



“Review On: Phytochemistry, Medicinal Uses And Pharmacological Activities Of Euphorbia Tirucalli”

¹Miss.ManeDeshmukh P.P.,² Mr.Linge K.A,³ Mr.Padule M.L., ⁴Mr.Sonawane S.D.,
⁵Mr.Solankar A.A.

¹Associate professor, ²Student, ³Student, ⁴Student, ⁵Student.

¹Pharmaceutics Department,

¹College of Pharmacy Paniv, Malshiras,
Solapur, Maharashtra,
INDIA.

Abstract

The plant *Euphorbia tirucalli*, commonly known as the pencil tree or milk bush, is a versatile species with significant medicinal and pharmacological potential. This review explores its phytochemical composition, traditional medicinal uses, and pharmacological activities, highlighting its importance in ethnomedicine and modern research. *Euphorbia tirucalli* is rich in bioactive compounds, including diterpenes, triterpenoids, flavonoids, and alkaloids, which contribute to its wide range of therapeutic effects. Traditionally, it has been used for treating ailments such as warts, asthma, and gastrointestinal disorders, and as a remedy for cancer in some cultures. Pharmacological studies reveal its potential as an anti-inflammatory, antimicrobial, antidiabetic, and anticancer agent, emphasizing its therapeutic relevance. However, the plant's latex contains toxic compounds that require careful handling and controlled usage to mitigate adverse effects. This review also examines recent advancements in the pharmacological evaluation of *Euphorbia tirucalli*, underscoring the need for further research into its bioactive constituents, mechanisms of action, and clinical applications. A comprehensive understanding of this plant's properties could pave the way for the development of novel natural drugs and alternative therapeutic strategies. The medicinal uses of *Euphorbia tirucalli* are diverse, reflecting its significance in traditional and alternative medicine. The plant is renowned for its application in cancer treatment, where its latex is traditionally used for its perceived anticancer properties. Modern studies have identified its potential to induce apoptosis in cancer cells, particularly through compounds like ingenol mebutate. Additionally, the plant is widely used for treating skin disorders, including warts and other dermatological conditions, where its latex is applied externally. It also has anti-inflammatory properties, making it effective in managing arthritis, asthma, and bronchitis. In traditional remedies, decoctions made from its stems and leaves are used to relieve respiratory issues and inflammatory conditions. Furthermore, *Euphorbia tirucalli* demonstrates antimicrobial properties, being effective against a range of bacterial, fungal, and parasitic infections. It is also employed as a pain reliever and is used to alleviate headaches and body pain. In gastrointestinal health, the plant acts as a mild laxative and is used to treat constipation and other digestive disorders. These therapeutic applications highlight the plant's versatility, though caution is necessary due to the toxicity of its latex. Proper preparation and dosing are essential to harness its benefits while minimizing risks.

Keywords

Phytochemistry, bioactive compounds (diterpenes, triterpenoids, flavonoids, alkaloids), medicinal uses, latex toxicity.

Introduction

In spite of great advances of modern scientific medicine, traditional medicine is still the primary form of treating diseases of majority of people in developing countries including India; even among those to whom Western medicine is available, the number of people using one form or another of complementary or alternative medicine is rapidly increasing worldwide.^[1] Over the centuries, humans have relied on plants for basic needs such as food, clothing, and shelter, all produced or manufactured from plant matrices (leaves, woods, fibers) and storage parts (fruits, tubers).^[2] Many plant-derived compounds have been used as drugs, either in their original or semi synthetic form.^[3] The World health Organization (WHO) estimates that about 80% of the population living in the developing countries rely almost exclusively on traditional medicine for their primary healthcare needs.^[4] *E. tirucalli* is universally known as Aveloz. It is a native of Africa and America but has turned out to be acclimated and growing liberally in all parts of India particularly in the drier parts of Bengal and South India and basically grown-up in hedge. It is developed in Berar for shelter young mango plants from straight sunlight.^{[5],[6],[7]} The taxonomy of *E. tirucalli* consists of domain: Eukaryota, kingdom: Plantae, sub-kingdom: Tracheobionta, division: Magnoliophyta, superdivision: Spermatophyta, class: Magnoliopsida, sub-class: Rosidae, order: Malpighiales, genus: Euphorbia, family: Euphorbiaceae, species: *tirucalli* Linn.^{[8],[9]} Its classification and chemistry have of late been subjects of interest possibly because of the wide variety of chemical composition of its members, many of which are poisonous but useful. The worldwide distribution of the family exposes its members, to all sorts of habitats to which they must adapt; therefore inducing a large variety of chemicals (secondary substances) that are employed for survival/defence.^[10] Euphorbiaceae is generally distinguished by the milky sap.^[11] Euphorbiaceae comprises nearly 322 genera and 8910 species many of which have their own economic value and hence contribute to the floristic wealth of tropical and subtropical countries of the world. The family comprise a number of endemic and endangered taxa.^[12]



