Research & Reviews

Research and Reviews: Journal of Pharmacognosy and Phytochemistry

Medicinal Value of *Euphorbia tirucalli* : A Review

Nishi Gupta*, Garima Vishnoi, Ankita Wal, and Pranay Wal

PSIT, Kanpur, Uttar Pradesh, India.

Review Article

Received: 28/02/2013
Revised: 27/03/2013
Accepted: 18/04/2013

***Corresponding author:**

PSIT, Kanpur, Uttar Pradesh, India.

Keywords: *E. tirucalli*, lupeol, resin

ABSTRACT

Natural products play an important role in drug discovery and many approved therapeutics as well as drug candidates have been derived from natural sources. They have been the source of most of the active ingredients of medicines. The beneficial medicinal effects of plant materials typically result from the combinations of secondary products present in the plan. These secondary metabolites constitute the medicinal value of a drug plant, which produces a definite physiological action on human body. The plant of Euphorbia tirucalli belongs to family-Euphorbiaceae is commonly known as Barki-thohar. This plant is native of America but has become acclimatised and grows freely in all parts of India. This is a common medicinal plants of India; the plant parts used milky juice and stem bark. Milky juice in small doses is a purgative but in large doses it is acrid, counter-irritant and emetic. E. tirucallilatex seems to reduce the specific cellular immunity associated with the virus Epstein-Barr injection by activating the virus lytic cycle. The bark / latex of E. tirucallipresents pharmacological activities as anantibacterial, molluscicide, antiherpetic and anti-mutagenic. It also shows co-carcinogenic and anticarcinogenicactivities.In the northeast of region in Brazil, the latex of E. tirucalliis used as a folk medicine against syphilis. As an antimicrobial; a laxative agent to control intestinal parasites to treat asthma, cough, earache, rheumatism, verrucae, cancer, epithelioma, sarcoma and skin tumors. E. tirucallicontains a large quantity of terpenes and sterols among its constituent and the following substances which have been isolated; alcohol eufol, alfaeuforbol and taraxa sterol e tirucallol (Imai, 1994 This review highlights on the existing information particularly on the phytochemistry and various pharmacological properties of Euphorbia tirucalli which may provide incentive for proper evaluation of the plant as a medicinal agent.

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 of 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 Organisation (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]. India is the largest producer of medicinal herbs and is appropriately called the botanical garden of the world[5]. In recent years, the use of herbal medicines worldwide has provided an excellent opportunity to India to look for therapeutic lead compounds from an ancient system of therapy, i.e. Ayurveda, which can be utilized for development of new drug [6].

Euphorbia L. (Euphorbiaceae, Euphorbioideae) is considered the second largest genus in the angiosperms, including ca. 2000 species[7]. The Euphorbiaceae family includes trees, succulents and herbaceous plants[8]. Different species of Euphorbia grow all over the world, either wild, or as cultivated specimens in the house or garden[9].Euphorbiaceae is among the large flowering plant families consisting of a wide variety of vegetative forms some of which are plants of great importance. 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 comparise a number of endemic and endangered taxa[12].

About the plant

A large unarmed shrub or a small tree up to 5 m tall with erect branches; bark rough, cracked, greenish brown, exuding a milky sap when cut, branch lets slender, smooth, cylindrical, polished, whorled and modified into phylloclade[13]. E. tirucalliis probably the best known and most widespread of all tree Euphorbia species[14]. It is a shrub or a small tree endemic to tropical areas with pencil-like branches from which it derives its vernacular name, the pencil-tree. E. tirucalliis generally evergreen since its stems and branches remain green all year round and are rarely fed on by herbivores. It bears white poisonous latex which may possibly account for the low herbivore pressure and medicinal features.

Taxonomic Description

In the binomial system (USDA plants data at www.plants.usda.gov), E. tirucalliL. belongs to:

Kingdom: Plantae.
Division: Magnoliophyta.
Class: Magnoliopsida
Order: Malpighiales.
Family: Euphorbiaceae.
Genus: Euphorbia.
Species: E. tirucalli.
Binomial name: Euphorbia tirucalli

Vernacular Names [15]

Amharic: Kinchib;
Arabic: Knjil;
English: Finger euphorbia, Indian spurge tree, milk bush, naked lady, pencil-tree, rubber euphorbia;
Filipin: Bali bali;
French: Arbre de Saint Sebastien, Euphorbeeffileeuphorbe, Gardemaison, Tirucalli;
Malay: Kayupatah, Tentulang, Tulang, Tulang-tulang;
Somali: Dana;
Spanish: Alfabeto chino, Antena, Esqueleto, Palito, Aveloz;
Swahili: Mtupamwitu, Mwasi, Utupa;
Thai: Khiacheen, Khiathian;
Ugandan: Kakoni (luganda), Oruyenje (runyankole);
Vietnamese: San h(oo) xanh, X(uw) (ow)ng c(as).

