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EUPHORBIA TIRUCALLI L.: A REVIEW ON ITS POTENTIAL PHARMACOLOGICAL USE IN CHRONIC DISEASES

Biological Science

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ABSTRACT

Euphorbia Tirucalli L. is a succulent cactus-like plant endemic to tropical and subtropical areas. It has been used as a traditional folk medicine in many countries for the treatment of a number of diseases including leprosy, cough, intestinal parasites, nose ulcer, rheumatic pain, gastric mucosa diseases and asthma. The plant exhibits diverse pharmacological actions because of its antioxidant property. It protects cells against oxidative damage. It can act as a radical scavenger. In this review the phytoconstituents present in different parts of this plant and their pharmacological applications on different chronic diseases have been discussed.

KEYWORDS:

Euphorbia tirucalli L. phytoconstituents; ethnomedicinal applications; pharmacological applications

I. INTRODUCTION:

Euphorbiaceae is a very complex family due to its wide variation of chemical composition. The distributions of chemical components present in different parts of of all *Euphorbiaceae* family members are not same and these differences arise because of adaptation in different climate conditions. The secondary metabolites (chemical compounds) generated in plants of this family members are useful for giving relief from various external and internal stresses. Some species belong to *Euphorbiaceae* family have been used for the treatment of skin diseases, gonorrhea, migraine, and intestinal parasites and as wart cures (Singla and Kamala, 1990). The compounds isolated from *Euphorbiaceae* family members exhibit pharmacological activities including cytotoxic activity, antimicrobial and anti-inflammatory activity (Shi et al., 2008). Hence *Euphorbiaceae* family is one of the best families for investigation to find out new plant-based medicines.

Euphorbia Tirucalli L. belongs to Euphorbiaceae family. It is a 10-15 m tall succulent, cactus-like spineless, monoecious perennial shrub with pencil like branches. It is commonly planted as an ornamental or hedge plant (Fig. 1). It has some unique properties with respect to other *Euphorbiaceae* family members. It grows very fast and produces lot of biomass as its stems and leaves allow to assimilate CO2 for 24 hours every day. The tree is fed on by herbivores. [1] It is originated from tropical East Africa and endemic in countries such as Angola, Eritrea, Ethiopia, Kenya, Malawi, Mauritius, Rwanda, Senegal, Sudan, Tanzania, Uganda, and Zanzibar. [2] It is commonly found in tropical and subtropical regions. Currently it is being cultivated in America and southern part of Europe. [3] In India, it is widely grown in Rajasthan, Malabar Coast of India and other low rainfall regions having saline soils. [4] There is a hypothesis that the Portuguese people brought this plant on the Malabar Coast of India from East Africa (Juliani et al. 2013).

The taxonomic description of Euphorbia tirucalli L. is
Kingdom: *Plantae*
Division: *Magnoliophyta*
Class: *Magnoliopsida*
Order: *Malpighiales*
Family: *Euphorbiaceae*
Genus: *Euphorbia*
Species: *Euphorbia tirucalli*
Binomial name: *Euphorbia tirucalli*

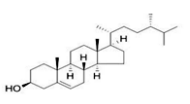
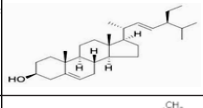
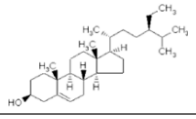
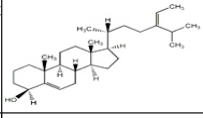
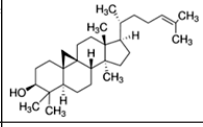
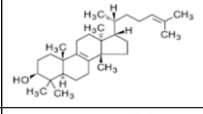
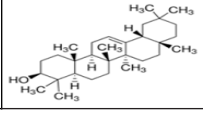