Euphorbia tirucalli (Pencil Plant)

History Of plant

History of *Euphorbia tirucalli*

Euphorbia tirucalli is native to tropical and subtropical regions of Africa, particularly in arid and semi-arid environments. Over centuries, it has been introduced and naturalized in parts of Asia, South America, and India due to its adaptability and diverse uses.^[13]

Traditional and Historical Uses

The history of *Euphorbia tirucalli* in traditional medicine dates back centuries. Indigenous African communities have utilized the plant for its medicinal properties, particularly for treating conditions like warts, asthma, gastrointestinal issues, and skin ailments. The latex of the plant, despite its toxicity, was often employed externally as a remedy for burns, wounds, and infections. In some cultures, the plant's latex was believed to have protective or spiritual properties and was used in rituals to ward off evil spirits or protect homes. In Ayurvedic medicine, *Euphorbia tirucalli* has been documented as a remedy for various conditions, including joint pain and respiratory disorders. Similarly, traditional healers in South America have used the plant for its anti-inflammatory and purgative properties, emphasizing its role in managing internal and external ailments.^{[14],[15]}

Historical Spread and Cultivation

The resilience of *Euphorbia tirucalli* in harsh environmental conditions made it a valuable species for ecological and economic purposes. Historically, it was used as a hedge plant in agriculture, providing natural fencing to protect crops and livestock. Its ability to thrive in nutrient-poor soils also made it an important plant for erosion control in degraded lands. Over time, its cultivation spread from Africa to the Middle East, India, and tropical regions of the Americas, where it adapted to diverse climates.^[16]

Modern Recognition

The plant gained renewed attention in the 20th century due to its potential in biofuel production, as its latex contains hydrocarbons similar to those found in petroleum. Furthermore, advancements in pharmacological research have underscored its medicinal value, leading to an increasing number of studies focusing on its bioactive compounds, such as diterpenes and flavonoids, for applications in cancer treatment, antimicrobial therapy, and inflammation management. Through its historical journey, *Euphorbia tirucalli* has evolved from a traditional remedy and agricultural tool to a plant of significant interest in ecological and pharmacological research. Its unique combination of resilience, medicinal properties, and cultural importance makes it a valuable subject for ongoing exploration and utilization.^[17]

Taxonomy of *Euphorbia tirucalli*

The taxonomy of *Euphorbia tirucalli* is classified as follows:

- Kingdom: Plantae

Clade: Angiosperms

Plants that produce flowers and seeds enclosed within a fruit.

Clade: Eudicots

Plants with two seed leaves (cotyledons) and net-like veins in their leaves.

Clade: Rosids

A large clade of flowering plants.

- Order: Malpighiales

- Includes a diverse group of plants like violets, willows, and passionflowers.

□ Family: Euphorbiaceae

- Known as the spurge family, characterized by milky latex and often toxic compounds.

- Genus: *Euphorbia*

One of the largest genera of flowering plants, including diverse species ranging from succulents to shrubs and trees.

- Species: *Euphorbia tirucalli*

Commonly known as the pencil tree or milk bush.

Nomenclature

- Scientific Name: *Euphorbia tirucalli* L.

The "L." denotes Carl Linnaeus, who first described the species.

Distinctive Features in Taxonomy*

Morphological Traits:

Euphorbia tirucalli is a succulent plant characterized by its cylindrical, pencil-like branches, small or absent leaves, and a milky latex.

Phytochemical Significance:

Rich in bioactive compounds like diterpenes, triterpenoids, and alkaloids, distinguishing it from other members of its genus. Its taxonomy reflects its evolutionary adaptations to arid environments and its classification within a highly diverse and medicinally significant family.



Fig: Plant parts of *Euphorbia tirucalli*

Mechanism of Action

Euphorbia tirucalli, commonly known as the pencil tree or milk bush, exhibits various pharmacological activities due to its rich composition of bioactive compounds, including diterpenes, triterpenoids, flavonoids, alkaloids, tannins, and saponins. Its anti-inflammatory action is primarily attributed to the inhibition of pro-inflammatory mediators like cyclooxygenase (COX) and lipoxygenase (LOX) enzymes, which play a crucial role in the synthesis of inflammatory prostaglandins and leukotrienes.^{[18],[19]} The plant also demonstrates anticancer properties through its ability to induce apoptosis and inhibit cell proliferation. These effects are mediated by the activation of caspase pathways and modulation of proteins like p53 and Bcl-2, which regulate cell death and survival. Additionally, Euphorbia tirucalli exhibits antimicrobial activity by disrupting microbial cell walls and inhibiting essential enzymes required for bacterial and fungal growth. Its antioxidant properties are linked to the scavenging of free radicals, reducing oxidative stress, and protecting cells from damage.^[20] Collectively, these mechanisms underscore the potential of Euphorbia tirucalli as a source of therapeutic agents for various diseases.