Habitat

Commonly planted as an ornamental or hedge plant[16]. In Hawai'i (Kaua'i), "sparingly naturalized locally as it forms dense thickets along Lawa'i Road where it is propagating vegetatively" [17]. E. tirucalliis probably the best known and most widespread of all tree Euphorbia species [18]. It originated from tropical East Africa and it is endemic in countries such as Angola, Eritrea, Ethiopia,

Kenya, Malawi, Mauritius, Rwanda, Senegal, Sudan, Tanzania, Uganda and Zanzibar. The same authors intimate that the tree is currently widely distributed in southern Europe, Asia and the Americas having been steadily introduced due to its ornamental and medicinal features. E. tirucallican survive in a wide range of habitats[19-20]. Plant can grow under conditions in which most crops and other trees cannot grow. They include: tropical arid areas with low rainfall, on poor eroded soils, saline soils and high altitudes up to 2000 m but cannot survive frost. Its distribution is therefore limited by low temperatures[21].

Botanical Description

E. tirucallis is a succulent, cactus-like (FAO) spineless, unarmed, much-branched, monoecious or more often dioecious, easy to recognize, perennial shrub or tree up to 10-15 m tall.

Trunk or stem

The rubber-hedge euphorbia reach usually 2-5 m but may grow up to 15 m on occasion with a 2-4 m spread. The main trunk and branches are woody and brownish and may thickening up to a diameter of 25 cm. It grows with single or multiple trunks. The bark of very old specimens is grey and rough with longitudinal dents and ridges that break up into very small fragments. There are sometimes conspicuous, small protuberances, such as a bulge, knob, or swelling, on the bark, and occasionally black, rough, crosswise bands.

Branches

E. tirucalliis a plant very branched with branches often arranged in pseudo whorls10 forming brush-like masses that are the best known feature of this species.

Leaves

Leaves are rarely seen as they fall very early o quickly (early deciduous), tiny, few, simple, fleshy, small or minute, slender and alternate. The leaf blade is linear-lanceolate to oblanceolate, 1-2.5 cm long, 3-4 mm broad and 2 mm thick, acute at tip, tapered to the sessile base, arranged spirally, present only at the tips of young branchlets. The extreme tips of young leafy branchlets are sparsely tomentose, with curled brown hairs, and soon glabrescent. Stipules are minute, glandular and dark brown. The function of the leaves is taken over by the green branches.

Flowers

Plants are monoicous or dioicous, the chromosome number is 20 and the diploid number is 2n. The flowers are small or very small, yellow, green or pink arranged in groups on the terminal branches, discreet, and grouped at the top of the short branches, in heads, stalkless at the end of twigs, and carried in clusters at the apex of the short branches or in the angles of branches.

Fruits

Fruits are tripartite capsule and a capsule measures about 8-12 mm in diameter, is subglobose (nearly globose), almost glabrous or glabrescent, longitudinally very slightly lobed, short-stalked (8 mm), bent at an angle, pale green, with a pink tinge and conspicuously pubescent (soft hairs). Capsules dehisce while still on the tree, and exserted on a tomentosepedicelto 1 cm long.

Seeds

The seeds are ovoid (oval), about 3-4 mm x 2.8-3 mm, glabrous, smooth, buff speckled with brown and with a dark brown ventral line (with a white line), around the small white caruncle 1 mm across.

Latex

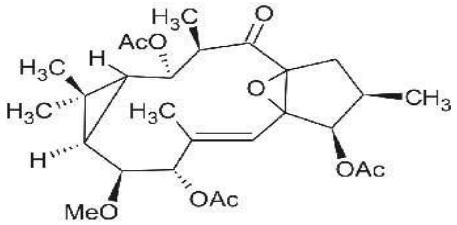
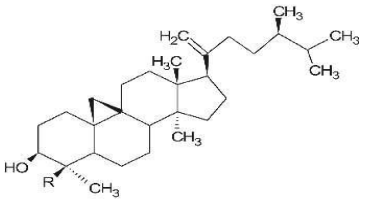
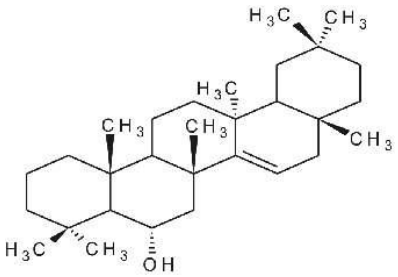
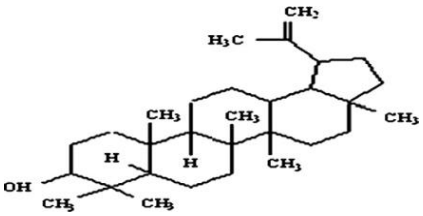
The latex is a caustic milky white sap when damaged, like many other Euphorbia species.

