

EUPHORBIA NERIIFOLIA LINN. (SNUHI): AN INTEGRATIVE REVIEW OF BOTANICAL IDENTITY, ETHNOMEDICINE, PHARMACOGNOSY, PHYTOCHEMISTRY, PHARMACOLOGICAL POTENTIAL AND SAFETY

Dr. Rishabh Singh¹, Prof. (Dr.) Pravin Kumar Joshi², Dr. Vikram Kumar³, Dr. Shubhanjali Singh⁴, Dr. Nisha Paikra⁵, Dr. Jhanak ram⁶, Dr. Roshan rathore⁷, Dr. Chumman Sahu⁸

¹MD Scholar, Department of Dravyaguna Vigyan Vibhag, Shri NPA Govt. Ayurved College Raipur, (CG); Pt. Deendayal Upadhyay Memorial Health Sciences and Ayush University of Chhattisgarh. Email: rishabhsingh1819@gmail.com

²Professor & HOD, Department of Dravyaguna Vigyan Vibhag, Shri NPA Govt. Ayurved College Raipur, (CG); Pt. Deendayal Upadhyay Memorial Health Sciences and Ayush University of Chhattisgarh. Email: pravinkumarjoshi1970@gmail.com

³MD Scholar, Department of Dravyaguna Vigyan Vibhag, Shri NPA Govt. Ayurved College Raipur, (CG); Pt. Deendayal Upadhyay Memorial Health Sciences and Ayush University of Chhattisgarh. Email: vk403264@gmail.com

⁴MD Scholar, Department of Dravyaguna Vigyan Vibhag, Shri NPA Govt. Ayurved College Raipur, (CG); Pt. Deendayal Upadhyay Memorial Health Sciences and Ayush University of Chhattisgarh. Email: sshubhanjali22@gmail.com

⁵MD Scholar, Department of Dravyaguna Vigyan Vibhag, Shri NPA Govt. Ayurved College Raipur, (CG); Pt. Deendayal Upadhyay Memorial Health Sciences and Ayush University of Chhattisgarh. Email: nishapaikra224@gmail.com

⁶MD Scholar, Department of Dravyaguna Vigyan Vibhag, Shri NPA Govt. Ayurved College Raipur, (CG); Pt. Deendayal Upadhyay Memorial Health Sciences and Ayush University of Chhattisgarh. Email: jhanakramjaiswal1998@gmail.com

⁷MD Scholar, Department of Dravyaguna Vigyan Vibhag, Shri NPA Govt. Ayurved College Raipur, (CG); Pt. Deendayal Upadhyay Memorial Health Sciences and Ayush University of Chhattisgarh. Email: roshanrathore2419@gmail.com

⁸MD Scholar, Department of Dravyaguna Vigyan Vibhag, Shri NPA Govt. Ayurved College Raipur, (CG); Pt. Deendayal Upadhyay Memorial Health Sciences and Ayush University of Chhattisgarh. Email: chummansahu766@gmail.com

ABSTRACT

Euphorbia neriifolia Linn. (Euphorbiaceae), traditionally known as Snuhi or Sehund, is a succulent, latex-bearing medicinal plant widely associated with dry and rocky habitats of the Indian subcontinent. Its long-standing use in Ayurveda, Unani and regional ethnomedicine has stimulated extensive pharmacognostic, phytochemical and pharmacological investigation. This review consolidates botanical identity, distribution, classical categorization, vernacular nomenclature, cultivation and seasonal collection, macroscopic and microscopic characters, ethnobotanical applications, Ayurvedic properties and formulations, physicochemical standards, medicinal uses, phytochemical constituents, pharmacological evidence, petro-crop potential, quality-control requirements, toxicological concerns and future research priorities. The plant contains chemically diverse constituents, particularly triterpenes, diterpenes, flavonoids, saponins, glycosides, phenolic compounds and latex proteins. Compounds and fractions reported from different organs include euphol, taraxerol, β -amyrin, cycloartenol, neriifolione, eupnerias, eurifoloids, phorneroids and several ingenane- and abietane-type diterpenoids. Experimental studies describe antioxidant, anti-inflammatory, anti-arthritis, antimicrobial, antiviral, antidiabetic, immunomodulatory, wound-healing, radioprotective, analgesic, hepatoprotective and anticancer-related effects. However, evidence remains heterogeneous and is dominated by in vitro and animal studies; traditional use should therefore not be equated with established clinical efficacy. The latex is biologically active and potentially irritant or toxic, making correct identification, dose control, processing, safety evaluation and standardized quality testing essential. Future work should integrate authenticated plant material, validated chemical fingerprints, mechanism-based assays, pharmacokinetic studies and well-designed clinical investigations to define reproducible therapeutic applications.

KEYWORDS: *Euphorbia neriifolia*; Snuhi; Sehund; Euphorbiaceae; ethnobotany; pharmacognosy; phytochemistry; diterpenoids; triterpenoids; latex; pharmacological activities; standardization; toxicology

1. INTRODUCTION

Medicinal plants remain important sources of traditional healthcare knowledge and chemically diverse natural products.¹ Their contemporary investigation requires integration of botanical authentication, pharmacognosy, phytochemistry, pharmacology and safety assessment rather than reliance on historical use alone.² *Euphorbia neriifolia* Linn.³ is a prominent succulent member of Euphorbiaceae that has been used in several Asian traditional systems.⁴ It is recognizable by its green succulent branches, persistent paired spines, terminal leaves and characteristic milky latex.⁵ The species has attracted research attention because its different organs yield chemically diverse metabolites, including diterpenoids and triterpenoids with reported antiviral, anti-inflammatory, antioxidant, cytotoxic or antiproliferative-related activities in experimental models.⁶ Ethnomedicinal reports describe applications involving respiratory, gastrointestinal, dermatological, inflammatory and other disorders, while Ayurvedic literature assigns Snuhi distinctive rasa, guna, virya, vipaka and karma.⁷ At the same time, the latex can cause marked irritation and other toxic effects, emphasizing the

importance of dose, processing and quality control.⁸ The present review therefore brings together classical descriptions and contemporary evidence in a single, systematically organized account of *E. neriifolia*, with emphasis on identification, traditional applications, phytochemical diversity, pharmacological evidence, safety and research gaps.

2. Botanical Identity, Etymology, Distribution and Origin

The genus name *Euphorbia* is traditionally linked with Euphorbus, the physician associated with King Juba II of Mauretania.⁹ The specific epithet *neriifolia* refers to the foliage resembling that of *Nerium* or oleander.¹⁰ *E. neriifolia* is a succulent, xerophytic species adapted to dry conditions and is commonly associated with rocky terrain, hill slopes and rock crevices. In the Indian subcontinent it has been reported particularly from dry and semi-arid regions, while its cultivation as a living fence or hedge has been documented in India and several neighbouring regions.¹²

2.1 Scientific Classification

Table 1. Scientific classification of *Euphorbia neriifolia*

Rank	Classification
Kingdom	Plantae
Subkingdom	Tracheobionta
Super-division	Spermatophyta
Division	Magnoliophyta
Class	Magnoliopsida
Subclass	Rosidae
Order	Malpighiales
Sub-order	Euphorbiales
Family	Euphorbiaceae
Subfamily	Euphorbioideae
Tribe	Euphorbieae
Subtribe	Euphorbiinae
Genus	<i>Euphorbia</i>
Species	<i>neriifolia</i> Linn.

