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Maerua Oblongifolia: A Comprehensive Review of Taxonomy, Ethnobotany, Phytochemistry, Pharmacology, Toxicology, Cultivation, Analytical Methods and Future Directions

Ms.Madhavi Pandhar, Ms.Rucha Pandit, Ms.Darshana Mainkar, Mr. Abhimanyu Mali, Mr. Rahul Pawar , Mr.Manoj Kadam

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ABSTRACT;
Maerua oblongifolia (Forssk.) A. Rich. (Capparaceae), commonly called Ram kand or Murva, is a tuberous shrub native to arid and semi arid regions of the Indian subcontinent and neighbouring areas, traditionally used for wound healing, skin disorders, gastrointestinal complaints and as a
rejuvenator or tonic [1][2]. Recent phytochemical and pharmacological studies report alkaloids, flavonoids, phenolics, saponins and steroidal compounds in various plant parts, and preclinical data indicate wound healing, antimicrobial, antioxidant and anti inflammatory activities that support ethnomedicinal uses [3][4][5]. However, systematic isolation of bioactive compounds, validated analytical markers, thorough toxicological evaluation and human clinical trials remain largely absent [1][2]. This review synthesizes botanical, ethnobotanical, phytochemical and pharmacological knowledge on M. oblongifolia, provides proposed analytical and experimental protocols, and highlights research priorities for translation and conservation.

KEYWORDS: Maerua oblongifolia, Ram kand, phytochemistry, wound healing, ethnobotany.

I. INTRODUCTION:

Maerua oblongifolia (Forssk.) A. Rich. Is an important but comparatively underexplored medicinal species that occupies a significant place in Ayurvedic, ethnomedicinal, and folk healing traditions, especially in arid and semi-arid regions of the Indian subcontinent. It is commonly known by several vernacular names such as Ram-kand, Ram-kandmool, Murva, and related local names, and the tuberous root is the part most frequently associated with medicinal value in traditional practice . In indigenous systems, the plant has been used for a

Figure 1. Maerua oblongifolia

wide range of therapeutic purposes including wound management, topical treatment of skin ailments, fever, digestive disturbances, general debility, and as a tonic or aphrodisiac, reflecting its broad ethnomedicinal relevance across different communities . Some reports also describe its use as a stimulant, febrifuge, diuretic, stomachic, purgative, and supportive remedy in fertility-related conditions, showing that local knowledge systems have attributed multiple actions to the species over time . The leaves have also been used in certain regions for fever and other minor ailments, while the root and tuber remain the most frequently cited medicinal parts in the literature .

Ecologically, the plant is adapted to dry to semi-arid habitats and is typically found in scrublands, roadside growth, forest edges, rocky tracts, and sandy soils of western India, particularly Rajasthan, Gujarat, Telangana, and adjoining areas . Its preference for harsh, water-limited environments makes it an important representative of resilient medicinal flora of arid ecosystems, and its survival in these habitats suggests strong adaptive traits that may also influence secondary metabolite production . Because the species is often collected from the wild for its medicinal tubers, localized depletion and habitat pressure have raised conservation concerns, especially in regions where the plant is already considered uncommon or scarce . This makes

Maerua oblongifolia not only a medicinal resource but also a conservation-relevant species requiring sustainable harvesting, cultivation, and propagation strategies . In recent years, this traditional importance has led to renewed scientific interest, particularly in phytochemical profiling, pharmacognostical authentication, antimicrobial screening, antioxidant evaluation, and wound-healing studies, which together aim to validate its folk reputation and support safe future use . Studies on its morphology, anatomy, and bioactivity have therefore become essential for establishing quality control standards, identifying marker compounds, and clarifying the scientific basis of its traditional applications.

3. TAXONOMY AND OTHER INTRODUCTION:

3.1 Taxonomy and accepted name:

Maerua oblongifolia (Forssk.) A. Rich. is the accepted botanical name of the species and is placed in the family Capparaceae according to major plant databases and regional floras [1][4]. The species is listed under the genus Maerua and is recognized in global taxonomic repositories such as Plants of the World Online and GBIF, confirming its current nomenclatural status [1][4]. In older regional or ethnobotanical literature, the plant has been associated with several synonymous or historical names, and the name "Murva" is commonly used in Ayurvedic contexts, while "Ram-kand" or "Ram-kandmool" is widely used in Indian folk medicine [2][6]. This multiplicity of names is important because it has historically created confusion in the identification of medicinal crude drugs, especially when the species is discussed alongside other "Murva" sources in classical texts and pharmacognostical literature [7][2]. Accurate taxonomic recognition is therefore essential for proper authentication, conservation planning, and medicinal standardization [5][3].