Root system [22]

The plant produces lateral roots that do not grow very deep.

Euphorbiaceae plants store abundant amounts of latex in an organ called the laticifer[23]. The major constituents of latex are isomers of triterpenes with the molecular formula $C_{30}H_{50}O$ (MW: 426), such as euphol, tirucallol, glut-5-en-3-b -ol, cycloeuphordenol, euphorginol, aamyrin, lanosterol, cycloartenol, and others[24-27].12,20-Dideoxyphorbol- 13 isobutyrate, 12-deoxy-4 β-hydroxyphorbol-13-phynylacetate-20-acetate &euphol isolated from latex, glut-5-en-3β-ol& cycloart-23-en-3β, 25-Diolisolated from stem bark, a new macrocyclicditerpenetirucalicine isolated from latex & its structure determined, isolation& characterization of 31 – nortriterpene – cycloeuphordenol – from latex, a new triterpenescyclotirucanenol isolated & its absolute configuration is determined, euphorginol isolated from the stem bark & its stereo structure determined[28].

Table 1: Phytoconstituents

Tirucalicine	
Cyclotirucanenol, R = Me, Cycloeuphordenol, R = H	
Euphorginol	
Lupeol	

Plant Extract

Extraction, as the term is used pharmaceutically, involves the separation of medicinally active portions of plant or animal tissues from the inactive or inert components by using selective solvents in standard extraction procedures. The purposes of standardized extraction procedures for crude drugs are to attain the therapeutically desired portion and to eliminate the inert material by treatment with a selective solvent known as menstrum. The extract thus obtained may be ready for use as a medicinal agent in the form of tinctures and fluid extracts, it may be further processed to be incorporated in any dosage form such as tablets or capsules, or it may be fractionated to isolate individual chemical entities such as ajmalicine, hyoscine and vincristine, which are modem drugs. Thus, standardization of extraction procedures contributes significantly to the final quality of the herbal drug. General Methods of Extraction of Medicinal Plants- Maceration, Infusion, Digestion, Decoction, Percolation, Hot Continuous Extraction (Soxhlet), Aqueous Alcoholic Extraction by Fermentation, Counter-current Extraction, Ultrasound Extraction (Sonication), Supercritical Fluid Extraction and Phytonics Process[29].E. tirucalli can be extracted in methanol, chloroform, pet ether, acetone for various activities.

Ethnomedicinal Uses

Just like the complexity in classification, ethnomedicine of Euphorbiaceae is very diverse. This diversity is due to the presence of a wide range of unusual secondary metabolites that makes most of the members poisonous[30]. In addition, some members are said to cause or influence susceptibility to certain body ailments. For example E. tirucalli, E. leuconeura, J. curcasand others are known to be co-carcinogenic and can influence/promote excessive cell division resulting in tumour growth[19,20,31-32]. Also latex of E. tirucalliandE. royleanaisknown to cause conjunctivitis on contact with eyes[33,34]. In the northeast region of Brazil, the latex of E. tirucalliis used; as an antimicrobial agent; a laxative agent; to control intestinal parasites; to treat asthma, cough, earache, rheumatism, verrucae, cancer, chancre, epithelioma, sarcoma, skin tumors and as a folk remedy against syphilis[20].