2.2 Nomenclature and Synonyms

The literature records several taxonomic or historical names associated with *E. neriifolia* and closely related *Euphorbia* taxa.¹⁴ Names reported in the reviewed sources include *Euphorbia ligularia* Roxb.¹⁵; *E. antiquorum* Linn.¹⁶; *E. nivulia* Buch.-Ham.¹⁷; *E. royleana* Boiss.; *E. tirucalli* Linn.; *E. caducifolia* Haines; and *E. trigona* Haw. Because some historical names may represent distinct taxa rather than strict nomenclatural synonyms, they should be treated cautiously during pharmacognostic authentication.

2.3 Classical Ayurvedic Categorization

Classical Ayurvedic lexicons place *Snuhi* in different pharmacognostic groupings, including *Guduchyadi Varga* in *Dhanvantari Nighantu*, *Shodhala Nighantu* and *Bhavaprakasha Nighantu*; *Aushadhi Varga* in *Kaiyadeva Nighantu*; and *Shalmalyadi Varga* in *Raja Nighantu*.⁸

2.4 Vernacular and Regional Names

Table 2. Vernacular names of *Euphorbia neriifolia*

No.	Region / Language	Reported names
1	English	Indian spurge tree; milk hedge; oleander spurge; hedge <i>Euphorbia</i>
2	Sanskrit	<i>Snuhi</i> ; <i>Sudha</i> ; <i>Snuk</i> ; <i>Vajri</i> ; <i>Vajravriksha</i> ; <i>Nistrinshapatra</i> ; <i>Ksheerakanda</i> ; <i>Bahushakha</i>
3	Hindi	<i>Thuhar</i> ; <i>Sehund</i> ; <i>Sij</i> ; <i>Patton-ki-send</i> ; <i>Danda-thor</i>
4	Gujarati	<i>Thor</i> ; <i>Tuaria</i> ; <i>Kantalo</i> ; <i>Kantaluthohar</i>
5	Marathi / Maharashtra	<i>Nivadunga</i> ; <i>Vayinivadunga</i> ; <i>Mingut</i>
6	Bengal / Oriya	<i>Mansasij</i> ; <i>Shij</i> ; <i>Siju</i> ; <i>Kantalothor</i>
7	Tamil / Malayalam	<i>Ilaikkalli</i> ; <i>Kalli</i> ; <i>Elakkalli</i> ; <i>Ilakkalli</i>
8	Kannada / Telugu	<i>Yelekalli</i> ; <i>Elekalli</i> ; <i>Akujemudu</i> ; <i>Kadajemudu</i>
9	Urdu / Tibetan / regional Asian names	<i>Zaqqum</i> ; <i>Thuhar</i> ; <i>Snu-ha</i> ; <i>Som chao</i> ; <i>Sesudu</i>

The nomenclature is highly region-dependent; vernacular names should therefore be interpreted together with botanical authentication rather than used alone for identity¹³

2.5 Unani Descriptions and Morphological Types

In Unani literature, *Thuhar* is described as a latex-bearing herbal drug and is represented by morphological varieties distinguished mainly by stem and leaf form.¹⁸ The reviewed description recognizes *Chaudhara Thuhar* with quadrangular stem and leaves, *Tadhara Thuhar* with triangular stem and leaves, and *Danda Thuhar* with rounded stem and leaves.

3. Cultivation, Propagation and Seasonal Harvesting

3.1 Cultivation Requirements

E. neriifolia is a hardy succulent that performs well under good sunlight but can tolerate partial shade.¹⁹ It is naturally suited to dry, rocky and well-drained substrates. Because of its xerophytic habit, prolonged water stagnation around the roots should be avoided. The reviewed literature describes regular watering during active growth, particularly from March to September, followed by comparatively dry winter conditions. Once established, the plant requires relatively little routine management and may attain substantial size within a few years.

3.2 Seasonal Collection of Plant Parts

Traditional collection practices are linked with the season and plant part.¹⁹ The reviewed Ayurvedic sources report rainy-season collection for leaves, pre-rainy-season collection for roots, early winter collection for latex, autumn collection for bark and summer collection for fruit. The broader seasonal framework summarized below is intended as a traditional collection guide rather than a substitute for validated quality-control specifications.

Table 3. Traditional seasonal collection of different plant parts

Plant part / category	Traditional collection period
Leaves and branches	Spring (Vasanta) and rainy season (Varsha)
Roots	Late winter (Shishira) and summer (Grishma)
Latex, rhizome and bark	Autumn (Sharad), heartwood in its appropriate season, and early winter (Hemanta)
Fruit and flower	As appropriate to the season of maturity (Ritu)
Plants described as hot in potency	Summer (Grishma)
Plants described as cold in potency	Late winter (Shishira)

4. Morphological and Macroscopic Characteristics

4.1 General Plant Habit

E. neriifolia is a xerophytic, succulent shrub or small tree that may reach approximately 20 ft under favourable conditions.²⁰ The plant is highly branched and generally glabrous when erect. Branches are succulent and angular in cross-section, commonly showing five longitudinal ribs associated with paired stipular spines. Thick, fleshy leaves occur toward the terminal portions of branchlets, while the mature bark develops a reticulate appearance.

4.2 Stem

The stem is green, succulent and cylindrical to angular, with a prominent ribbed surface and sharp paired spines.²¹ Internally, the central region contains a pale parenchymatous mass and a conspicuous pith; dried material may fracture readily and expose the hollow or porous central tissue.²² The stem has an acrid and astringent character in traditional descriptions.²³

4.3 Leaves

Leaves are thick, succulent, short-petiolate and generally concentrated near the ends of young branches.¹¹ They are deciduous and may be sparse or absent for extended periods, with renewed foliage commonly appearing during the monsoon and continuing into the later rainy season.²⁰ Reported dimensions are approximately 8–14 cm in length and around 8 cm in breadth, with an acute apex and leathery to fleshy texture.²⁴

4.4 Stipular Spines

The spines are persistent, short, rigid and sharply pointed, usually blackish-brown to brown.²⁰ They arise from the longitudinal ribs and occur in pairs at low, conical tubercles arranged along the stem.²² Their paired and regularly spaced arrangement is an important macroscopic diagnostic feature.

4.5 Inflorescence

The reproductive unit is a cyathium, the characteristic pseudanthial inflorescence of *Euphorbia*.²⁵ A cyathium contains highly reduced male and female flowers organized within a common involucre. The female component develops a three-locular ovary, whereas numerous reduced male flowers surround it.

4.6 Involucre and Associated Structures

The involucre is associated with nectariferous glands, bracteoles and specialized lobed structures.²⁵ The cyathial organization includes a central female flower and peripheral male units, with the styles terminating in bifid stigmatic structures.²⁴ Capsules are deeply three-lobed and may vary in visibility depending on reproductive development.

4.7 Fruit

The fruit is a three-lobed capsule with three chambers and a radiating follicular appearance.²⁴ It is greenish when immature and becomes more conspicuous as it matures. Each chamber may contain a seed, although fruit and seed production can be relatively inconspicuous in some field observations.

4.8 Seeds

Seeds are small, approximately mustard-seed sized, and may appear greyish-brown.²¹ The surface is comparatively soft and may show fine hair-like or textured features.²² Seed characters are useful as supporting observations but are less practical than vegetative and microscopic characters for routine authentication.