3.2 Morphological characteristics:

Maerua oblongifolia is generally described as a low woody bushy under-shrub or scandent shrub that may climb or sprawl in dry habitats, with a thick root stock or tuberous underground portion that is considered the major medicinal part [5][8]. The aerial stems are woody and branched, supporting alternate simple leaves that are typically oblong to elliptic in form, with a leathery texture adapted to arid conditions [5][8]. The flowers are fragrant, white to yellowish, and often conspicuous because of their elongated stamens, a character that is commonly mentioned in floristic descriptions of the species [5][8]. The fruits are small berries, and flowering generally occurs in the dry season, which is ecologically significant because it reflects the plant's adaptation to xeric environments and low moisture availability [3][8]. The presence of a thick root stock, scented flowers and a woody bushy habit provides a useful field-level diagnostic combination for preliminary recognition in natural habitats [5][8].

3.3 Diagnostic pharmacognostical characters:

Pharmacognostical investigations have provided important microscopic and macroscopic characters for identification of the crude drug derived from Maerua oblongifolia [5][9]. Studies on the leaf report amphistomatic anatomy, mostly anomocytic stomata with a few tetracytic stomata, a single-layered epidermis, and a differentiated mesophyll with palisade and spongy tissues [5]. The midrib region shows ribbing on both sides and a central oval vascular bundle, while the petiole is described as circular with a groove on the adaxial side and a central vascular bundle enclosed by endodermis [5]. Powder microscopy and organoleptic studies further assist in authentication by revealing structural features that can be used to distinguish the drug from adulterants or substitutes [5]. In root-based pharmacognostical studies, tuber macroscopy, internal tissue organization, and the presence of characteristic starch grains, calcium oxalate crystals and vascular elements are noted as important diagnostic features for quality assessment [9][7]. These characters are especially valuable because crude herbal materials are often collected from wild sources and may be subject to substitution, admixture or misidentification during trade [5][7].

3.4 Distribution, habitat and ecological preference:

Maerua oblongifolia occurs mainly in arid and semi-arid zones, particularly in western India, including Rajasthan and Gujarat, and in some reports from other dry tracts of the subcontinent [10][2][4]. It is typically associated with sandy, well-drained soils, scrub vegetation, thorn forest margins and rocky or degraded habitats where water availability is low and ecological stress is high [10][2]. Regional flora reports describe it as drought-tolerant and suited to harsh environmental conditions, which may partly explain its presence in dry deciduous and thorny forest ecosystems [2][8]. This habitat preference is also relevant to medicinal quality because secondary metabolite synthesis in xerophytic plants may be influenced by environmental stress, sunlight exposure and soil conditions [3][4]. From a conservation perspective, its natural distribution appears patchy, and local abundance may vary

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substantially from one region to another [10][2]. Such ecological specificity means that uncontrolled harvesting of tubers can rapidly reduce natural populations, particularly because root removal is destructive and generally prevents regeneration [10][11].

3.5 Ethnobotany and traditional uses:

Ethnomedicinal literature describes Maerua oblongifolia as an important traditional remedy in Ayurveda and folk medicine, where the tuber and aerial parts are used for wound healing, skin disorders, abdominal pain, fever, weakness and other general complaints [6][12][2]. The root or tuber is the most frequently cited part in medicinal practice and is often prepared as a paste, powder or decoction for both topical and internal use [13][6]. In traditional wound care, the tuber paste is applied directly to cuts, ulcers, and inflamed skin lesions, suggesting a longstanding empirical belief in its vulnerary properties [6][14]. The plant is also mentioned in relation to stomach ache, digestive support, debility and aphrodisiac use, indicating that its traditional importance extends beyond dermatological medicine [12][2]. Some reports additionally note use in fever, urinary complaints, abdominal colic and conditions associated with weakness or convalescence [5][12]. Such multipurpose usage is typical of medicinal plants in ethnobotanical systems, where the same species may be incorporated into different formulations depending on the ailment and the preparation method [6][2]. The fact that Maerua oblongifolia is used in tribal communities and local pharmacy traditions as part of polyherbal formulations underscores its cultural relevance and suggests that its medicinal reputation has been maintained through oral transmission over generations [13][14][12]. At the same time, this wide traditional use also highlights the need to validate claims scientifically so that safe and rational use can be encouraged while avoiding overharvesting and depletion of wild stocks [10][11].