Uses

Traditional Medicine

Possibly due to a great variety of chemical substances found in E. tirucalli tissues, medical folklore literature of different parts of the world (especially tropical and subtropical areas where it is endemic) is tainted with its curative ability. In East Africa, latex is used against sexual impotence, warts, epilepsy, toothache, hemorrhoids, snake bites, extraction of ecto-parasites and cough among others. In Peninsular Malaysia, a poultice of the roots or stems is applied to nose ulceration, haemorrhoids and swellings. Root scrapings mixed with coconut oil are taken for stomach-ache[19,20]. In India, it is an unavoidable plant in most traditional homesteads and used as a remedy for ailments such as : spleen enlargement, asthma, dropsy, leprosy, biliousness, leucorrhoea, dyspepsia, jaundice, colic, tumors and bladder stones. The latex of vesicant and rubifacient is emetic in large doses, it is purgative in small doses and applied against toothaches, earaches, rheumatism, warts, cough, neuralgia and scorpion bites. The same author points out that its branch and root decoctions are administered for colic and gastralgia while ashes are applied as caustic to open abscesses[35]. In Brazil, E. tirucalliis used against cancer, cancroids, epitheliomas, sarcomas, tumors and warts, although they argue that this has no scientific basis since the same tree is known to be co-carcinogenic. In Malabar (India) and the Moluccas, latex is used as an emetic and anti-syphilitic while in Indonesia, the root infusion is used for aching bones while a poultice of roots or leaves is used to treat nose ulcers, hemorrhoids and extraction of thorns. Wood decoctions are applied against leprosy and hands and feet paralysis following childbirth. The same author states that in Java, the plant latex is used to cure skin ailments and bone fractures[19,36].

Ornamental

E. tirucalli has increasingly become popular as an ornamental plant. Potted plants are placed in offices and homes but can also be grown in lawns. It is preferred for its ease of maintenance and beautiful evergreen pencil-like branches which factors have increased its international trade resulting into a wide distribution in areas where it was not endemic.

Source of Energy

It was reported that latex of E. tirucalliis composed of petroleum like hydrocarbons largely C_{30}triterpenoids, which on cracking yield high-octane gasoline. It was estimated that a crude gasoline yield between 4 and 8 barrels per hectare from an E. tirucalli planted field per year; and calculated at about three dollars per barrel, it is three times cheaper than normal crude oil[37-39]. E. tirucalliis still looked at as a potential source of biodiesel as it can produce a high biomass and grow in marginal areas unfit for production of other crops. Of late, there has been increasing attention on biodiesel production in order to reduce overdependence on fossil fuel[40].Associated with biodiesel production is methane and biogas generation; many scientists, considering its reported high biomass production and ease with which it ferments, note that it is a potential source of methane and biogas[41-42]. It was experimentally demonstrated that E. tirucalliproduces suitable biomass for biogas generation especially through chopped material under thermophilic conditions which can yield 1.06 l/day of biogas in just 19 days[43]. For the same reason, it has been recommended for commercial fuel wood production projects for purposes of woodlot restocking in semi-arid parts of Kenya[44]. E. tirucalliis preferred for this purpose due to its fast growth rate, high productivity, quick acclimatizion to an area and ease with which it dries.

Source of Rubber

E.tirucalliis reported for possessing hydrocarbon polymers that are used for manufacturing rubber substitutes. Several researchers point out that its latex is an emulsion of terpenes and resins in water which can easily be transformed into rubber at low cost[37,41,45]. Also, due to the strong fixative power of the resin, it has for long been used on the East African coast in local gum manufacture for fastening knife-blades to wood handles and spear-heads to shafts[19]. The resin produces comparably good wood-based glue and adhesives whereas with a few modifications, it would compete favourably with other commercial resins[46].

Conservation and Agroforestry

Due to its favourable agronomic features such as drought resistance, E.tirucalliis used in semi-arid areas to carry out afforestation and re-forestation for purposes of achieving soil conservation. These plants can be used as a soil cover in places where

other plants (even grasses) cannot grow[21]. Involvement of E.tirucallihas been mentioned in successful reforestation and conservation programs in: Tanzania[47], Kenya[48,41]and Sri Lanka[49] among others. It has also featured in agroforestry programs[50-52] as a hedge plant or as anintercrop. Other related uses of E. tirucalliinclude: boundary demarcation[19,53], live fencing around compounds and kraals[19,54,55], cultural connotations for example as a sign of starting a new home in Luo culture of East Africa[44] and as a windbreak in semi-arid areas[56]. Plant plays these roles due to its latex toxicity and hence low herbivore pressure[55].

Pesticides

E. tirucallilatex has been reported to have pesticidal features against such pests as aphids (Brevicorynebrassicae)[57], mosquitoes (Aedesaegyptiand Culexquinquefasciatus)[58], microorganisms such as bacteria (Staphylocococcusaureus)[59] and molluscs (Lymneaenatalensis) and Biomphalariagabrata[60]among others. A dose dependent latex toxicity to parasitic nematodes was also reported such as Haplolaimusindicus, Helicotylenchusindicusand Tylenchusfiliformis in vitro, with increasing exposure period, although some nematodes like Meloidogynespp. are known to attack the plant[61]. The latex is also reported to be a hunters' tool applied in local fishing and arrow poisoning in tropical Africa[62]. Piscicidal feature has been validated[60]. Although the plant is generally mentioned as a pesticidal plant; scanty experimental work has been performed to confirm this.