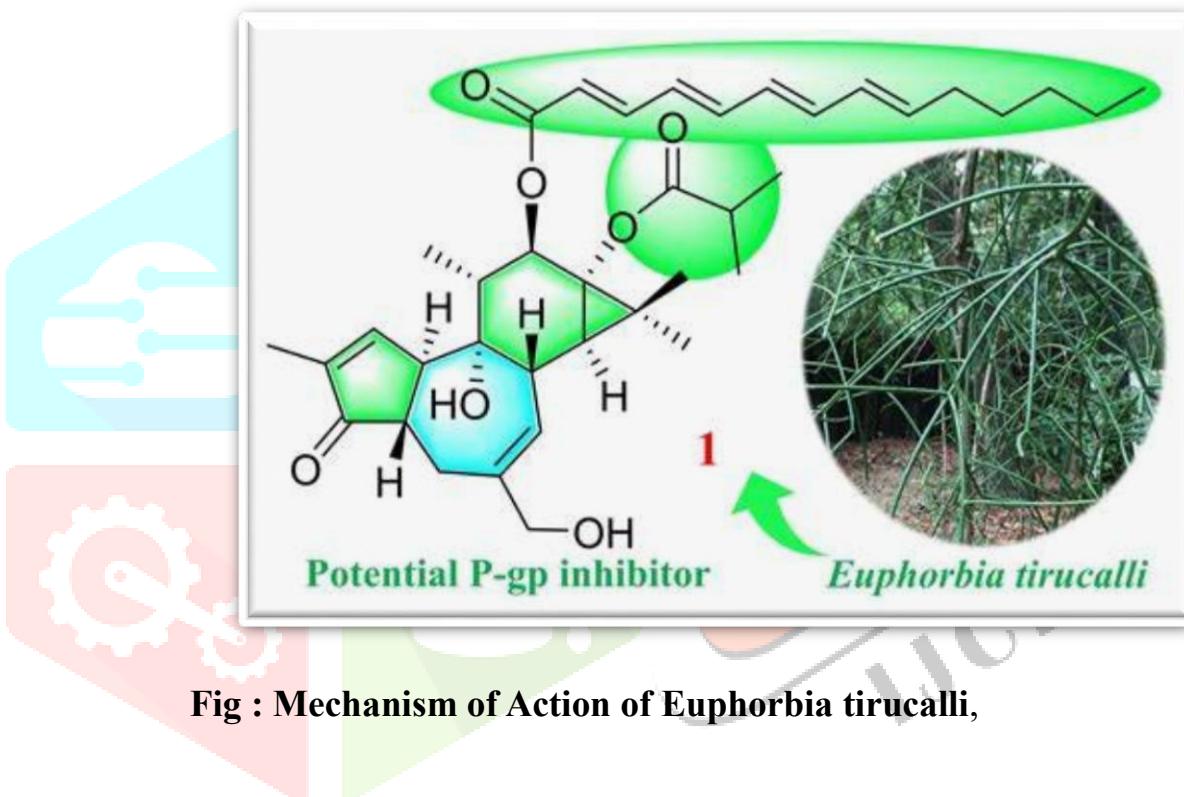


Fig : Mechanism of Action of Euphorbia tirucalli,

Traditional Uses

Euphorbia tirucalli (commonly known as the pencil tree or milk bush) has a rich history of traditional uses across various cultures, particularly in Africa, Asia, and South America. Its uses often draw from its medicinal and practical properties. Here are some key traditional applications:^[21]

1. Medicinal Uses

- In India, it is useful in treatment of biliousness, leprosy and leucorrhea. In Brazil, it is used against cancroids, cancer, sarcomas, tumors, etc^{[23],[24],[25]}
- Latex of *E. tirucalli* is vesicant and rubefacient which is used for rheumatism, warts, cough, asthma, ear-ache, tooth-ache and neuralgia. It acts as a purgative in small doses while in big doses it is bitter irritant and emetic. Latex is poisonous to rats and fish. Milky juice is acrid counter-irritant and emetic in large doses. Externally it is rubefacient^{[26],[27]},
- In Java country, latex is used to heal skin ailment and bone fracture. In Malabar of India and Moluccas, the latex is used as an emetic and an anti-syphilitic. Oil obtained from the latex was in the past used in linoleum, oil skin and leather cloth industry. Methane gas can be formed by anaerobic fermentation of latex^[28]

- The fresh milky juice is good alternative in syphilis and a good application in neuralgia. In Kokan, it is given as a purge [29]
- In East Africa, latex is used against tooth-ache, sexual impotence, hemorrhoids, epilepsy, snake bites and cough [30],[31]
- The sap is irritating to the human eye and causes kerato-conjunctivitis and uveitis from the sap of *E. tirucalli*. The eyes of dogs are exposed to the sap of *E. tirucalli* causes corneal opacities which is appeared after (24–36) h and cleared in one to three weeks [32]
- Little twigs of plant can be roast and chew for tender throat [33]. A decoction of branches is used in gastralgia and colic. Ash is useful as caustic to release abscess. □ Bark is used in treatment of fractures [34].