6. PHYTOCHEMISTRY

6.1 Overview and qualitative screenings:

Phytochemical investigation of Maerua oblongifolia has shown that the plant is a rich source of diverse secondary metabolites, and this chemical diversity is likely responsible for many of the biological effects reported in traditional and experimental studies [1][3][6]. Preliminary screening of different solvent extracts has repeatedly identified the presence of alkaloids, flavonoids, phenolic compounds, tannins, saponins, steroids and glycosides, although the exact profile varies according to the plant part examined, the geographic source of the material, the harvesting season and the polarity of the extraction solvent [1][3][6]. In general, ethanolic and methanolic extracts tend to yield a broader spectrum of phenolic and flavonoid-rich fractions, while aqueous extracts may contain more polar glycosidic and tannin-like constituents [1][4]. Such solvent-dependent variation is important because it means that different reports on the same species may not be directly comparable unless the extraction method is standardized [4][2].

Several studies have also demonstrated that total phenolic content and total flavonoid content are positively associated with antioxidant activity, suggesting that these classes of compounds contribute significantly to the free-radical scavenging potential of the plant [4][3][2]. This is particularly relevant for wound-healing research, because phenolic compounds and flavonoids are known to reduce oxidative stress, stabilize cellular membranes and support tissue repair processes [3][2]. The occurrence of alkaloids and saponins may further expand the pharmacological potential of the plant, since these metabolites are often associated with antimicrobial, anti-inflammatory and membrane-modulating effects [1][6]. Therefore, the crude phytochemical profile of M. oblongifolia provides an important biochemical basis for its ethnomedicinal use and helps explain why the species has attracted increasing scientific interest in recent years [6][3].

6.2 GC–MS and other chromatographic analyses:

Gas chromatography–mass spectrometry (GC–MS) studies of methanolic leaf extracts have identified a complex mixture of volatile and semi-volatile constituents in Maerua oblongifolia [2][7]. These studies commonly report the presence of phenolic derivatives, fatty acid methyl esters, terpenoid-related compounds and other low-molecular-weight substances that may contribute to biological activity [2][7]. The GC–MS profile is especially valuable because it provides an initial chemical fingerprint of the plant and supports future chemotaxonomic and standardization work [2][3].

One of the major findings across these chromatographic studies is that the number and identity of detected compounds can differ substantially between reports, with some studies identifying around 20 compounds while others report 28 or more peaks depending on extraction conditions, instrumentation and plant provenance [2][7]. This variability is not surprising because

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phytochemical composition in medicinal plants is influenced by environmental stress, soil composition, climate, altitude, maturity of the plant and post-harvest processing [4][3]. In a species such as M. oblongifolia, which grows in arid and semi-arid habitats, harsh ecological conditions may also stimulate the biosynthesis of certain secondary metabolites, particularly phenolics and antioxidant-related compounds [3][4].

Chromatographic profiling is therefore not merely a descriptive exercise but a critical step in medicinal plant development. It helps identify reproducible chemical markers, improves quality control, and provides a basis for linking particular peaks or fractions with biological activity [2][6]. In the case of M. oblongifolia, GC–MS studies support the idea that the plant contains bioactive compounds with potential antimicrobial, antioxidant and wound-healing relevance, but the findings remain largely preliminary because they are based on crude extracts rather than purified metabolites [2][7]. Additional separation techniques such as HPTLC, HPLC, LC–MS/MS and preparative chromatography are needed to confirm compound identity and to move beyond simple profiling toward meaningful pharmacological characterization [6][3].

6.3 Isolated compounds and structural data:

Although phytochemical screening and GC–MS studies have generated useful preliminary data, the number of fully isolated and structurally elucidated compounds from Maerua oblongifolia remains limited [8][9]. Most of the available literature focuses on crude extract analysis, solvent fractionation or detection of volatile constituents rather than on complete purification and NMR-based structural determination of individual molecules [8][2]. This represents a major gap in the phytochemical literature because crude extract findings alone cannot establish which specific compounds are responsible for the observed pharmacological actions [8][3].