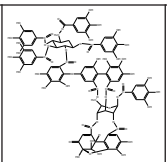
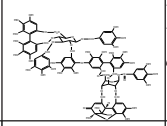
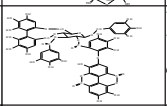
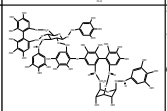
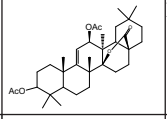
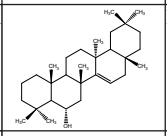
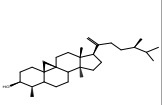
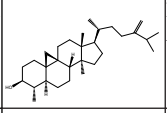
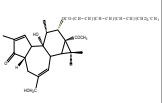
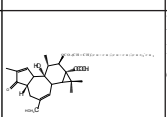
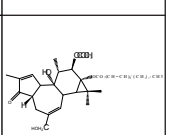
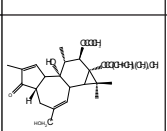
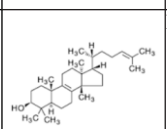
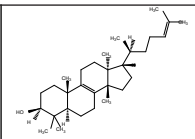
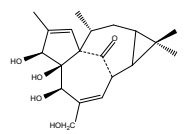
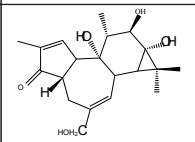
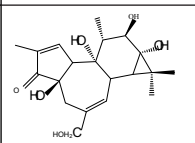
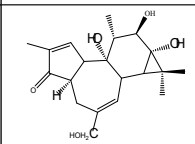
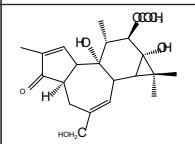
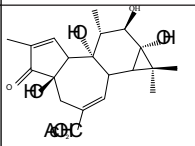
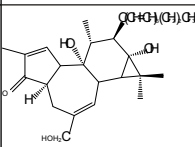
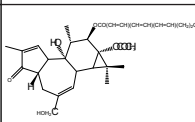
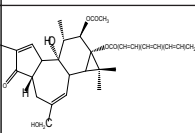
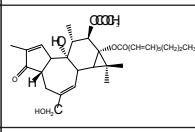
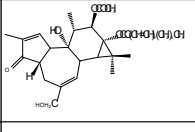
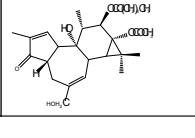
Fig.1. *Euphorbia Tirucalli L* plant

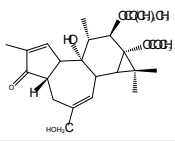
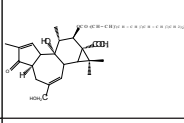
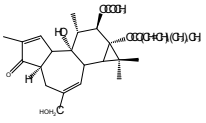
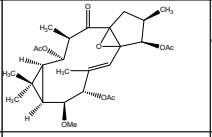
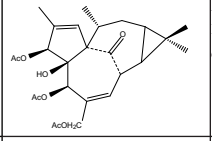
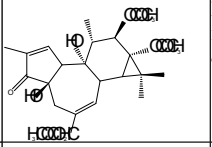
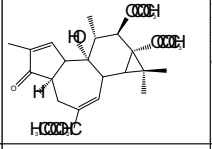
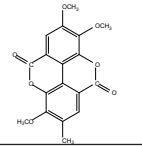
II. PHYTOCONSTITUENTS OF *Euphorbia Triucalli L.*:

The different parts of *Euphorbia Tirucalli* L. rich with terpenoids, triterpenes, polyphenols, serine proteases, steroids, flavanoids, isoflavanoids, acids and esters shown in Table 1. The chemical components were isolated with the help of solvent extraction technique. Various clinical studies have been performed by different groups in different times by taking the isolated chemical substances of *E. Tirucalli* L.. The complex physiochemical mechanisms of those compounds for the treatment of different diseases are under investigation till now.

Table 1. Phytochemicals present in Euphorbia Triucalli L.

Source (plant part)	Phytochemicals		Chemical Structure	References
Stem callus	**Sterol**	Campesterol		**Uchida** *et al.* (2010)
		Stigmasterol		**Uchida** *et al.* (2010)
		Beta-sitosterol		**Uchida** *et al.* (2010)
		Isofucosterol		**Uchida** *et al.* (2010)
		Cycloartenol		**Uchida** *et al.* (2010)
	Terpene	Euphol		**Uchida** *et al.* (2010)
		Beta-amyrin		**Uchida** *et al.* (2010)