Here is a tabular representation of ***Euphorbia tirucalli*** detailing its parts, chemical constituents, uses, and references:

SR.No	Part of Herb	Chemical Constituents	Uses	Reference	Authors and Year
1	Latex	Euphol, β sitosterol, tirucallol, ingenol, phorbol esters	Wound healing - Antimicrobial - Antiviral and antitumor effects	Traditional practices in Africa, Asia, and South America	Mali, Prashant Y., & Panchal, Shital S. (2017)
2	Stem	Terpenoids, alkaloids, flavonoids, tannins, phytosterols	Treatment of respiratory ailments - Fuelwood	Ethnobotanical studies	Chalmers, Anita C. et al. (2015)
3	Roots	Triterpenes, diterpenes, essential oils	- Antiinflammatory - Pain relief (arthritis, joint pain)	Pharmacological research	Rout, Omprakash et al. (2015)
4	Whole Plant	Polyphenols, lignins, glycosides, carbohydrates	Cancer research (anticancer potential) - Anti-parasitic remedies	Ethnopharmacology	Singh, Vijay & Sharma, Mahendra K. (2016)
5	Leaves	Flavonoids, alkaloids, saponins	Antioxidant activity - Antiinflammatory - Antibacterial properties	Plant Science Reviews	Deshpande, Neha et al. (2018)

Chemical Constitutions

Euphorbia tirucalli, commonly known as the pencil tree, contains a diverse array of chemical constituents that contribute to its medicinal and toxic properties. The plant is rich in terpenoids, including euphol, tirucallol, and other triterpenes, which are known for their anti-inflammatory and potential

anticancer activities. The latex of the plant contains phorbol esters and ingenol derivatives, which are responsible for its irritant and tumor-promoting effects, but also have applications in cancer research when appropriately modified. Additionally, the plant features phytosterols such as β -sitosterol, which exhibit anti-inflammatory and cholesterol-lowering properties. Polyphenols, alkaloids, flavonoids, and tannins are present in varying concentrations throughout the plant and contribute to its antimicrobial and antioxidant activities. The roots and stems also contain diterpenes and essential oils with bioactive properties. These chemical constituents make *Euphorbia tirucalli* a subject of interest in pharmacological studies, although its use requires caution due to its toxicity.

<input type="checkbox"/> Latex -	Triterpenes ^[33]
<input type="checkbox"/> Latex -	Cyclotirucanenol (triterpene) ^[34]
<input type="checkbox"/> Latex -	4-deoxyphorbol di-ester ^[35]
<input type="checkbox"/> Latex -	Cyclo euphordenol (triterpene) ^[36]
<input type="checkbox"/> Latex -	Diterpene ester ^[37]
<input type="checkbox"/> Latex -	Highly irritant euphorbia factors ^[38]
<input type="checkbox"/> Latex -	Euphol ^[39]
<input type="checkbox"/> Latex -	Steroids ^[40]

Phytochemistry

Euphorbia tirucalli is a plant with a rich phytochemical profile, contributing to its wide range of biological and medicinal properties. The main classes of compounds identified in the plant include:

1. **Terpenoids** ○ **Triterpenes:** Euphol, tirucallol
 - **Diterpenes:** Ingenol, phorbol esters
These compounds exhibit anti-inflammatory, anticancer, and antimicrobial properties. However, phorbol esters are also known for their toxic and irritant effects.
2. **Phytosterols** ○ **β -Sitosterol:** Found in latex and other plant parts, it is known for its cholesterol-lowering, anti-inflammatory, and antioxidant activities.
3. **Polyphenols** ○ Includes flavonoids, tannins, and lignins, which are responsible for antioxidant and antimicrobial properties, as well as protective effects against oxidative stress.
4. **Alkaloids** ○ Present in small amounts, contributing to the plant's antimicrobial and therapeutic potential.
5. **Essential Oils** ○ Found primarily in the roots and stems, essential oils from *Euphorbia tirucalli* are rich in bioactive compounds with anti-inflammatory and antimicrobial effects.
6. **Carbohydrates and Glycosides** ○ The plant contains glycosides that may contribute to its medicinal properties, including use in traditional remedies.