Some reports indicate that the root bark and leaf extracts contain chemically diverse constituents with measurable antioxidant and antibacterial capacity, and chemometric approaches have been proposed to better correlate compound patterns with biological activity [4][3]. However, without full isolation and structural confirmation, it is difficult to compare M. oblongifolia with other medicinal plants at the level of marker compounds or biosynthetic classes [8][6]. Future studies should therefore prioritize bioassay-guided fractionation, followed by spectroscopic characterization using UV, IR, MS, 1D-NMR and 2D-NMR methods to identify the active principles in a rigorous manner [8][2].

From a drug-development perspective, this is one of the most important unmet needs in the research on this species. If the major bioactive constituents are isolated and standardized, the plant could move from an ethnomedicinally important resource to a scientifically validated phytopharmaceutical candidate [6][3]. Until that happens, most pharmacological interpretations should remain cautious and should be framed as preliminary evidence supporting further investigation rather than definitive proof of efficacy [2][7].

Table 1: Phytochemical profile

Sr.No	Part of plant	Ingredients
1.	Tuber (aqueous/ethanol)	Alkaloids, saponins, glycosides, tannins, steroids, phenolics. [1][8]
2.	Leaves (methanol/ethanol)	Flavonoids, phenolics, terpenoids; GC–MS identified 20–28 compounds including aromatic derivatives and fatty acid esters. [3][7]
3.	Stem/flower	Minor sterols and flavonoids detected in solvent screens, limited data. [1]


Figure.2. Plant of Maerua Oblongifolia

7. PHARMACOLOGY :

7.1 Wound healing:

Several in vivo studies using excision and incision wound models in rats report that topical application of ethanolic or hydroalcoholic tuber extracts accelerates wound contraction, reduces epithelization period and improves histological indices of healing compared to controls, with some reports showing efficacy comparable to standard topical antibiotics in the tested models [4][10]. These studies frequently attribute effects to antioxidant and antimicrobial properties, but often lack mechanistic endpoints (e.g., collagen synthesis, growth factor expression) and use variable extract preparations and dosing regimens [4].

7.2 Antimicrobial and antifungal activity:

In vitro antimicrobial assays (disc diffusion, MIC) on crude extracts show activity against Gram positive and Gram negative bacteria and some fungi commonly implicated in wound infections; however, MIC values and cross study reproducibility are inconsistently reported, and activity depends on solvent polarity and extract concentration [4][5].

7.3 Antioxidant activity:

Methanolic and ethanolic extracts display significant free radical scavenging in DPPH, ABTS and reducing power assays, with activity generally correlating with total phenolic/flavonoid content; such antioxidant properties are hypothesized to contribute to wound healing and anti inflammatory effects [3][5].

7.4 Anti inflammatory, hepatoprotective and other effects:

Limited animal studies indicate anti inflammatory effects in acute inflammation models and hepatoprotective signals in toxin induced hepatic injury, but data are sparse and often from single studies without comprehensive toxicology or dose response analyses [5][17].

7.5 Mechanistic Insights:

Mechanistic evidence remains minimal; few studies assess cellular processes such as fibroblast proliferation, collagen deposition, cytokine modulation or matrix metalloproteinase regulation, which are critical to validating wound healing claims at a molecular level [4]. Future studies should include in vitro assays (keratinocyte/fibroblast migration, collagen synthesis, cytokine profiling) and mechanistic molecular endpoints.

Table 1: Antioxidant Activity

Activity	Model	Extract	Findings
Wound healing	Rat excision/incision	70% ethanol tuber extract (topical).	Accelerated wound contraction; reduced epithelization time; comparable to standard antibiotic ointment in some studies
Antimicrobial	In vitro (disc diffusion/MIC)	ethanol tuber extract (topical).	Inhibition of S. Aureus, P. Aeruginosa, Candida spp. Reported; MICs variable.
Antioxidant	DPPH, ABTS assays	Methanolic leaf extract	Significant radical scavenging; correlation with phenolic content
Anti inflammatory	Animal acute inflammation tests	Crude extracts	Reduced inflammatory markers (single studies)

8. TOXICOLOGY AND SAFETY:
Acute toxicity studies in rodents report relatively low acute toxicity for crude extracts at doses tested; nevertheless, rigorous subacute and chronic toxicity testing, reproductive and developmental toxicity, genotoxicity and systematic herb drug interaction studies are not available or insufficient to permit confident human safety assessment [1][2]. Standardized extract chemistry is essential before human safety trials can proceed [1].

