECTIONS

Standardised, voucher-authenticated collection across Jalgaon talukas, season and plant part, with GC-MS/LC-MS or HPLC fingerprints.

CLSI/EUCAST-aligned MIC/MBC testing against ATCC strains and local clinical isolates, including multidrug-resistant organisms [1,3].

Bioassay-guided fractionation to identify active constituents, plus synergy testing with standard antibiotics.

Cytotoxicity and toxicity assessment before any therapeutic claim.

Community-engaged documentation of tribal knowledge with benefit-sharing and conservation of threatened species.

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VIII. CONCLUSION

Jalgaon District harbours medicinal plants whose congeners and chemistry are strongly associated with antimicrobial activity in the recent global literature, but district-specific, quantitative and chemically characterised evidence is still limited. A coordinated programme of standardised extraction, chemical profiling, MIC-based testing and safety evaluation of Jalgaon-sourced material would turn existing ethnobotanical knowledge into evidence that can inform AMR-oriented drug discovery.

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