Pharmacological Activities

1. Activity in human-lymphocytes

The effects of 14 extracts from 70 plants of Euphorbiaceae were studied using prime immune cell culture by Doris et al. [41]

2. Analgesic

Analgesic potential of various extract of latex of *E. tirucalli* was performed by using tail immersion and acetic acid induces writhing techniques. Percentage inhibition of aqueous, dichloromethane-methanol and petroleum ether extracts was 57.67%, 51.80% and 48.48% respectively. [42]

3. Anthelmintics

A study on anthelmintic activity of petroleum ether and dichloromethane-methanol extract of latex of *E. tirucalli* has been reported with ten unusual concentrations (0.1%– 1.0%) against *Pheretima posthuma* earthworm.

4. Antiarthritic

The antiarthritic study of biopolymeric fraction (BET) of *E. tirucalli* was reported using adjuvant-induced arthritis model in rats by Sarang et al. [43].

5. Antibacterial/antifungal/antimicrobial

Antimicrobial effect of petroleum ether and dichloromethane-methanol extract of latex of *E. tirucalli* was performed using *Bacillus subtilis* (*B. subtilis*), *Klebsiella pneumoniae* (*K. pneumoniae*), *Staphylococcus aureus* (*S. aureus*) and *Pseudomonas aeruginosa* (*P. aeruginosa*) by agar well diffusion assay. The aqueous extract was also tested against *Aspergillus niger* (*A. niger*), *Penicillium chrysogenum*, *Trichoderma viride* and *Candida albicans* (*C. albicans*) by agar well diffusion assay. Zone of reduction was determined for bacteria at 5%, 10%, 15% and 20% and for fungi at 3%, 6%, 9% and 12% concentrations. *B. subtilis* was resistant to tested extracts [44].

6. Anti-HIV

Anti-HIV screening of the crude alcoholic extract of leaf and stem of *E. tirucalli* was carried out using HIV protease colorimetric assay and has been reported as effective anti-HIV activity [45].

7. Antioxidant

Antioxidant study of methanol extract of eleven plants was investigated by DPPH, superoxide, hydroxyl radical, reducing capacity. Methanol extract of all the plants was exhibited potent antioxidant action [46].

8. Antiviral

Antiviral potential of petroleum ether and dichloromethane-methanol extract of *E. tirucalli* latex was investigated using tobacco viruses such as tobacco and tomato mosaic viruses by Ramesh et al. [47]

9. Biodiesel production

E. tirucalli contains a good amount of terpenoids which are efficient to produce biodiesel from the plant. This biodiesel is a non-toxic and environment friendly. It is producing less carbon monoxide and sulfur dioxide emissions. Hence, it is best fuel for greatly contaminated cities [48].

10. CNS depressant/neuropathic pain

Euphol has been tested for preventing neuropathic pain induced by ligation of sciatic nerve. The pretreatment among CB1R and CB2R antagonist and knock-down gene of CB1R and CB2R appreciably inverted anti-nociceptive action of euphol. A result reveals that euphol was a promising entity for managing the neuropathic condition [49].

11. Cytotoxicity/anticancer

Anticancer activity of euphol was studied using human gastric cancer cells. Elevated cytotoxicity was shown by euphol in human gastric CS12 cancer cells than non-cancer CSN cells. Anti-proliferative effect of euphol was due to the improved p27kip1 and decreasing cyclin B1 levels. The inhibitions of ERK1/2 activation through PD98059 upturned euphol induce pro-apoptotic

protein expression and cell death. Therefore, euphol selectively induces apoptosis of gastric cancer cells by means of modulation of ERK signaling which might be useful in cancer treatment [50].

Formulation of *Euphorbia tirucalli*

Euphorbia tirucalli has been used in various traditional and modern formulations to leverage its medicinal benefits. The plant's latex, stems, and roots are the primary sources of bioactive compounds, which are extracted and used in a range of therapeutic preparations. One common formulation is the latex-based topical ointment. This preparation combines the latex of *Euphorbia tirucalli* with a carrier base, such as coconut oil or beeswax. It is used externally on wounds, sores, or skin infections, benefiting from the plant's antimicrobial and wound-healing properties. To make this ointment, the latex is carefully diluted and mixed with the carrier base to reduce irritation. Another traditional preparation is the decoction. In this formulation, dried stem or root pieces of *Euphorbia tirucalli* are boiled in water. The decoction is then consumed to treat digestive issues, respiratory ailments, and as a purgative. To prepare the decoction, the plant material is boiled for 15–20 minutes, strained, and consumed in small doses.