Pharmacological Activities

Oxytoxic Activity

Latex of this plant showed strong oxytoxic activity against isolated strips of the gravid ratuterus.

Anti-arthritic Activity:

The biopolymeric fraction (BET) from plant E. tirucalliBoiss (Euphorbiaceae). The fraction showed dose dependent anti-arthritic activity and also showed in vivo immunomodulatory capacity being a major component in inhibiting arthritis. It caused suppression of CD4+ and CD8+ Tcells, inhibition of intracellular Interleukin-2 (IL-2) and Interferon-gamma (IFN-_) by flow cytometry[28].

Molluscicide activity

An aqueous solution of the latex of E. tirucalli collected at sites receiving large amounts of sunlight showed molluscicide action on Biomphalariaglabrata, with LD50 obtained at the concentration of 28,0 ppm and LD90 at the concentration of85,0 ppm. The toxicity of the product for fish was similar to that of Bayluscide and of copper sulfate used for comparison. However, the wide distribution of the plant, its easy propagation and the simple procedure for extraction of the active substance, which is biodegradable, favor "avelos" as a promising agent in the control of schistosomiasis[63].

Antimicrobial Activity

Acetone extracts of the stem of E. tirucalliwere inhibitory to all the test microorganisms. E. coli was found to be highly sensitive to the acetone extracts of E. tirucalli. The MIC was 500 µg for C. albicansand 750 µg for A. nigerand A. fumigatus. The chloroform extracts of the stem of E. tirucalliare active against *B. subtilis, E. coli, P. vulgaris, S.aureus, A. niger*and*C. albican s*and the minimum inhibitory concentration was 250 µgfor*P. vulgaris,* 500 µg for *E. coli* and *S. aureus,* while it was 750 µg against *B. subtilis*and*C. albicans,* 1000 µg for *A. niger.* The methanol extracts of the stem of *E. tirucalli*showed activity against *B. subtilis, E. coli, E. faecalis, S. aureus*and *C. albicans*and its minimum inhibitory concentration was found tobe 500 µg for *E. coli* and *S. aureus,* while it was 750 µg for *B. subtilis, E. faecalis*and1000µg for *C. albicans.* The petroleum ether and hexane extracts did not show activity against the test organisms[64].

Antiherpetic Activity

To evaluate the capacity of the extracts to inhibit the lytic activity of herpes simplex virus type 2 (HSV-2) and the reduction ofviability of infected or uninfected cell cultures, the end-point titration technique (EPTT) and the MTT [3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide] colorimetric assay were used, respectively. The therapeutic index of the positive extracts for the antiviral activity was determined by calculating the ratio CC (50% cytotoxic concentration) overIC50 (50% inhibitory concentration of the viral effect). Five of the47 extracts (11%) representing 3 out of 10 Euphorbia species(30%) exhibited antiherpetic action; the highest activity was found in the leaf/stem water-methanol extracts from E. cotinifoliaand E. tirucalli[65].

Antioxidant Activity

A systemic and scientific investigation of aqueous extract of E.tirucallifor its antioxidant, Antioxidant property was assessed by using reducing property, superoxide anion scavenging and hydroxyl radical scavenging property. The aqueous extract has demonstrated dose-dependent in vitro antioxidant property (at 20 µg, 40 µg,60µg, 80 µg, 100 µg) in all the models of the study.

Hepatoprotective Activity

A systemic and scientific investigation of aqueous extract of E.tirucallifor its hepatoprotective potential against carbon-tetrachloride-induced hepatic damage in rats was carried out. Hepato-protective property was assessed by measuring the extent of reversal of enhanced biochemical markers of hepatitis, like Serum glutamate pyruvate transaminase, serum glutamate oxaloacetate transaminase, alkaline phosphatase ALP, biluribin, cholesterol, triglycerides and also by estimating the tissue glutathione (GSH) levels and the extent of reduction in the tissue lipid peroxidation. Similarly, aqueous extract of E. tirucalli at the doses of 125mg/kg and 250mg/kg produced significant hepatoprotective effect by decreasing the serum enzymes, bilirubin, cholesterol, triglycerides and tissue lipid peroxidation, while it significantly increased the levels of tissue GSH in a dose- dependent manner[66].