4.9 Latex

The plant produces a characteristic white, sticky latex after tissue injury.¹⁹ The latex is stored in specialized laticiferous structures and contains a chemically complex mixture of resinous substances, terpenoids, diterpenes, proteins and other metabolites.²⁰ Reported analytical values include substantial resinous matter and solid content, although these parameters vary with plant part, collection conditions and analytical method.²⁶

5. Ethnomedicinal and Therapeutic Uses

The ethnobotanical record of *E. neriifolia*.²⁷ is extensive and geographically diverse. The reviewed literature describes uses of the whole plant, latex, leaves, stems and roots for respiratory, gastrointestinal, inflammatory, dermatological and other traditional indications. These reports represent traditional or experimental evidence and should not be interpreted as proof of clinical efficacy.

Table 4. Ethnobotanical and therapeutic uses of different plant parts of *Euphorbia neriifolia*

Plant part	Representative traditional medicinal uses
Whole plant	Fever, inflammation, piles, bronchial complaints, digestive disorders, selected Vata disorders
Leaves	Asthma, earache, wound care, cough/bronchitis, piles, carminative and expectorant uses
Stem	Cough/cold, expectoration, warts, selected respiratory and fistula-related uses
Latex	Purgative use, piles, warts, selected skin disorders, rheumatic complaints, burns and wounds
Bark	Selected urinary and traditional medicinal applications
Roots	Snake/scorpion bite traditions, antispasmodic and dropsical uses

5.1 Whole-Plant Applications

Whole-plant preparations have been traditionally associated with conditions such as fever, inflammation, piles, bronchial complaints, digestive disturbance and selected Vata-dominant disorders.¹¹ The plant is also used as a living fence because of its spines and has been reported in local agricultural practice as an insecticidal or protective plant.¹⁷

5.2 Latex Applications

Latex is among the most pharmacologically active and toxicologically important parts.¹⁸ Traditional applications include purgative preparations, piles, warts, selected skin disorders, earache, rheumatic complaints, fistula, burns, wounds and cracks of the feet.¹⁹ Regional reports also describe its incorporation into aphrodisiac mixtures and combinations with other plant materials.²⁸ Because fresh latex can irritate skin and mucosa, these traditional uses require careful interpretation and should not be translated directly into self-treatment recommendations.²⁷

5.3 Leaf Applications

Leaves have been traditionally used as carminative, stomachic and expectorant agents and in folk preparations for asthma, cough, bronchial complaints, earache, wound care, piles and selected inflammatory conditions.¹¹ Steamed leaves or leaf preparations are reported in wound management in traditional sources.²⁰ Experimental studies have also examined leaf extracts for antioxidant, anti-inflammatory, immunomodulatory, analgesic and anticancer-related effects.²⁴

5.4 Stem Applications

Stem juice or pulp has been reported in traditional practice for cough, cold, respiratory complaints, expectoration of phlegm, warts and hydrophobia.¹⁷ Combinations with honey, black pepper, ginger or other ingredients occur in regional descriptions.²⁷

5.5 Root Applications

Root preparations have been reported for snake bites, scorpion stings, antispasmodic applications and dropsical conditions, often in combination with black pepper or other materials.¹¹ These are historical ethnomedicinal reports and cannot substitute for emergency medical treatment in envenomation.¹⁷

6. Pharmacognostic Microscopy and Powder Diagnostics

6.1 Leaf Microscopy

A transverse section of the leaf shows a compact epidermal organization with differentiated adaxial and abaxial surfaces.²⁴ Stomata are predominantly anomocytic, while the mesophyll is dorsiventral and consists of palisade tissue toward the upper surface and spongy parenchyma toward the lower surface.²⁹ The midrib contains collenchymatous and parenchymatous tissues with prominent vascular elements, including lignified xylem and comparatively non-lignified phloem. Calcium oxalate crystals and starch grains may occur within the mesophyll. Trichomes and characteristic vein-islet features provide additional diagnostic value.

6.2 Stem Microscopy

The stem section shows a distinct epidermal layer with cuticular development, followed by chlorenchymatous and parenchymatous tissues.²¹ Latex-containing structures and oil globules may occur in the peripheral regions.²⁹ The cortex surrounds a large parenchymatous pith and a conspicuous vascular system.³⁰ Xylem vessels, fibres, medullary rays, phloem and pericyclic tissues contribute to the diagnostic microscopic profile.³¹ Laticiferous elements containing granular latex are also characteristic.³²

6.3 Latex Microscopy

Latex is produced and transported through specialized laticifers.³⁰ In *E. neriifolia*.³¹ these are principally non-articulated, elongated and branched structures that develop from individual cells and may form extensive secretory networks.³² Latex contains proteins, resins, terpenoids and other metabolites and coagulates after exposure to air. Starch-grain patterns and laticifer morphology can support differentiation among *Euphorbia* species. Powder microscopy provides useful diagnostic

evidence when crude drug material is no longer recognizable by gross morphology.²⁴ Powdered *E. neriifolia*.²⁹ may show fragments of epidermis and cuticle, parenchymatous tissues, xylem elements, lignified fibres, stone cells, sclereids, trichome fragments, laticiferous structures and characteristic calcium oxalate crystals.³³ Both simple and compound starch grains may occur. Reported crystal forms include acicular, prismatic, square, idioblastic and rosette forms. Anomocytic stomata, xylem parenchyma and specialized cells containing volatile material may further assist authentication.

7. Ayurvedic Pharmacodynamic Profile

Properties and Actions

Ayurvedic pharmacodynamic descriptions characterize Snuhi by Katu and Tikta Rasa, Guru and Tikshna Guna, Ushna Virya and Katu Vipaka. Reported actions include Bhedana, Tikshna Virecana and Kapha-Vatahara effects within the classical framework.³⁴

Table 5. Ayurvedic properties and actions of *Euphorbia neriifolia*

Parameter	Ayurvedic description
Rasa	Katu, Tikta
Guna	Guru, Tikshna
Virya	Ushna
Vipaka	Katu
Actions	Bhedana, Tikshna Virecana, Kapha-Vatahara

8. Ayurvedic Formulations and Therapeutic Applications

E. neriifolia is included in a number of traditional formulations.²⁷ The following table summarizes formulations specifically reported in the reviewed literature; the table is descriptive and does not constitute prescribing guidance.

Table 6. Representative Ayurvedic formulations containing *Euphorbia neriifolia*

Ayurvedic medicine	Reported traditional application
Abhaya Lavana	Disorders involving spleen and liver
Ayaskriti	Weight loss, selected skin disorders, irritable bowel syndrome and anemia
Vishatinduka Taila	Selected skin disorders, gout and numbness
Shanka Dravaka	Spleen/liver disorders, ascites and indigestion
Agnivara Taila	Blisters and burns
Jalodarari Rasa	Hepatic disorders and ascites
Ardra Ka Ghrita	Gastritis, indigestion and chronic diarrhea
Arsha Kutara Rasa	Hemorrhoids
Madhusnuhi Rasayana	Rheumatoid arthritis, tumors, fistula, piles, diabetes, psoriasis and eczema-related skin disorders

9. Nutritional and Physicochemical Profile

The pharmacognostic evaluation of *E. neriifolia*.⁵ demonstrates the presence of carbohydrates, fats and proteins together with mineral elements such as calcium, magnesium, iron, chloride, sulphate, phosphate, carbonate and nitrate.³³ Reported physicochemical parameters vary by organ and extraction method, making authenticated raw material and standardized analytical procedures essential.³⁵ The principal reported nutritional and physicochemical parameters are summarized in Table 8.