Stemz Stem Bark	**Polyphenol**	Euphorbin A		**Yoshida and Yokoyama** *et al. (1991)*
		Euphorbin F		**Yoshida and Yokoyama** *et al. (1991)*
Stem Bark	**Tannin**	Tirucallin A		**Yoshida and Yokoyama** *et al. (1991)*
		Tirucallin B		**Yoshida and Yokoyama** *et al. (1991)*
	Triterpene	Taraxerane		**Rasool** *et al. (1989)*
		Cycloeuphordeno		**Khan** *et al. (1989)*
	Terpene	Cyclotirucanenol		**Khan** *et al. (2010)*
		Cyclotirucanenol		**Khan and Ahmed** *et al. (1988)*
	Serine proteases	Mr74kDa T_1		**Lynn and Clevett** *et al. (1985)*
		Mr74kDa T_2		
		Mr74kDa T_3		
		Mr74kDa T_4		
Latex	**Highly irritant euphorbia factors**	12- 0-[(2Z , 4E)-2,4,6 -decatrienoyl]-4-deoxyphorbol-13- acetate (Ti1)		**Khan and Ahmed** *et al. (1988)*
		12- 0-[(2Z , 4E)-2,4,6 -decatrienoyl]-4-deoxyphorbol-13- acetate (Ti1)		**Furstenberger and Hecker** *et al. (1977)*
		12- 0-[(2Z , 4E)-2,4,6 -decatrienoyl]-4-deoxyphorbol-13- acetate (Ti1)		
		12-0-acetyl-4-deoxyphorbol-13-(2,4,6,8-tetradecatetraenoate) (Ti4)		
	Steroids	Euphol		**Nielson** *et al. (1979)*
		Tirucallol		**Nielson** *et al. (1979)* Mujeeb *et al., 2014)*
		Ingenol		**Furstenberger and Hecker** *et al. (1977)*
		4-deoxy phorbol		**Furstenberger and Hecker** *et al. (1977)*
	Diterpene alcohols	Phorbol		**Furstenberger and Hecker** *et al.* (1977)
		4-deoxy-4α-phorbol		**Furstenberger and Hecker** *et al.* (1977)
		19Y4NSiG8kkzwWjMD17euEaQ5PErpwxWkP		**Furstenberger and Hecker** *et al.* (1977)
	Diterpene monoesters	Phorbol monoester		**Furstenberger and Hecker** *et al.* (1977)
		12-0-(2,4,6-decatrienoyl)-4-deoxy-4α-phorbol		**Furstenberger and Hecker** *et al.* (1977)
		12- 0-[(2Z , 4E)-2,4,6-decatrienoyl]-4-deoxyphorbol-13- acetate		**Kinghorn** *et al.* (1979)
	Diterpenediesters	12-0-acetyl-4-deoxyphorbol-13-[(2Z, 4E)-2,4,6-decatrienoate]		**Kinghorn** *et al.* (1979)
	(4 -deoxyphorbol diesters)	12-0-acetyl-4-deoxyphorbol-13-(2,4,6,8,10-tetradecapentaenoate)		**Kinghorn** *et al.* (1979)
		12-0-acetyl-4-deoxyphorbol-13-(2,4,6,8,10-tetradecapentaenoate)		**Kinghorn** *et al.* (1979)
		12-0-acetyl-4-deoxyphorbol-13-(2,4,6,8,10-tetradecapentaenoate)		**Kinghorn** *et al.* (1979)

		4-deoxy-DPA		**Kinghorn** *et al.* (1979)
	Diterpen diesters (4-deoxy-4-α-phorbol diesters)	12- 0-[(2Z , 4E)-2,4,6-decatrienoyl]-4-deoxy-4a-phorbol-13-acetate		**Kinghorn** *et al.* (1979)
		12-0-acetyl-4-deoxy-4a-phorbol-13-(2,4,6,8-tetradecatetraenoate)		**Kinghorn** *et al.* (1979)
	Diterpenetriesters	Tirucalicine		**Malik** *et al.*,1988
		Ingenol-3,5,20-triacetate		**Furstenberger and Hecker** *et al.* (1977)
		phorbol-12,13,20-triacetate		**Furstenberger and Hecker** *et al.* (1977)
		4-deoxy-4a-phorbol-12,13,20-triacetate		**Furstenberger and Hecker** *et al.* (1977)
	Trimethylellagic acid			**Furstenberger and Hecker** *et al.* (1977)

III. ETHNOMEDICINAL APPLICATIONS OF Euphorbia Triucalli L.:

In modern era, the pharmacological approaches of ethno medicinal treatment are getting importance day by day for searching newer and newer medicines because plants or shrubs are the key sources for most of the required medicines. To find out a new potential medicinal plant we have to follow ethnomedicinal origin (Muthu *et al*., 2006). Plants produce many secondary metabolites in their body to protect itself from natural or atmospheric stresses. Many of the secondary metabolites have strong ability to fight against different microbial disasters and can be used as medicines (Anon, 1994; Muthu *et al.,* 2006). Secondary metabolites can also play active role to repair the unwanted physiochemical disordering in human body or other animal bodies.