Immunomodulatory Activity

Myelosuppression concomitant with increased numbers ofspleen CFU-GM was observed in tumour-bearing mice. Treatment of these animals with E. tirucalli L. (ET) (125,250 and 500 mg/kg) stimulated marrow myelopoiesis and reduced spleencolony formation, with no differences observed between the effects of the three doses. The changes produced by the tumour in total and differential marrow cell counts were restored by the treatment with ET. Prostaglandin E2 (PGE2) levels, which were dramatically increased in tumour bearers, was also abrogated by the treatment with the plant extract. E. tirucalli L. significantly enhanced survival and concurrently reduced tumour growth in the peritoneal cavity[67].

Cytotoxic and Antiviral Activities

Forty-seven plant extracts of 10 species of the genus Euphorbia (Euphorbiaceae). The capacity of the extracts to inhibit the lytic activity of herpes simplex virus type 2 (HSV-2) and the reduction of viability of infected or uninfected cell cultures, the end-point titration technique (EPTT) and the MTT [3-(4,5-dimethylthiazol-2-yl)- 2,5-diphenyltetrazolium bromide]colorimetric assay were used, respectively. The therapeutic index of the positive extracts for the antiviral activity was determined by calculating the ratio CC50 (50% cytotoxic concentration) overIC50 (50% inhibitory concentration of the viral effect). The highest activity was found in the leaf/stem water methanol extract of E. tirucalli[65].

Diseases

A number of diseases have also been mentioned. Associated with its vesicant and rubifacient features, E. tirucallilatex is reported to cause conjunctivitis[68-71] when it accidentally gets in contact with the eyes. Symptoms range from mild epithelial keratoconjunctivitis to severe keratitis with stromal oedema, epithelial sloughing and anterior uveitis which usually heal in 2 to 7days but can also result into permanent blindness. It should be handled with caution. Research also shows that E. tirucalliis co-carcinogenic[72]. It was observed that papillomas and malignant tumors were elicited in mice treated with acetone extracts of Euphorbia lattices[73]. Mizuno reports a high incidence of Burkitt's lymphoma - a latent Epstein-Barr virus (EBV) malignancy in East Africa where E. tirucalliis endemic. EBV causative factors were detected in soil and drinking water (where E. tirucalligrows) implying that people living in such areas run a high cancer risk[74]. The findings have been further clinically validated in rats[75-78]; some of which developed full blast lymphomas. However, folklore reports anti-cancer treatment by the latex[79], and there are scientific indications that it may modulate myelopoiesis and enhance resistance against tumor bearing[80], both of which are suggestive of a cancer cure. E. tirucalliis known to be an irritant to herbivores and due to its nasty and acrid features, most herbivores learn to avoid it. This is one of the reasons why it is a good live fencing material. Evidently, quite a lot has been done on exploration of its chemistry and evaluation of its potential as an energy plant. However, most of the medicinal uses mentioned have been left to folklore and need validation. For example, in spite of the vast number of ailments it is reported to cure, to our knowledge, no substance of pharmaceutical importance has so far been obtained from it. Also scanty literature has been cited on validation of other functions like the reported insecticidal, nematicidal, piscicidal and molluscicidal features. This calls for more research/laboratory investigation, in order to establish scientific authenticity of these important functions and to ascertain with confidence that E. tirucalliis a wonder plant for modern science. It remains a research issue whether people should continue to use E. tirucallifor the mentioned uses but as it were, many societies have always applied it and will continue to do so until its effects are scientifically proved dangerous[55,81].

REFERENCES

1. Thomas S.C. Medicinal plants culture, utilization and pharmacology, Li. United States CRC Press., 1995;119-54
2. HarborneJ B. Phytochemical Methods: A Guide to Modern Techniques of Plant Analysis, Chapman and Hall, New York., 1984; 2
3. Salim AA, Chin YW, Kinghorn AD. Drug Discovery from Plants. Bioactive Mol Med Plants. 2008; XXIV: 380, 91.