Table 7. Nutritional and physicochemical profile of *Euphorbia neriifolia*

Plant part	Parameter	Reported value / range
Leaves	Water-soluble ash	4.54 ± 0.11%
Leaves	Acid-insoluble ash	0.82 ± 0.04%
Leaves	Total ash	7.36 ± 0.07%
Leaves	Moisture	3.45 ± 0.09%
Leaves	Water-soluble extractive	26.31 ± 0.12%
Leaves	Alcohol-soluble extractive	14.32 ± 0.04%
Leaves	Foreign organic matter	0.87 ± 0.03%
Stem	Water-soluble ash	3.042 ± 0.017%
Stem	Acid-insoluble ash	3.005 ± 0.004%
Stem	Total ash	0.506 ± 0.015%
Stem	pH	5.1–5.5
Stem	Moisture	10.8 ± 0.1%
Latex	Resinous matter	18.32%
Latex	pH	5.20 ± 0.17

Latex	Solid content	10.95%
Latex	Weight per mL	1.14 ± 0.08 g
Latex	Refractive index	1.41 ± 0.12
Latex	Total ash	0.315 ± 0.003%
Latex	Water-soluble ash	1.719 ± 0.196%
Latex	Acid-insoluble ash	1.95 ± 0.045%
Latex	Sulfated ash	0.147 ± 0.001%
Latex	Moisture	16 ± 0.057%
Bark	Water-soluble ash	1.719 ± 0.196%
Bark	Acid-insoluble ash	1.95 ± 0.045%
Bark	Total ash	0.315 ± 0.003%
Bark	pH	5.6–5.9
Bark	Moisture	16 ± 0.057%

10. Medicinal Applications of Different Plant Parts

Medicinal applications vary substantially by plant part. Leaves, stems and roots are associated with respiratory, inflammatory, gastrointestinal and other ethnomedicinal uses, whereas the latex is particularly prominent in purgative, dermatological and topical applications. Because latex is also irritant, therapeutic interpretation requires careful attention to preparation, dose and safety.²⁷

11. Phytochemical Composition and Bioactive Constituents

11.1 Terpenoid Constituents

Terpenoids form the most chemically diverse group reported from *E. neriifolia*.⁶ The species contains tetracyclic triterpenes belonging to euphane, tirucallane, cycloartane and related skeletons, together with structurally diverse diterpenoids.⁷ Reported compounds include euphol, taraxerol, β -amyrin, cycloartenol, neriifolione, eupnerias, eurifoloids, phoneroids, phonerilins and ingenane- or abietane-type diterpenoids.³⁸ Some diterpenoids have shown antiviral or cytotoxic activity in experimental systems, while triterpenes such as taraxerol and euphol have been investigated for anti-inflammatory, antioxidant, antinociceptive and anticancer-related effects.³⁹

11.2 Flavonoid Constituents

Flavonoids represent another important chemical class and include flavonols, flavanones, anthocyanins and related polyphenolic structures.⁴⁰ The reviewed literature reports flavonoid-rich leaf fractions and isolated compounds with antioxidant, anti-inflammatory and chemoprotective properties.³⁹ Kaempferol and related flavonoids have also been quantified or structurally investigated in *E. neriifolia* leaves.⁴¹

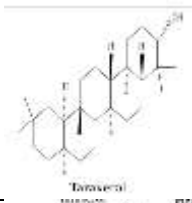
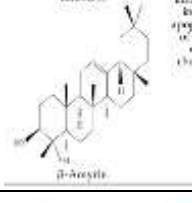
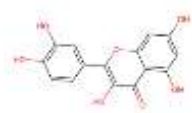
11.3 Saponin Constituents

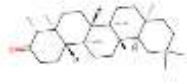
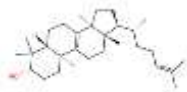
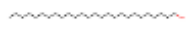
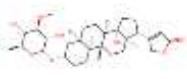
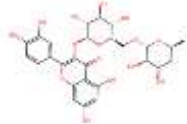
Saponins are surface-active glycosidic metabolites composed of steroidal or triterpenoidal aglycones linked to sugar residues.⁴² A saponin fraction containing euphol has been investigated for antioxidant and hepatoprotective effects, including protection in experimental chemical-injury models.⁴³ Their biological activity is likely influenced by both the aglycone and sugar components.

11.4 Other Bioactive Constituents

The table presents representative compounds with their 2D chemical structures to improve chemical identification and readability.

Table 8. Representative bioactive compounds reported from *Euphorbia neriifolia*

Plant part / fraction	Representative compound	Structural class	2D chemical structure	Reported significance
Whole plant / non-polar fraction	Taraxerol	Pentacyclic triterpene		Investigated in antioxidant and anticancer-related experimental models.
Whole plant / non-polar fraction	β -Amyrin	Pentacyclic triterpene		Reported as a bioactive triterpene associated with antimicrobial and other experimental activities.
Leaves hydroethanolic fraction	Quercetin	Flavonol polyphenol		Associated with antioxidant, anti- inflammatory and chemoprotective activity.

Leaves ethanolic fraction	/	Friedelin	Friedelane triterpenoid		Reported among triterpenoid constituents investigated for biological activity.
Stem / bark		Euphol	Tetracyclic triterpene alcohol		Investigated for anti- inflammatory and antinociceptive-related activity.
Bark		1-Hexacosanol	Long-chain fatty alcohol		Reported as a bark constituent in phytochemical investigations.
Latex		Neriifolin	Cardenolide glycoside		A latex-associated constituent investigated for biochemical and biological activity.
Root		Cycloartenol	Triterpene phytosterol	/	Reported from roots and other plant fractions and investigated in biological models.
Leaves flavonoid-rich fraction	/	Rutin	Flavonol glycoside		Associated with antioxidant and antimicrobial-related activity.

12. Pharmacological Activities and Experimental Evidence

Experimental research indicates a broad pharmacological profile, but the strength of evidence differs markedly among activities.¹¹ Most reports are preclinical, involving crude extracts, fractions or isolated compounds; therefore, findings should be interpreted as evidence of biological potential rather than established clinical efficacy.²⁰

12.1 Antioxidant Activity

Leaf, stem, bark and latex extracts have demonstrated free-radical scavenging, reducing and metal-chelating activities in different *in vitro* assays.⁴⁵ Euphol-containing saponin fractions and cycloartenol have attracted particular attention.⁴² Reported antioxidant effects include inhibition of lipid peroxidation and scavenging of reactive oxygen species.⁴³ These observations provide a plausible basis for some of the plant's traditional anti-inflammatory and tissue-protective applications, although assay-specific results should not be directly extrapolated to clinical antioxidant effects.⁴⁶

12.2 Antidiabetic Activity

Experimental studies of leaf, stem and stem-bark preparations have reported reductions in blood glucose and improvements in lipid parameters in diabetic animal models.⁴⁷ Methanolic and other solvent extracts have been evaluated using alloxan- or streptozotocin-associated models.⁴⁸ The observed effects appear to involve antioxidant and metabolic mechanisms, but dose-response relationships, active markers and clinical relevance require further investigation.⁴⁹

12.3 Immunomodulatory Activity

Hydroalcoholic leaf extracts have been investigated in experimental immunosuppression models.⁵⁰ Reported changes in immune parameters suggest immunomodulatory activity rather than a simple unidirectional stimulation.⁵¹ Such effects may relate to triterpenes, flavonoids and other secondary metabolites, but standardized marker-based preparations are needed before the activity can be compared across studies.