E. tirucalli L. has very high ethnomedicinal value and its different parts are used as medicines especially by the local people of tropical and subtropical areas **(Table 2).**

Table 2. Use of *E. tirucalli L.* as a traditional medicine in different parts of the world.

Different parts of the plant	Diseases	Country	References
Latex	Wart, epilepsi, sexual impotence, toothache, hemorrhoids, snake bites	East Africa	**Schmelzer** *et al.,*2008
Latex	Cancer, cancroids, ephitheliomas, sarcomas, tumors, wart	Brazil	**Duke** *et al.,* 2009
Latex	Asthma, Cancer, Cough, Ear problems, Snake bite and scorpion sting, Toothache, Intestinal parasites, Skin problems	India	**Upadhyay** *et al.,* 2010
Root	Colic, Gastralgia and Rheumatism	India	**Kumar** *et al.,* 1999
Stem	Thorn Extraction, Swelling, Leprosy and Paralysis, Colic and gastric problems	India	**Upadhyay** *et al.,* 2010
Leaves	Skin problems, Nose ulcers and hemorrhoids	India	**Upadhyay** *et al.,* 2010
Root	Aching bones, nose ulcers, hemorrhoids	Indonesia	**Duke** *et al.,* 2009

In India the different parts of *E. tirucalli L.* which has been used for preparing folk medicines and their doses for the treatment of a particular disease is shown in Table 3.

Table 3. Ethnomedicinal importance of *E. Tirucalli L.* in India.

Part used	Diseases treated	Mode of Administration	Reference
	Asthma	Five ml diluted latex is administered twice a day.	**Kumar** *et al.,* 1999 **Upadhyay** *et al.,* 2010
	Cancer	Paste of Fresh leaves and latex is diluted with water and taken once a day	**Kumar** *et al.,* 1999 **Upadhyay** *et al.,* 2010
	cough	Latex diluted with water taken twice a day.	**Kumar** *et al.,* 1999 **Upadhyay** *et al.,* 2010
	Ear problems	Latex is boiled in Mustard oil in ratio of 1:5, and 3 to 4 drops of this oil are dropped in affected ear twice a day.	**Upadhyay** *et al.,* 2010
	Snake bite and scorpion sting	About two gm of latex with about 100ml water is taken orally within 2 hours of snakes bite.	**Kumar** *et al.,* 1999 **Upadhyay** *et al.,* 2010
	Toothache	A decoction obtained by boiling latex water in ratio of 1:6, This decoction is used as mouth wash twice a day.	**Upadhyay** *et al.,* 2010
	Intestinal parasites	Dried latex and a fine paste of seeds are taken internally with Luke warm water after each meal.	**Kumar** *et al.,* 1999 **Upadhyay** *et al.,* 2010
	Skin problems	Fresh latex is applied on the affected area.	**Upadhyay** *et al.,* 2010

Leaves	Skin problems	Decoction of leaves applied on affected skin externally.	**Upadhyay** *et al.,* 2010
	Nose ulcers and hemorrhoids	Poultice of the root or leaves is used for nose ulcers and hemorrhoids.	**Kumar** *et al.,* 1999 **Upadhyay** *et al.,* 2010
Stem	Thorn Extraction	The powdered stems are used as a poultice to extract thorns.	**Upadhyay** *et al.,* 2010
	Swelling	Crushed stem are applied to swellings.	**Upadhyay** *et al.,* 2010
	leprosy and paralysis	Wood decoction is used for leprosy and paralysis of the hands and feet after childbirth.	**Kumar** *et al.,* 1999 **Upadhyay** *et al.,* 2010
	colic and gastric problems	decoction of the branches is used for colic and gastric problems.	**Kumar** *et al.,* 1999 **Upadhyay** *et al.,* 2010
Root	Rheumatism	Fresh root or latex and 'Asgandh' are taken in equal quantities and ground to a fine paste. Two gm Paste mixed with 5 gm honey is administered orally twice a day.	**Kumar** *et al.,* 1999 **Upadhyay** *et al.,* 2010