4. Mukerjee PK. Quality control of herbal drugs, New Delhi: Business Horizons Publication. 2002; 1: 2-24.
5. Ahmedulla M, Nayer MP. Red data book of Indian plants. Calcutta: Botanical survey of India.1999; 4
6. Baker JT, Borris RP, Carte B, Cordell GA, Soejarto DD. Natural product drug discovery and development : New perspective on international collaboration. J Natl Prod.1995;58:1325-57
7. Oudejans RCHM. World catalogue of species names publishedin the Euphorbieae (Euphorbiaceae) with their geographicaldistribution. Utrecht: published by the author.,1990
8. Webster GL. Irritant plant in Spurge family (Euphorbiaceae) Clin Dermatol. 1966;4: 36-45.
9. Elder S Duke. System of Ophthalmology. London: Kimpton.1972; 14: 1185.
10. Julius TM, Patrick VD. Why do Euphorbiaceae tick as medicinal plants? A review of Euphorbiaceae family and its medicinal. (Accepted 21 December, 2010).
11. Gibbs RD. 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, et al. Flora of China. 2008; 11: 163.
13. Baniakina J, Eyme J. Studies onthe morphological and anatomical structures in the Family Euphorbiaceae. Revuede Medicine Set Pharmacopees Africaines. 1997; 12: 27-48.
14. Gildenhuys S. The three most abundant tree Euphorbia species of the Transvaal (South Africa). Euphorbia W., 2006; 2: 9-14.
15. Julius M, Patrick VD. Euphorbia tirucalliL. (Euphorbiaceae) – The miracle tree: Current status of available knowledge. Sci Res Essays. 2011; 6(23): 4905-4914,
16. 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.
17. Lorence David H Flynn, Timothy W, Wagner, Warren L. Contributions to the flora of Hawai'i. III. New additions, range extensions, and rediscoveries of flowering plants. In: Evenhuis, Neal L. and Miller, Scott, E., eds. Records of the Hawaii Biological Survey for 1994. Part 1: Articles. Bishop Museum Occasional Papers., 41:19-58.
18. Gildenhuys S. The three most abundant tree Euphorbia species of the Transvaal (South Africa). Euphorbia W., 2006; 2: 9-14.
19. Van Damme P. Het tradition eelgebruik van Euphorbia tirucalli.(The traditional uses of Euphorbia tirucalli). Afr. Focus., 1989; 5: 176-193.
20. Schmelzer GH, Gurib-Fakim A.(2008) Medicinal plants. Plant Resour Trop Afr. 2008;412-415.
21. Van Damme PLJ. Euphorbia tirucallifor high biomass production, in: A. Schlissel and D.Pasternak (Eds.), Combating desertification with plants, Kluwer Academic Pub. 2001; 169-187.
22. John L, Luz AM, Ywe JF. Euphorbia tirucalli Bioenergy Manual. 2001.23.
23. Scassellati-Sforzolini GL' Euphorbia Tirucalli. L. In: Biblioteca Agraria Coloniale. Istituto Agricolo ColonialeItaliano, Firenze.1916; 1-87.
24. McDonald AD, Warren FL, Williams JM. TheEuphorbiaresins. Part I. Euphol J ChemSoc.1949: S155-S157.
25. Nemethy EK, Otvos JW, Calvin M. Analysis of extractables from one Euphorbia. J Am Oil ChemSoc.1979;56: 957-960.
26. Nemethy EK, Calvin M. Terpenoid biosynthesis inEuphorbialatex. In: Thomson WW, Mudd JB, Bibbs M (eds)Biosynthesis and Function of Plant Lipids: Proceedings of The Sixth Annual Symposium in Botany. University of California,Riverside. 1983; 216-228.
27. Nielsen PE, Nishimura H, Otvos JW, Calvin M. Plant cropsas a source of fuel and hydrocarbon-like materials. Sci. 1977;198:942-944
28. Rastogi, Mehrotra. E.tirucalli L. (compend. Indian madeplants, volume 3, PID New Delhi., 1993; 3: 286)
29. Handa Sukhdev Swami, Khanuja Singh, Suman Preet, Longo Gennaro, Dev Dutt Rakesh. Extraction Technologies for Medicinal and Aromatic Plants ICSHP Trieste., 2008
30. Seigler DS. Phytochemistry and systematics of the Euphorbiaceae. Annals of the Missouri Botanical Garden., 1994; 81: 380-401.
31. Hirota M, Suttajit M. A new tumor promoter from the seed oil of JatrophacurcasL.,an Intra molecular diester of 12-deoxy-16-hydroxyphorbol. Cancer Res. 1988;48: 5800-5804.
32. Vogg G, Mattes E, Rothenburger J, Hertkorn N, Achatz S, Sandermann H. Tumor Promoting diterpenes from Euphorbia leuconeura L. Phytochem. 1999;51:289-295.
33. Shlamovitz G, Gupta M, Diaz J. A Case of Acute Keratoconjunctivitis from Exposure to Latex of Euphorbia tirucalli(Pencil Cactus). J Emerg Med. 2009; 36:239-241.
34. Correia MP, Dicionario de PlantasUteis do Brasil e das ExoticasCultivadas, Instituto Braileirode Desenvovimento Florestal, Rio de Janeiro., 1994; 63.
35. Kumar A. Some potential plants for medicine from India, Ayurvedic medicines, University of Rajasthan, Rajasthan.1999; 1-12.
36. Duke JA. Handbook of Energy Crops. Purdue University centre for new crops and plant products. 1983.
37. Calvin M. Chemistry, population, resources. Pure Appl Chem. 1978; 50: 407-425.
38. Calvin M. Petroleum plantations for fuel and materials. Biosci. 1979; 533-538
39. Prusty B, Chandra R, Azeez P. Freedom from Dependence on Fossil Fuels? Biodiesel, Nature Publishing Group, Coimbatore, India. 2008; 234.
40. Rajasekaran P, Swaminathan K, Jayapragasam M. Biogas production potential of Euphorbia tirucalliL.along with cattle manure. Biol Waste.1989; 30: 75-77.
41. Van Damme P. Gebruik van Euphorbia tirucallials rubber lever an cierenenergiege was (The Use of Euphorbia tirucallias Rubber and Energy Crop). Afr. Focus., 1990; 6: 19-44.