12.4 Anti-inflammatory and Anti-arthritis Activity

Leaf triterpene fractions and other extracts have shown anti-inflammatory and anti-arthritis effects in experimental models.³⁷ Neriifoline and euphol are among the constituents associated with these observations.⁵⁰ Proposed mechanisms include attenuation of inflammatory mediators and modulation of oxidative stress, while newer studies of ingenane-type diterpenoids have examined PKC/MAPK and NF- κ B-associated pathways.⁵²

12.5 Wound-Healing Activity

Leaf extracts and latex have been investigated for wound repair.⁵³ Experimental observations include improved tissue regeneration and modulation of inflammatory responses.⁵⁴ The activity may reflect combined antimicrobial, antioxidant, anti-inflammatory and proteolytic effects. Because fresh latex is irritant, the wound-healing literature should be interpreted in relation to preparation, dose and processing method.

12.6 Antimicrobial and Antiviral Activity

Extracts of leaves, stems, latex and whole plant material have shown activity against selected Gram-positive and Gram-negative bacteria and fungi.²⁷ Dried leaf juice, stem extracts and latex-based preparations have also been tested against microbial strains.⁵⁵ Certain triterpenoids and diterpenoids have demonstrated activity against human coronaviruses or HIV-related experimental systems.⁵⁶ These findings are promising but remain dependent on extract composition, assay conditions and concentration.⁵⁷

12.7 Radioprotective Activity

Polyphenolic and saponin-rich fractions have been evaluated for protection against radiation-associated oxidative damage.⁵⁸ Proposed mechanisms include free-radical scavenging, reduction of lipid peroxidation, preservation of antioxidant enzymes and modulation of stress-response pathways.⁵⁹ The evidence is predominantly experimental and should not be interpreted as proof of clinical radioprotection.⁶⁰

12.8 Analgesic and Anti-nociceptive Activity

Hydroalcoholic leaf extracts and isolated triterpenes have demonstrated analgesic or anti-nociceptive activity in animal models.⁵⁰ Euphol has received particular attention in inflammatory and neuropathic pain models, including evidence for involvement of the cannabinoid system.⁶¹

12.9 Anti-asthmatic and Respiratory-Related Activity

Traditional use of *E. neriifolia* includes asthma, cough and bronchial complaints.⁶² Experimental studies have evaluated ethanolic and ethyl-acetate extracts in models of airway hyper-responsiveness and related responses. These findings provide preclinical support for traditional respiratory use but require controlled clinical validation.

12.10 Anticancer and Antiproliferative Activities

Several extracts, flavonoid fractions and diterpenoids from *E. neriifolia* have been investigated in cancer-related models.⁵⁵ Reported effects include inhibition of proliferation, apoptosis-associated changes, modulation of oxidative stress and interference with selected signaling pathways.⁵⁰ Taraxerol, diterpenoid-rich fractions and isolated flavonoids have received attention, while recent work has also examined lignans and structurally diverse diterpenoids.⁶³ Importantly, these findings are not equivalent to clinical anticancer efficacy and require mechanistic, pharmacokinetic and clinical confirmation.⁶⁴

12.11 Hepatoprotective Activity

Hydroethanolic and methanolic extracts, together with euphol-containing saponin fractions, have shown protective effects in experimental hepatotoxicity models.⁴³ Reported findings include improvement of biochemical markers, restoration of antioxidant enzymes and reduced histological injury.⁶⁵ These data support further investigation of standardized preparations rather than unsupervised medicinal use.

12.12 Other Reported Pharmacological Activities

Additional experimental activities include anti-ulcer, anxiolytic, anticonvulsant, antithrombotic, anti-atherosclerotic, anti-diarrheal, antifertility, pesticidal, fish-stupefying and anti-venom-related observations.²⁷ The evidence base for these activities is uneven, and several findings originate from crude extracts or traditional reports.⁶⁶ Future work should prioritize reproducible models, validated chemical markers and clinically relevant endpoints.⁶⁷

Table 9. Selected antimicrobial activities of *Euphorbia neriifolia*

Plant material	Extract / preparation	Representative organism	Reported observation
Whole plant	Ethanol/methanol	<i>Bacillus megaterium</i>	Antibacterial activity reported
Whole plant	Ethanol/methanol	<i>Bacillus subtilis</i>	Antibacterial activity reported
Leaves	Ethyl acetate/water	<i>Pseudomonas</i> spp.	Growth inhibition reported
Leaves	Ethyl acetate/water	<i>Aspergillus flavus</i>	Antifungal activity reported
Leaves	Ethanol / leaf juice	<i>Escherichia coli</i>	Growth inhibition reported
Whole plant	Methanol/ethanol	<i>Pseudomonas aeruginosa</i>	Antibacterial activity reported
Whole plant	Methanol/ethanol	<i>Pseudomonas putida</i>	Activity reported
Leaves	Leaf juice	<i>Staphylococcus aureus</i>	Activity reported
Stem	Methanol	<i>Aspergillus niger</i>	Concentration-dependent inhibition reported
Stem	Methanol	<i>Candida albicans</i>	Concentration-dependent inhibition reported
Latex	Latex-based preparation	<i>Aspergillus fumigatus</i>	Antifungal activity investigated

Table 10. Representative pharmacological activities of *Euphorbia neriifolia*

Activity	Plant material / representative constituent	Key experimental observation	Evidence level
Antioxidant	Leaf; saponin; cycloartenol	Free-radical scavenging, reducing and lipid-peroxidation effects	Mostly in vitro / animal
Antidiabetic	Stem; stem bark; leaf extracts	Lower glucose and improved lipid parameters in diabetic models	Animal / preclinical
Immunomodulatory	Hydroalcoholic leaf extract	Modulation of immune parameters in experimental immunosuppression	Animal
Anti-inflammatory / anti-arthritis	Leaf triterpenes; euphol; neriifolione	Reduced inflammatory and pain-related responses	Animal / mechanistic
Wound healing	Leaf extract; latex	Improved tissue repair in experimental models	Animal
Antimicrobial	Leaf, stem, latex and whole plant extracts	Activity against selected bacteria and fungi	In vitro
Antiviral	Triterpenoids / diterpenoids	Anti-HIV and anti-HCoV-related experimental activity	In vitro
Radioprotective	Leaf fractions / polyphenols	Reduced oxidative injury and preserved antioxidant systems	Experimental
Analgesic	Leaf extracts; euphol	Reduced nociceptive responses	Animal
Anti-asthmatic	Whole-plant extracts	Activity in experimental airway models	Animal
Anticancer-related	Leaves; latex; diterpenoids; flavonoids	Reduced proliferation / apoptosis-related effects in selected models	In vitro / animal
Hepatoprotective	Methanolic extract; saponin/euphol fraction	Improved biochemical and histological parameters	Animal

13. Petro-Crop Potential of *Euphorbia neriifolia*

Latex-bearing *Euphorbia* species have been investigated as potential sources of hydrocarbon-rich material.⁶⁸ The latex can be collected by controlled lancing and processed or coagulated to obtain biocrude, which may be converted into petroleum-like hydrocarbons under catalytic conditions.⁶⁹ *E. neriifolia* is of interest because it is adapted to marginal environments and may be cultivated on land with limited agricultural inputs. Its petro-crop potential therefore relates to renewable hydrocarbon research rather than to conventional medicinal use.