IV. MODERN PHARMACOLOGICAL APPLICATIONS OF *Euphorbia tirucalli L.:*

The biologically active molecules (sterols, tannins, polyphenols, resins and terpenoids) present in different parts of *Euphorbia tirucalli L.* plant have wide range of pharmacological applications. The biologically active components exhibit antimicrobial, antifungal, antibacterial, antidiabetics, antioxidant and anticancer activities. At present era, *Euphorbia tirucalli L.* is not only limited to ethnopharmacological treatment but it is also being used as a source of medicine and medicinal precursors of different diseases in modern therapeutics.

Anti-microbial activity:

The alcoholic extracts of stem bark and leaves of *E. tirucalli* were have antimicrobial activity against Staphylococcus aureus, *Salmonella enteritidis, Eschericia coli, Bacillus subtilis, Proteus vulgaris, Klebsiella pneumoniae, Pseudomonas aeroginosa, A. fumigates, C. tropicalis,Candida albicans, Fusarium oxysporum, A. flavus, and Aspergillus niger.* [5]

Acetone, hexane, methanol, chloroform and petroleum ether extracts of the stem of *E. tirucalli L.* possess antibacterial activity against Escherichia coli, Bacillus megaterium, *Enterobacter faecalis, B. subtilis, Enterobacter faecalis, Pseudomonas aeroginosa, Staphylococcus aureus and Proteus vulgari.*[6]

The methanol and petroleum ether extract of the stem of *E. tirucalli L.* antifungal activity against *A. fumigates, Aspergillus niger and Candida albicans.* [7, 8] The alcoholic stem extract of *Euphorbia Tirucalli L* has strong inhibitory effect against Drechsleria oryzae, Alternaria alternate and Aureobasedium pollulans. [9]

The triterpenoids and terpenes present in the stem and stem-bark of *E. tirucalli L.* play significant role to reduce microbial effects.

Anti-arthritic activity:

There is no particular reason for arthritis. It may cause due to following possible reasons.

(I) Degenerative arthritis occurs due to injury, (ii) Gout and pseudogout occurs due to abnormal metabolism, (iii) Osteoarthritis is mainly due to inheritance, (iv) Arthritis may happen because of infection during Lyme disease, (v)Rheumatoid arthritis (RA) and Systemic lupus erythematosus (SLE) are generally happen due to immune system dysfunction. Sometimes few bacteria such as *Staphylococcus, Streptococcus, or Neisseria gonorrhoeae* cause acute septic arthritis whereas *Mycobacterium tuberculosis and Candida* albicans cause chronic septic arthritis. Chronic septic arthritis is less common than acute septic arthritis.

The methanolic extracts of the stembark, stem and leaf of *E. tirucalli L.* have strong potential to destroy the bacterial effect of *Staphylococcus aureus and Candida albicans.* The triterpenoids extracted from *E. tirucalli* latex in methanol solvent are potent natural anti-inflammatory therapeutic agent for the treatment of arthritis like disorders. The biologically active substances will inhibit arthritis by increasing the concentration of CD4+ and CD8+ T cells and intracellular interleukin-2 (IL-2) and interferon-gamma cells (INF-γ). [10]

Antitumor and Anticancer activity:

Crude *E. tirucalli* latex extract is potentially useful in antitumor treatments. *Euphorbia tirucalli* extract diluted in saline is useful for ascitic tumors. Hematopoiesis and enlarged spleens become normal after treatment with the plant extract (Valadares et al., 2006). Cytokines are the strong mediators for the development of adequate and efficient immunological responses against pathogens. The crude latex of *E. tirucalli* helps to increase the production of the type 1 cytokines (IFN-γ and TNF-α) and the type 2 cytokines (IL-4 and IL-10) in human body. CD4+ T lymphocytes are key cells involved in antitumor immune responses. The percentage of CD4+ T lymphocyte cell increases in human body due to increase of type –I cytokines (IFN-γ and TNF-α (Bethânia et al., 2011).