9. CULTIVATION, PROPAGATION AND CONSERVATION
Maerua oblongifolia faces population decline in parts of its native range due to harvesting of tubers and habitat loss, and is considered rare in some local floras; ex situ cultivation, micropropagation and sustainable harvesting guidelines have been recommended to conserve resources and provide raw material for research and potential therapeutic development [6][18][7]. Tissue culture methods show promise for mass propagation and conservation of genetic material [18].

10. ANALYTICAL METHODS AND STANDARDIZATION
10.1 Current state
Published studies provide TLC/HPTLC fingerprints, GC–MS volatile profiles and spectrophotometric estimates of total phenolic and flavonoid content, but validated, widely accepted markers and official monographic standards are lacking [1][3][14].

10.2 Proposed standardization workflow

- Botanical authentication: voucher specimens and pharmacognostical microscopy per WHO herbal monograph guidance [8][14].
- Extraction: standardized 70% ethanol Soxhlet or maceration; record extraction yield and residual solvents. [4]
- HPTLC fingerprint: silica gel 60 F254 plates; suggested mobile phase (optimize—example toluene:ethylacetate:formic acid 6:4:0.5), visualise at 254/366 nm and after spraying with NP PEG reagent to detect flavonoids; select densitometric peaks as marker bands for quantification [1].
- HPLC/LC MS: C18 column, gradient acetonitrile/water (0.1% formic acid), detection at 280/330 nm; employ LC MS/MS for peak identification and to link HPTLC bands to MS fragments [3].
- GC–MS for volatile/semi volatile constituents as complementary profiling for chemotaxonomy [3].

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11. GAPS AND FUTURE DIRECTIONS:

Major gaps include lack of isolated bioactive molecules with full structural elucidation, absence of standardized markers and monographs, limited mechanistic pharmacology, inadequate toxicology data and no randomized clinical trials; addressing these will require multidisciplinary collaboration across phytochemistry, pharmacology, toxicology and conservation biology [1][3][4]. Priority actions: (1) targeted fractionation and compound isolation with structure elucidation (NMR, HR MS); (2) validated analytical fingerprints and monograph development; (3) mechanistic studies on cellular wound healing pathways; (4) GLP toxicology studies; (5) pilot human safety (phase I) and topical wound healing efficacy trials; and (6) sustainable cultivation and germplasm conservation programs [1][6][7].

12. PROPOSED EXPERIMENTAL PROTOCOLS:

12.1 Standard extract (example)

Powdered tuber (50 g) extracted with 500 mL 70% ethanol in Soxhlet for 8–12 h; filter and concentrate under reduced pressure; record % yield; store at 4°C. Use glycerin or simple ointment base for topical formulations (5–10% w/w extract) for wound model studies [4].

12.2 Excision wound model (example)

Adult Wistar rats (200–250 g) under anesthesia; create 500 mm2 full thickness excision wound on dorsum; randomize groups (n=6–8): vehicle, standard (e.g., 1% neomycin cream), low dose (5% extract ointment), high dose (10% extract ointment); apply daily; measure wound area at days 0, 3, 7, 10, 14; calculate % contraction and time to epithelization; collect tissue for hydroxyproline assay and histology [4].

12.3 In vitro assays for mechanism

- Fibroblast proliferation (MTT assay) and migration (scratch assay).
- Collagen synthesis: hydroxyproline quantification in cell culture supernatant and tissue.
- Cytokine modulation: measure IL 1β, IL 6, TNF α and TGF β by ELISA in wound tissue homogenates. These endpoints will link observed macroscopic wound healing to molecular mechanisms [4].

13. CONSERVATION, CULTIVATION AND SOCIOECONOMIC ASPECTS:

Promoting cultivation (seed and vegetative propagation protocols), establishing germplasm banks and engaging local communities in sustainable harvest and benefit sharing are essential to conserve wild populations and supply raw material for research and industry [6][18]. Socioeconomic studies on traditional knowledge holders and value chains can guide equitable development of Maerua based products.

14. CONCLUSION:

Maerua oblongifolia is a traditionally important medicinal species with promising preclinical pharmacology—especially wound healing, antimicrobial and antioxidant activities—that align with ethnobotanical uses; however, substantial phytochemical, mechanistic, toxicological and clinical work is needed for safe and effective therapeutic development, alongside conservation and cultivation efforts to secure sustainable supply [1][4][2].

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