14. Standardization, Authentication and Quality Control

A reliable medicinal plant product requires authentication, physicochemical standardization, chemical characterization, contaminant testing, bioactivity assessment and controlled storage.⁵ Botanical identification should begin with macroscopic and microscopic examination, supported where necessary by a deposited voucher specimen and molecular

tools such as DNA barcoding.²⁹ Physicochemical quality control should include moisture content, total ash, water-soluble ash, acid-insoluble ash, extractive values and pH, with additional parameters selected according to the plant part. Phytochemical screening can establish the presence of terpenoids, flavonoids, phenolics, alkaloids, glycosides and other relevant groups.³³ Chromatographic techniques such as TLC/HPTLC, HPLC and GC-MS can provide marker-based fingerprints and assist batch-to-batch comparison.⁶⁸ Safety testing should include microbial load, pesticide residues and heavy metals such as lead, arsenic, mercury and cadmium, together with appropriate toxicological evaluation. Packaging should limit exposure to moisture, excessive heat, light and air when these factors compromise chemical stability.⁶⁹ Standardization should ultimately align with applicable pharmacopoeial, GMP and regulatory requirements.

Table 11. Standardization and quality-control parameters for *Euphorbia neriifolia*

Quality-control domain	Recommended parameters
Botanical identity	Authenticated specimen, macroscopic and microscopic characters, voucher specimen
Physicochemical	Moisture, ash values, extractive values, pH, foreign matter
Phytochemical	Preliminary screening plus marker compounds
Chromatographic	TLC/HPTLC, HPLC and/or GC-MS fingerprinting
Contaminants	Heavy metals, pesticide residues, microbial load
Biological quality	Validated in vitro/in vivo bioassays where justified
Storage	Protection from moisture, light, heat, air and contamination
Regulatory	Applicable pharmacopoeial, GMP, WHO and national requirements

15. Toxicity and Safety Considerations

The biological activity of *E. neriifolia*.²⁶ latex also underlies its toxicological importance.²⁸ Fresh latex can produce marked irritation and inflammation of skin and eyes.²⁷ Ocular exposure may range from conjunctival irritation to severe kerato-uveitis and may threaten vision.⁶⁸ Ingestion can produce burning, vomiting, diarrhea, abdominal irritation, severe purgation and systemic toxicity; the reviewed literature also reports convulsive or severe outcomes after significant exposure. The toxicity is associated with a complex mixture of latex constituents.³⁰ Euphorbon and diterpenoid compounds such as phorbol- and ingenol-related metabolites have been discussed in relation to biological activity and toxicity. Consequently, therapeutic interpretation of latex studies must distinguish pharmacological activity from irritant or toxic effects.

16. Exposure Management and Management of Adverse Effects

After external exposure, the affected area should be washed thoroughly with running water. Eye exposure requires urgent ophthalmic assessment because chemical injury can progress after the initial contact. Ingestion or systemic symptoms require prompt medical evaluation and should not be managed by home remedies.

16.1 Symptomatic Management

The reviewed literature describes gastric decontamination approaches such as normal-saline lavage and activated charcoal in selected ingestion scenarios, but such interventions should be performed only by qualified clinicians after assessment of airway and aspiration risk.⁶⁸

16.2 Management of Skin and Ocular Exposure

For skin exposure, removal of contaminated material and thorough washing are primary measures; symptomatic treatment may include topical therapy under medical supervision.⁶⁸ Ocular injury may require pressure-lowering treatment, lubricating or tear-substitute therapy and antibiotic eye drops according to ophthalmic assessment.

17. Discussion and Future Research Directions

The literature portrays *E. neriifolia*.¹¹ as a chemically and pharmacologically diverse medicinal plant whose traditional importance is supported by a substantial preclinical evidence base.²⁰ Its strongest research themes include pharmacognostic authentication, terpenoid chemistry, antioxidant and anti-inflammatory activity, antimicrobial investigation, wound healing, metabolic effects and cancer-related experimental studies.²⁷ Nevertheless, the available evidence is not uniform. Many studies use crude extracts with incomplete chemical standardization, making direct comparison difficult. A major research priority is therefore the development of reproducible, marker-defined preparations.²⁹ Botanical authentication should be followed by standardized harvesting, drying, extraction and storage protocols.³³ Chemical fingerprints should be linked to quantitative markers such as representative triterpenes, flavonoids or diterpenoids.⁶⁸ This would allow investigators to determine whether apparently different biological results arise from true biological differences or from variation in plant material and extraction conditions. Mechanistic research should move beyond general antioxidant or cytotoxicity assays toward target-specific studies, validated signaling pathways, pharmacokinetics and metabolite profiling.⁶ For anticancer research in particular, future studies should distinguish antiproliferative effects from nonspecific cellular injury and should include appropriate normal-cell controls, dose-response relationships and reproducible exposure conditions.⁵⁰ The diverse diterpenoid and triterpenoid chemistry of the plant provides a rational basis for such work.⁶³ Clinical translation remains limited.²⁸ Carefully designed pharmacokinetic, safety, dose-escalation and controlled clinical studies are required before traditional indications can be converted into evidence-based therapeutic claims. Special attention is necessary for latex-containing preparations because toxicity and therapeutic activity may coexist within the same chemical fraction. The plant may also have non-medicinal value as a

petro-crop and as a hardy boundary plant capable of growing under relatively dry conditions. Such applications should be evaluated within ecological, economic and sustainability frameworks rather than assumed solely from laboratory findings.⁶⁹ Overall, the future research agenda should integrate classical Ayurvedic knowledge, ethnobotany, pharmacognosy, metabolomics, analytical chemistry, molecular pharmacology, toxicology and clinical science. This integrated strategy could clarify which traditional uses are pharmacologically reproducible, which compounds are responsible for activity, and which preparations can be developed safely and consistently.

18. Conclusion

Euphorbia neriifolia Linn. is a distinctive succulent medicinal species with a long history in Ayurveda, Unani and regional ethnomedicine. Its botanical identity is supported by characteristic succulent stems, paired stipular spines, terminal fleshy leaves, cyathial inflorescences, three-lobed fruits and latex-bearing tissues. Pharmacognostic and physicochemical characteristics provide additional tools for authentication and quality assurance. The plant contains a wide range of secondary metabolites, particularly triterpenes, diterpenes, flavonoids, saponins, anthocyanins, glycosides and proteinaceous latex constituents. Experimental studies have reported antioxidant, anti-inflammatory, anti-arthritis, antimicrobial, antiviral, antidiabetic, immunomodulatory, wound-healing, analgesic, radioprotective, hepatoprotective and anticancer-related activities. These findings explain why *E. neriifolia* continues to attract interest as a source of pharmacologically active natural products. However, the same biological richness also creates safety concerns. Fresh latex is irritant and potentially toxic, and the therapeutic value of the plant cannot be separated from careful dose selection, processing, authentication and contaminant control. The current evidence remains predominantly preclinical, so traditional use should not be presented as established clinical efficacy. Future research should focus on standardized preparations, validated chemical markers, mechanistic pharmacology, pharmacokinetics, long-term toxicology and controlled clinical studies. With these safeguards, *E. neriifolia* can be investigated more rigorously as a source of traditional therapeutics and structurally diverse natural products.