The macrocyclic diterpene and triterpene compounds have been shown to possess anticancer activity (Shi et al., 2008; Manez et al., 1997). The polyphenols present in the stem, stem bark, leaf and latex of E. tirucalli play remarkable role as an anti-pancreatic agent. [11] Euphol which is extracted from *E. tirucalli* latex has prominent effect against oesophageal squamous cell and pancreatic cell carcinomas. [12] Prof. Peter Gordon Parsons got US Patent (Patent No. US 2003/0171334 A1) in September, 2003 for the invention of biologically active molecules responsible for prostate cancer present in the latex of *E. tirucalli.* Prof. Luiz F. Pianowski got another US patient (Patent No. US 2009/0142421 A1) in June, 2009 for the invention of biologically active components 3-(2,4,6 dodecatrienoyl)-ingenol and 3-(2,4,6,8-tetradecatetranoyl)-ingenol from butanol extract of the *Euphorbia tirucalli linnaeus* plant latex. These compounds are highly potent for the treatment of diseases concerning cell proliferation or angiogenesis.

Hepatoprotective Activity and Antioxidant Activity:

The hepatoprotective activity of a drug depends on its ability to reduce the harmful effects caused by the hepatotoxin. The extent of hepatic damage is assessed by measuring the elevated levels of serum marker enzyme aspartate aminotransferase (AST), serum glutamate pyruvate transaminase (SGPT), alanine aminotransferage (ALT), serum glutamate oxaloacetate transaminase (SGOT), triglycerides and alkaline phosphatase (ALP). At the same time the hepatic damage will cause gradual decrease the concentration of glutathione (GSH), catalase (CAT), glutathione peroxidase (GPx) and superoxide dismutase (SOD) and total protein. The proper dose of aqueous extract of E. tirucalli l. has significant hepatoprotective role by decreasing AST, ALT, ALP, SGPT, SGOT and triglyceride levels and increasing total protein level. [13]

The phenolic compounds present in the latex of *E. tirucalli* exhibit strong antioxidant property. Aqueous extract of aerial parts of *E. tirucalli,* shows reducing power activity, superoxide anion scavenging activity and hydroxyl radical scavenging activity. [14]

Antiviral Activities:

The terpenoid compounds, sterols and tannins present in the stem, stem bark and stem callus respectively of *E. tirucalli* are very sensitive against herpes simplex virus type 2 (HSV-2). The antiviral activities of the petroleum ether extract, ethanol extract, dichloromethane extract of the stem of *E. tirucalli* were evaluated by J Roldan and coworkers. They also calculated the antiviral activities of water-methanol extract of *E. tirucalli* leaves. They showed that the ratio CC (50% cytotoxic concentration) over IC50 (50% inhibitory concentration of the viral

effect) i,e the therapeutic index of the water-methanol extract of *E. tirucalli* stem and leaf is greater than 7.1.

Antipesticidal effect:

The auqueous and methanolic extract of the latex of *Euphorbia tirucalli* plant has pesticidal effect against pests as such aphids *(Brevicoryne brassicae)* and mosquitoes *Aedes egypti* and *Culex quinquefasciatus.* [15,16].

V. CONCLUSION:

Inspite of several medicinal applications, the bio-molecules present in *E. tirucalli L.* has many hazardous roles. *E. tirucalli* latex is reported to cause conjunctivitis. [17, 18] The acetone extract of the latex will accelerate papillomas and malignant tumors in mice. [19] The *E. tirucalli L.* play direct or indirect role to increase Epstein-Barr virus (EBV) (Minzuno et al). However, most of the medicinal uses of E. tirucalli L. mentioned have been left to be folklore and need validation. Based on the folklore reports scientist have found also its experimental anticancer activity [20] and tumor resistance ability [21] both of which are suggestive of a cancer cure. Till now the biological activity of the all the constituents present in it is not known clearly. More proper investigation and research is necessary to find out their active roles and then they can be used in modern therapy. In the mean while we have understood the physiochemical behavior of the few isolated compounds but the properties of the non-isolated compounds are completely unknown to us. The presence of those compounds may become harmful during folk treatment. Scientific research is also necessary to find out those compounds and their physical and chemical properties.