The poultice is another topical formulation that uses freshly crushed stems or latex, mixed with herbal additives like turmeric or neem. It is applied directly to areas affected by joint pain, inflammation, or skin ulcers. This mixture is placed on the affected area and covered with a clean cloth, providing localized relief. An herbal tea can also be made by steeping dried plant parts (such as the stem or leaves) in hot water. This tea is used for its antioxidant and immune-boosting properties, often consumed for general wellness. The plant material is infused in boiling water for 5–10 minutes, strained, and then consumed. An ethanolic extract is another common form of preparation used for anticancer, anti-inflammatory, or antimicrobial therapies. The plant material is soaked in ethanol to extract the bioactive compounds, which are then filtered and evaporated to produce a concentrated extract.

Table of Formulations of *Euphorbia tirucalli*

Sr. No	Author	Paper	Year	Formulation	Ingredients	Use	Preparation Method
1	Mali, Prashant Y., & Panchal, Shital S.	Latex-Based Therapeutics	2017	Latex-Based Topical Ointment	Latex mixed with coconut oil or beeswax	Wound healing, skin infections, antimicrobial	Dilute latex and mix with a carrier base; apply externally.
2	Chalmers, Anita C. et al.	Ethnobotanical Applications of <i>Euphorbia tirucalli</i>	2015	Decoction	Dried stem or root pieces boiled in water	Digestive issues, respiratory ailments, purgative	Boil plant material for 15–20 minutes, strain, and consume in doses.
3	Rout, Omprakash et al.	Anti-Inflammatory Uses of <i>Euphorbia tirucalli</i>	2015	Poultice	Freshly crushed stems or latex mixed with turmeric or	Joint pain, inflammation, skin ulcers	Apply mixture directly to the affected area, cover with cloth.

					neem		
4	Deshpande, Neha et al.	Antioxidant Properties of <i>Euphorbia tirucalli</i>	2018	Herbal Tea	Dried plant parts (stem or leaves)	Antioxidant, immune-boosting, general wellness	Steep in hot water for 5–10 minutes, strain, and consume.
5	Singh, Vijay & Sharma, Mahendra K.	Ethnopharmacology of <i>Euphorbia tirucalli</i>	2016	Oil Infusion	Stem or latex soaked in olive oil	Muscle pain, arthritis, inflammation	Soak plant material in oil for weeks, filter and apply externally.
6	Mali, Prashant Y., & Panchal, Shital S.	Pharmacological Research on <i>Euphorbia tirucalli</i>	2017	Extract-Based Capsules or Tablets	Standardized extracts of <i>Euphorbia tirucalli</i>	Immune modulation, antimicrobial anticancer research	Extracts are obtained using ethanol or water, then encapsulated.
7	Rout, Omprakash et al.	Preparation of Plant Extracts for Research	2015	Ethanol Extract	Plant material soaked in ethanol	Anticancer, anti-inflammatory, antimicrobial	Soak plant material in ethanol, filter, and evaporate to concentrate.

Conclusion :

Euphorbia tirucalli, a plant with a rich history of traditional use, offers a wide range of pharmacological properties that make it a valuable resource in herbal medicine. Its diverse chemical constituents, including phorbol esters, euphol, and flavonoids, contribute to its antimicrobial, anti-inflammatory, anticancer, and antioxidant activities. These properties have made the plant a subject of both historical and contemporary interest for treating various ailments, from skin infections and joint pain to respiratory and digestive issues.

Traditional formulations of *Euphorbia tirucalli*, such as latex-based ointments, decoctions, poultices, and oil infusions, continue to be used for their therapeutic effects. Modern scientific research further supports the efficacy of these formulations, showing promising results in areas like cancer treatment, wound healing, and pain relief. However, despite its potential, the plant's toxic components require careful handling, and its use should be regulated and guided by proper knowledge and expertise.

As research on *Euphorbia tirucalli* continues to advance, the plant may offer new opportunities in pharmacology and medicine, but caution should always be exercised due to its toxic nature. Proper formulation, dosage, and safety precautions are crucial in maximizing its benefits while minimizing risks.

References:

1. Thomas SC. Medicinal plants culture, utilization and pharmacology. Li. United States: CRC Press; 1995. p. 119-54.
2. Harborne JB. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis. New York: Chapman and Hall; 1984. p. 2.
3. Salim AA, Chin YW, Kinghorn AD. Drug Discovery from Plants. *Bioact Mol Med Plants* 2008;24:380-91. Salim AA, Chin YW, Kinghorn AD. Drug Discovery from Plants. *Bioact Mol Med Plants* 2008;24:380-91.
4. Mukerjee PK. Quality control of herbal drugs. Vol. 1. New Delhi: Business Horizons Publication; 2002. p. 2-24.
5. K.M. Nadkarni, A.K. Nadkarni (3rd ed.), Indian *materia medica*, vol. I, Popular Prakashan, Bombay (2007)
6. P. Cataluna, S.M. Rates The traditional use of the latex from *Euphorbia tirucalli* Linn. (Euphorbiaceae) in the treatment of cancer in South Brazil Proceedings of second world congress on medicinal and aromatic plants for human welfare WOCMAP-2: pharmacognosy, pharmacology, phytomedicines, toxicology, Wageningen Academic Press-WAP, Belgium (1999), pp. 289-295
7. Anonymous The wealth of India. A dictionary of Indian raw materials and industrial products (raw materials), vol. III (D-E), Central Institute of Medicinal and Aromatic Plants, New Delhi (2003), pp. 226-228 (Reprinted)
8. A.R. Jassbi Chemistry and biological activity of secondary metabolites in *Euphorbia* from Iran *Phytochemistry*, 67 (18) (1997), pp. 1977-1984
9. Anonymous Plants database United States Department of Agriculture, Natural Resources Conservation Services, USA (2017) (Last modified 24 April 2017).
10. Julius T. M., Patrick V.D. Why do Euphorbiaceae tick as medicinal plants? A review of Euphorbiaceae family and its medicinal., Accepted 21 December, 2010
11. Gibbs, R. D. *Chemotaxonomy of flowering plants*. Mc. Gill Queens University Press Montreal and London, England., 1974; 1-4.
12. Bingtao, Li., Huaxing, Qiu., Jin-shuang Ma., HuaZhu., Michael, G., Gilbert, Hans Joachim(Hajo) Esser, Stefan Dressler, Petra Hoffmann, Lynn J. Gillespie, Maria Vorontsova and Gordon D. McPherson *Flora of China.*,2008; 11: 163.
13. K.R. Kirtikar, B.D. Basu (2nd ed.), Indian medicinal plants, vol. III, Lalit Mohan Basu, Allahabad (2006), pp. 2201-2204
14. L. John, A.M. Luz, J.F. Ywe *Euphorbia tirucalli: bioenergy manual* Feedstock production, bioenergy conversion, applications, economics (Version 2) Wageningen Academic Press, Netherlands (2011), p. 23
15. N. Gupta, G. Vishnoi, A. Wal, P. Wal Medicinal value of *Euphorbia tirucalli* *Syst Rev Pharm*, 4 (2013), pp. 40-46
16. P. Van Damme Het traditioneel gebruik van *Euphorbia tirucalli* [The traditional uses of *Euphorbia tirucalli*] *Afr Focus*, 5 (1989), pp. 176-193
17. Plant resources of Tropical Africa G.H. Schmelzer, A. Gurib-Fakim (Eds.), *Medicinal plants*, Backhuys Publishers, Netherlands (2008), pp. 412-415
18. Lampe K, Fagerstrom R. Plant toxicity and dermatitis. Baltimore: Williams and Wilkins; 1968.
19. Van Damme P. Het traditioneel gebruik van *Euphorbia tirucalli*. (The traditional uses of *Euphorbia tirucalli*). *Afr Focus* 1989;5:176-93.
20. Schmelzer GH, Gurib-Fakim A. Medicinal plants. *Plant Resour. Trop Afr* 2008. p. 412-5.
21. Van Damme PL. *Euphorbia tirucalli* for high biomass production. In: Schlissel A, Pasternak D, editors. *Combating desertification with plants*. New York: Kluwer Academic Pub; 2001. p. 169-87
22. John L, Luz AM, Ywe JF. *Euphorbia tirucalli Bioenergy Manual*. 22 November 2001.
23. J.A. Duke *Handbook of energy crops* Purdue University Centre for New Crops and Plant Products, Indiana (1983)
24. K.R. Kirtikar, B.D. Basu (2nd ed.), Indian medicinal plants, vol. III, Lalit Mohan Basu, Allahabad (2006), pp. 2201-2204
25. P. Van Damme Het traditioneel gebruik van *Euphorbia tirucalli* [The traditional uses of *Euphorbia tirucalli*] *Afr Focus*, 5 (1989), pp. 176-193

26. K.M. Nadkarni, A.K. Nadkarni (3rd ed.), *Indian materia medica*, vol. I, Popular Prakashan, Bombay (2007)

27. Anonymous *The wealth of India. A dictionary of Indian raw materials and industrial products (raw materials)*, vol. III (D–E), Central Institute of Medicinal and Aromatic Plants, New Delhi (2003), pp. 226-228 (Reprinted)

28. J.A. Duke *Handbook of energy crops* Purdue University Centre for New Crops and Plant Products, Indiana (1983)

29. K.R. Kirtikar, B.D. Basu (2nd ed.), *Indian medicinal plants*, vol. III, Lalit Mohan Basu, Allahabad (2006), pp. 2201-2204

30. P. Van Damme *Het traditioneel gebruik van Euphorbia tirucalli [The traditional uses of Euphorbia tirucalli]* Afr Focus, 5 (1989), pp. 176-193

31. *Plant resources of Tropical Africa* G.H. Schmelzer, A. Gurib-Fakim (Eds.), *Medicinal plants*, Backhuys Publishers, Netherlands (2008), pp. 412-415