REFERENCES

1. Petrovska BB. Historical review of medicinal plants' usage. *Pharmacogn Rev.* 2012;6:1-5.
2. Ekor M. The growing use of herbal medicines: issues relating to adverse reactions and challenges in monitoring safety. *Front Pharmacol.* 2014;4:177.
3. Aye MM, Aung HT, Sein MM, Armijos C. A review on the phytochemistry, medicinal properties and pharmacological activities of 15 selected Myanmar medicinal plants. *Molecules.* 2019;24:293.
4. Dias DA, Urban S, Roessner U. A historical overview of natural products in drug discovery. *Metabolites.* 2012;2:303-336.
5. Chaudhary P, Janmeda P. Comparative pharmacognostical standardization of different parts of *Euphorbia neriifolia* Linn. *Vegetos.* 2023.
6. Li J, Feng X, Liu D, Zhang Z, Chen X, Li R, et al. Diterpenoids from *Euphorbia neriifolia* and their related anti-HIV and cytotoxic activity. *Chem Biodivers.* 2019;16:e1900495.
7. Chang SS, Huang HT, Lin YC, Chao CH, Liao GY, Lin ZH, et al. Neritriterpenols A-G, euphane and tirucallane triterpenes from *Euphorbia neriifolia* L. and their bioactivity. *Phytochemistry.* 2022;199:113199.
8. Gupta S, Acharya R. A critical review on Snuhi (*Euphorbia neriifolia* Linn.) with special reference to Ayurvedic Nighantus (lexicons). *Int J Res Ayurveda Pharm.* 2017;8:98-103.
9. Watt G. A Dictionary of Economic Products of India. Vol III. New Delhi: Cosmo Publication; 1972.
10. Sharma V, Sharma GK, Chandrul KK. Anti-microbial activity of *Euphorbia neriifolia*: a pharmacological review. *Eur J Biomed Pharm Sci.* 2019;6:159-166.
11. Mali PY, Panchal SS. *Euphorbia neriifolia* L.: review on botany, ethnomedicinal uses, phytochemistry and biological activities. *Asian Pac J Trop Med.* 2017;10:430-438.
12. Aditya S. A revision of geophytic *Euphorbia* species from India. *Euphorbia World.* 2010;6:18-21.
13. Hooker JD. The Flora of British India. Vol 5. London: L Reeve; 1890. p.914.
14. Burkill IH. A Dictionary of the Economic Products of the Malay Peninsula. Vol 1-2. London: Crown Agents for the Colonies; 1936.
15. Nadkarni AK. Indian Materia Medica. Vol 1. Bombay: Popular Prakashan; 1954. p.424-426.
16. Ambasta SP. The Useful Plants of India. New Delhi: CSIR Publication; 1994. p.270.
17. Chatterjee A, Pakrashi SC. The Treatise on Indian Medicinal Plants. Vol 3. New Delhi: Council of Scientific and Industrial Research; 1994.
18. Shamim SA, Fatima L. Pharmacological actions and therapeutic benefits of thuhar (*Euphorbia neriifolia*): a review. *Pharma Innov Int J.* 2018;7:221-222.
19. Dundappa CP, Amarprakash D. A comprehensive review on Snuhikshir (latex of *Euphorbia neriifolia* Linn.). *Int Ayurvedic Med J.* 2017;5:2936-2945.
20. Bigoniya P, Rana AC. A comprehensive phyto-pharmacological review of *Euphorbia neriifolia* Linn. *Phcog Rev.* 2008;2:57-66.
21. Upadhyaya C, Sathish S. A review on *Euphorbia neriifolia* plant. *Int J Pharm Chem Res.* 2017;3:149-154.
22. Pullaiah T. Medicinal Plants of India. Vol 1. Anantapur: Department of Botany, Sri Krishnsdevaraya University; 2002. p.245-246.
23. Shah JJ, Jani PM. The shoot apex of *Euphorbia neriifolia* Linn. *Proc Nat Inst Sci India.* 1963;30:81-91.