REFERENCES:

1. Little, Elbert L./Woodbury, Roy O./Wadsworth, Frank H. Common trees of Puerto Rico and the Virgin Islands, U.S. Department of Agriculture, Agriculture. 1974; 2: 1024.
2. Van Damme P. Het tradition eelgebruik van Euphorbia tirucalli. (The traditional uses of Euphorbia tirucalli). Afr Focus 1989;5:176-93.
3. Schmelzer GH, Gurib-Fakim A. Medicinal plants. Plant Resour. Trop Afr 2008. p. 412-5.
4. 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.
5. Upadhyay B, Singh KP and Kumar A, Ethno-medicinal, Phytochemical and Antimicrobial studies of Euphorbia tirucalli L. Journal of Phytology 2010; 2:65-77.
6. Parekh J, Jadeja S, Chanda S, Efficacy of aqueous and methanol extracts of some medicinal plants for potential antibacterial activity. Turkish Journal of Biology 2005; 29:203-210.
7. Prasad S, Swapna NL, Prasad M, Efficacy of Euphorbia tirucalli (L) towards microbicidal activity against human pathogens. International Journal of Pharma and Bio Sciences 2011;2: 12-18.
8. Sultan S, Kimaro CC, Amri E. Antifungal Activity and hytochemical Screening of Different Solvent Extracts of Euphorbia Tirucalli Linn. Journal of Advances in Biology & Biotechnology. 2016; 7(1):1-9.
9. Jadhav DM, Gawai DU, Khillare EM. Evaluation of Antibacterial and Antifungal Activity of Euphorbia tirucalli Linn. Bionano Frontier 2010; 3(2): 332-334.
10. Rastogi M, E.tirucalli L. (compend. Indian made plants, volume 3, PID. New Delhi: 1993;3:286.
11. Benzamin M, Vuong QV, Chalmers AC, Goldsmith CD, Bowyer MC, Scarlett CJ. Phytochemical, Antioxidant and Anti-Cancer Properties of Euphorbia tirucalli Methanolic and Aqueous Extracts. Antioxidants 2015; 4: 647-661.
12. Reis RM, Silva VAO, Rosa MN, Tansini A, Lima JPDSN, Jones C, Pianowski LF. Cytotoxic effect of Euphol from Euphorbia tirucalli on a Large Panel of Human Cancer Cell Lines. Available online: http://meetinglibrary.asco.org/content/117486-132 (accessed on 9 June 2015).
13. Jyothi TM, Shankariah MM, Prabhu S, Lakshminarasu S, Srinivasa GM, Setty SR. Hepatoprotective and Antioxidant Activity of E.tirucalli. Iran J Pharmacol Ther 2008;7:25-30.
14. Gupta N, Vishnoi G, Wal A, Wal P. Medicinal Value of Euphorbia Tirucalli. Systematic Reviews in Pharmacy 2013, 4(1), 40-46.
15. Rahuman A, Gopalakrishnan G, Venkatesan P, Geetha K. Larvicidal activity of some Euphorbiaceae plant extracts against Aedes aegypti and Culex quinquefasciatus (Diptera: Culicidae). Parasitology Research. 2008;102:867-873.
16. Mwine J, Van Damme P. Evaluation of selected pesticidal plant extracts against major cabbage insect pests in the field. Tropentag 2010: "World Food System – A Contribution from Europe", ETH Zurich, Switzerland; 2010.
17. Hsueh KF, Lin PY, Lee SM, Hsieh CF. Ocular injuries from plant sap of genera Euphorbia and Dieffenbachia. J Chin Med Assoc 2004;67:93-8.
18. Shlamovitz G, Gupta M, Diaz J. A Case of Acute Keratoconjunctivitis from Exposure to Latex of Euphorbia tirucalli (Pencil Cactus). J Emerg Med 2009;36:239-41.
19. Roe FJ, Peirce WE. Tumor promotion by Euphorbia latices. Cancer Res 1961;21:338-45.
20. Cataluna P, Rates SM. The traditional use of the latex from Euphorbia tirucalli Linnaeus (Euphorbiaceae) in the treatment of cancer in South Brazil. Second World Congress on Medicinal and Aromatic Plants for Human Welfare Wocmap-2: Pharmacognosy, Pharmacology, Phytomedicines, Toxicology. WOCMAP II 1999;289-95.
21. Valadares MC, Carrucha SG, Accorsi W, Queiroz ML. Euphorbia Tirucalli L. modulates myelopoiesis and enhances the resistance of tumourbearing mice. Int Immunopharmacol 2006;6:294-9.