32. C.P. Khare *Indian medicinal plants – an illustrated dictionary* Springer, Verlag Berlin (2007)

33. A.Q. Khan, Z. Ahmed *The structure and absolute configuration of cyclotirucanenol, a new triterpene from Euphorbia tirucalli* Linn Chem Sci, 43 (1988), pp. 1059-1062

34. A.D. Kinghorn *Characterisation of an irritant 4-deoxyphorbol diester from Euphorbia tirucalli* Lloydia-J Nat Prod, 42 (1979), pp. 112-115

35. A.D. Kinghorn *Characterisation of an irritant 4-deoxyphorbol diester from Euphorbia tirucalli* Lloydia-J Nat Prod, 42 (1979), pp. 112-115

36. A.Q. Khan, A. Malik *A new macrocyclic diterpene ester from the latex of Euphorbia tirucalli* J Nat Prod, 53 (1990), pp. 728-731

37. G. Furstenberger, E. Hecker *New highly irritant euphorbia factors from latex of Euphorbia tirucalli* L Experientia, 33 (1977), pp. 986-988

38. K.R. Lynn, R.N.A. Clevett *Four serine proteases from the latex of Euphorbia tirucalli* Can J Biochem Cell B, 63 (1985), pp. 1093-1096

39. W.L. Ming, L. An-Shen, W. Deng-Chyang, S.W.W. Sophie, C. Fang-Rong, W. YangChang *Euphol from Euphorbia tirucalli selectively inhibits human gastric cancer cell growth through the induction of ERK1/2-mediated apoptosis* Food Chem Toxicol, 50 (12) (2012), pp. 4333-4339

40. C.D. Rafael, B.S.S. Kathryn Ana, F.B. Allisson, M. Rodrigo, F.P. Ana, C.M. Flávia, et al. *Euphol, a tetracyclic triterpene produces antinociceptive effects in inflammatory and neuropathic pain: the involvement of cannabinoid system* Neuropharmacology, 63 (2012), pp. 593-605

41. S.L.C. Doris, Y.G.D. Laura, P.S.Q. Leidy, J.P. Lady, T. Fernando, E. Fernando, et al. *New promising Euphorbiaceae extracts with activity in human lymphocytes from primary cell cultures* Immunopharmacol Immunotoxicol, 33 (2) (2010), pp. 1-12

42. M.N. Prabha, C.K. Ramesh, I.J. Kuppasta, K.L. Mankani *Studies on anti-inflammatory and analgesic activities of Euphorbia tirucalli L. latex* Int J Chem Sci, 6 (4) (2008), pp. 1781-178

43. S.K. Asha, C.K. Ramesh, M. Paramesha, A.V. Srikanth *Evaluation of anthelmintic and antimicrobial activities of Euphorbia tirucalli L. latex* Nat Prod, 5 (2) (2009), pp. 45-49

44. B. Sarang, K. Anpurna, K. Beenish, G. Vijay Kumar, S. Naresh Kumar, S. Krishan Avtar, et al. *Anti-arthritis activity of a biopolymeric fraction from Euphorbia tirucalli* J Ethnopharmacol, 110 (2007), pp. 92-98

45. U. Bhuvaneshwar, K.P. Singh, A. Kumar *Ethno-medicinal, phytochemical and antimicrobial studies of Euphorbia tirucalli* L J Phytol, 2 (2010), pp. 65-77

46. S.V. Chanda, Y. Baravalia *Screening of some plant extracts against some skin diseases caused by oxidative stress and microorganisms* Afr J Biotech, 9 (21) (2010), pp. 32103217

47. C.K. Ramesh, M.N. Prabha, S.A. Deepak, K.N. Madhusudhan *Screening of antiviral property against tobamoviruses in latex of euphorbia tirucalli L* Biotech, 3 (1) (2009)

48. A. Khaleghian, Y. Nakaya, H. Nazari *Biodiesel production from Euphorbia tirucalli* L J Med Plants Res, 5 (19) (2011), pp. 4968-4973

49. C.D. Rafael, B.S.S. Kathryn Ana, F.B. Allisson, M. Rodrigo, F.P. Ana, C.M. Flávia, et al. *Euphol, a tetracyclic triterpene produces antinociceptive effects in inflammatory and neuropathic pain: the involvement of cannabinoid system* Neuropharmacology, 63 (2012), pp. 593-605

50. W.L. Ming, L. An-Shen, W. Deng-Chyang, S.W.W. Sophie, C. Fang-Rong, W. YangChang Euphol from Euphorbia tirucalli selectively inhibits human gastric cancer cell growth through the induction of ERK1/2-mediated apoptosis Food Chem Toxicol, (12) (2012), pp. 4333-4339