24. Pracheta SV. Microscopic studies and preliminary pharmacognostical evaluation of *Euphorbia neriifolia* L. leaves. *Indian J Nat Prod Resour.* 2013;4:348-357.
25. Arumugasamy K, Subramanian RB, Inamdar JA. Cyathial nectarines of *Euphorbia neriifolia* L.: ultrastructure and secretion. *Phytomorphology.* 1990;40:281-288.
26. Bigoniya P, Shukla A, Singh CS. Dermal irritation and sensitization study of *Euphorbia neriifolia* latex and its anti-inflammatory efficacy. *Int J Phytomed.* 2010;2:240-254.
27. Sultana A, Hossain J, Kuddus R, Rashid MA, Zahan MS, Mitra S, et al. Ethnobotanical uses, phytochemistry, toxicology, and pharmacological properties of *Euphorbia neriifolia* Linn. against infectious diseases: a comprehensive review. *Molecules.* 2022;27:4374.
28. Ramdas WP, Madhav PS, Sagar N. Comprehensive study of Sthavar Visha Snuhi Ksheera (*Euphorbia neriifolia* Linn.) and its detoxification. *Int J Res Ayurveda Med Sci.* 2019;2:40-43.
29. Tandon N, Sharma P. *Quality Standard of Indian Medicinal Plants.* Vol XI. New Delhi: Indian Council of Medical Research; 2013.
30. Benjamaa R, Moujanni A, Kaushik N, Choi EH, Essamadi AK, Kaushik NK. *Euphorbia* species latex: a comprehensive review on phytochemistry and biological activities. *Front Plant Sci.* 2022;13:1008881.
31. Rudall PJ. Laticifers in Euphorbiaceae-a conspectus. *Bot J Linn Soc.* 1987;94:143-163.
32. Mallavadhani UV, Satyanarayana KVS, Mahapatra A, Sudhakar AVS, Narasimhan K, Pandey DK, et al. Development of diagnostic microscopic and chemical markers of some *Euphorbia* latexes. *J Integr Plant Biol.* 2006;48:1115-1121.
33. Mali PY, Panchal SS. Pharmacognostical and physico-chemical standardization of *Euphorbia neriifolia* leaves. *Pharmacogn J.* 2017;9:696-705.
34. Chaudhary P, Janmeda P. Sehund: poison or medicine. *Agric Food E-Newsl.* 2021;3:254-256.
35. Sajwan S, Ansari SA, Khan AS. Pharmacognostic studies and quality control parameters of *Euphorbia neriifolia* L. *IJCRT.* 2022;10:574-580.
36. Sharma V, Janmeda P, Singh L. A review on *Euphorbia neriifolia* (Sehund). *Spatulla DD.* 2011;1:107-111.
37. Ilyas M, Parveen M, Amin KMY. Neriifolione, a triterpene from *Euphorbia neriifolia*. *Phytochemistry.* 1998;48:561-563.
38. Kemboi D, Peter X, Langat M, Tembu J. A review of the ethnomedicinal uses, biological activities, and triterpenoids of *Euphorbia* species. *Molecules.* 2020;25:4019.
39. Magozwi D, Dinala M, Mokwana N, Siwe-Noundou X, Krause R, Sonopo M, et al. Flavonoids from the genus *Euphorbia*: isolation, structure, pharmacological activities and structure-activity relationships. *Pharmaceuticals.* 2021;14:428.
40. Sharma DK. Bioprospecting for drug research and functional foods for the prevention of diseases: role of flavonoids in drug development. *J Sci Ind Res.* 2006;65:391-401.
41. Mali PY, Goyal S. HPTLC densitometric quantification of kaempferol from leaves of *Euphorbia neriifolia*. *Indian J Pharm Educ Res.* 2020;54:s586-s592.
42. Bigoniya P. Hemolytic and in-vitro antioxidant activity of saponin isolated from *Euphorbia neriifolia* leaf. In: *Recent Progress in Medicinal Plants: Natural Products-II.* Houston: Studium Press; 2006. Chapter 20.
43. Bigoniya P, Rana AC. Protective effect of *Euphorbia neriifolia* saponin fraction on CCl₄-induced acute hepatotoxicity. *Afr J Biotechnol.* 2010;9:7148-7156.
44. Yadav RP, Patel AK, Jagannadham M. Purification and biochemical characterization of a chymotrypsin-like serine protease from *Euphorbia neriifolia* Linn. *Process Biochem.* 2011;46:1654-1662.
45. Kasote DM, Katyare SS, Hegde MV, Bae H. Significance of antioxidant potential of plants and its relevance to therapeutic applications. *Int J Biol Sci.* 2015;11:982-991.
46. Pracheta SV, Paliwal R, Sharma S. In vitro free radical scavenging and antioxidant potential of ethanolic extract of *Euphorbia neriifolia* Linn. *Int J Pharm Pharm Sci.* 2011;3:238-242.
47. Mushir IM, Patel VM. Anti-diabetic potential of *Euphorbia neriifolia* Linn. in alloxan induced diabetic rats. *J Pharm Res.* 2012;5:2571-2573.
48. Datta S, Kar B, Mishra G, Nayak SS. Antidiabetic and hypolipidemic activity of *Euphorbia neriifolia* in streptozotocin induced diabetic rats. *J Nat Prod Plant Resour.* 2015;5:12-17.
49. Kumar A, Mahanty B, Goswami RCD, Barooah PK, Choudhury B. In vitro antidiabetic, antioxidant activities and GC-MS analysis of *Rhynchosyris retusa* and *Euphorbia neriifolia* leaf extracts. *3 Biotech.* 2021;11:1-10.
50. Bigoniya P. Immunomodulatory activity of *Euphorbia neriifolia* leaf hydro-alcoholic extract in rats. *Indian Drug.* 2008;45:90-97.
51. Gaur K, Rana AC, Chauhan LS, Sharma CS, Nema RK, Kori ML. Investigation of immunomodulatory potential of *Euphorbia neriifolia* Linn. against betamethasone induced immunosuppression. *Int J Pharmacog Phytochem Res.* 2009;1:8-11.
52. Bigoniya P, Siddique F. Anti-inflammatory and anti-arthritic effect of triterpene fraction isolated from *Euphorbia neriifolia* L. leaf. *Photon.* 2015;124:1007-1017.
53. Pattanaik S, Si SC, Pal A, Panda J, Nayak SS. Wound healing activity of methanolic extract of the leaves of *Crataeva magna* and *Euphorbia neriifolia* in rats. *J Appl Pharm Sci.* 2014;4:46-49.
54. Rasik AM, Shukla A, Patnaik GK, Dhawan BN, Kulshrestha DK, Srivastava S. Wound healing activity of latex of *Euphorbia neriifolia* Linn. *Indian J Pharm.* 1996;28:107-109.
55. Chang FR, Yen CT, El-Shazly M, Lin WH, Yen MH, Lin KH, et al. Anti-human coronavirus triterpenoids from the leaves of *Euphorbia neriifolia*. *Nat Prod Commun.* 2012;7:1415-1417.

56. Samresh D, SNS, CDS. Exploration of antimicrobial potential of methanolic extract of stems of *Euphorbia neriifolia*. *Int J Pharm*. 2013;4:271-273.
57. Raghuwanshi MG, Patil PS, Shaikh AA, Nazim S, Majaz Q. Evaluation of antimicrobial activity of dried juice of *Euphorbia neriifolia*. *J Sci Inf*. 2013;7:51-55.
58. Bigoniya P, Rana A. Radioprotective and in-vitro cytotoxic sapogenin from *Euphorbia neriifolia* (Euphorbiaceae) leaf. *Trop J Pharm Res*. 2010;8:521-530.
59. Jagetia GC. Radioprotective potential of plants and herbs against the effects of ionizing radiation. *J Clin Biochem Nutr*. 2007;40:74-81.
60. Paul P, Unnikrishnan MK, Nagappa AN. Phytochemicals as radioprotective agents—a review. *Indian J Nat Prod Resour*. 2011;2:137-150.
61. Dutra RC, da Silva KABS, Bento AF, Marcon R, Paszcuk AF, Meotti FC, et al. Euphol, a tetracyclic triterpene, produces antinociceptive effects in inflammatory and neuropathic pain: the involvement of cannabinoid system. *Neuropharmacology*. 2012;63:593-605.
62. Sawale JA, Patel JA, Kori ML. Evaluation of anti-asthmatic property of *Euphorbia neriifolia*. *Asian J Biomat Res*. 2017;3:39-48.
63. Gao Y, Zhou JS, Liu HC, Zhang Y, Yin WH, Liu QF, et al. Phorneroids A-M, diverse types of diterpenoids from *Euphorbia neriifolia*. *Phytochemistry*. 2022;198:113142.
64. Gao Y, Zhou JS, Liu HC, Zhang Y, Yin WH, Liu QF, et al. Phonerilins A-K, cytotoxic ingenane and ingol diterpenoids from *Euphorbia neriifolia*. *Tetrahedron*. 2022;123:132955.
65. Sharma V, Janmeda P. Protective assessment of *Euphorbia neriifolia* and its isolated flavonoid against N-nitrosodiethylamine-induced hepatic carcinogenesis in male mice: a histopathological analysis. *Toxicol Int*. 2014;21:38-43.
66. Bigoniya P, Rana AC. Psychopharmacological profile of hydro-alcoholic extract of *Euphorbia neriifolia* leaves in mice and rats. *J Pharmacol Exp Ther*. 2005;43:859-862.
67. Hasan M, Ganeshpurkar A, Bansal D, Dubey N. Protective effect of *Euphorbia neriifolia* extract on experimentally induced thrombosis in murine model. *Niger J Exp Clin Biosci*. 2014;2:86-89.
68. Bhatia V, Srivastava G, Garg V, Gupta Y, Rawat S, Singh J. Study of laticiferous (latex-bearing) plants as potential petro-crops. *Fuel*. 1983;62:953-955.
69. Kalita D, Saikia C. Chemical constituents and energy content of some latex bearing plants. *Bioresour Technol*. 2004;92:219-227.
70. Kaur N, Rani S, Saini V. Pharmacognostic and phytochemical evaluation of *Euphorbia neriifolia*: a therapeutic perspective. *J Neonatal Surg*. 2025;14(15s):1561-1572.
71. Chaudhary P, Meena M, Janmeda P. Microscopic characterization, TLC fingerprinting and optimization of total lipid content from *Euphorbia neriifolia* (L.) using response surface methodology. *Microsc Res Tech*. 2024.
72. Naga A, Jyothi A, Rajalakshmi R. A review on Upavisha-Snuhi (*Euphorbia neriifolia* Linn). *Int Ayurvedic Med J*. 2016;4:1231-1234.