42. Sow D, Ollivier B, Viaud P, Garcia JL. Mesophillic and thermophilic methane Fermentation of Euphorbia tirucalliMircen. J Appl Microbiol Biotechnol.1989; 5: 547-550.
43. Mahiri I. Rural household responses to fuelwood scarcity in Nyando District, Kenya. Land Degrad Dev. 2002; 14: 163-171.
44. Mahiri I. Comparing transect walks with experts and local people. PLA notes. 1998; 31:48.
45. Uzabakiliho B, Largeau C, Casadevall E. Latex constituents of Euphorbia candelabrum, E. grantii, E. tirucalli and Synadeniumgrantii. Phytochem. 1987; 26: 3041- 3045.
46. Murali R, Mwangi JG. Euphorbia tirucalliresin: potential ladhesive for wood Based industries. International Conference on Domestication and Commercialization of Non-Timber Forest Productsin Agro-systems. 19-23 February 1996. 1998.
47. Smith W, Meredith T, Johns T. Use and conservation of woody vegetation by the Batemi of Ngorongoro district, Tanzania. Econ Bot. 1996; 50: 290-299.
48. Macharia P. Community Based Interventions as a Strategy to Combat Desertification in the Arid and Semi-Arid Rangelands ofKajiado District, Kenya. Environ Monit Assess. 2004; 99: 141-147.
49. Melvani K. Role of forests in the bioremediation of water, XIII World Forestry Congress, Buenos Aires, Argentina. 2009.
50. Jama B, Njui A, Njenga K. Management and utilization of dry land forests in sub-Saharan Africa: The role of agroforestry, VITRI/ETFRN/IUFRO-SPDC workshop: Trees, agro forestry and climate change in dry land Africa, Hyytiälä, Finland. 2003; 30 June – 4 July.
51. Long AJ, Nair PKR. Trees outside forests: agro-, community, and urban forestry. New For. 1999; 17: 145-174.
52. Mbwambo L. Status of arid and semi-arid lands of Tanzania. Dry lands Agro forestry Workshop held at ICRAF, Nairobi-Kenya., 2004.
53. Kindt R, Van Damme P, Simons A, Beeckman H. Planning tree species diversification in Kenya based on differences in tree species composition between farms. I. Analysis of treeuses. Agro forest Syst. 2006; 67: 215-228.
54. Nascimento V, Sousa L, Alves A, Araújo E, Albuquerque U. Rural fences in agricultural landscapes and their conservation role in an area of caatinga (dryland vegetation) in Northeast Brazil. Environ Dev Sustain. 2009; 11: 1005-1029.
55. Simons T, Schmelzer G, Omino E. Auxiliary Plants.Prota 9, PROTA Foundation, Nairobi, Kenya. 2004.
56. Jama B, Njui A, Njenga K. Management and utilization of dry land forests in sub-Saharan Africa: The role of agroforestry, VITRI/ETFRN/IUFRO-SPDC workshop: Trees, agro forestry and climate change in dry land Africa, Hyytiälä, Finland., 2003; 30 June – 4 July.
57. Mwine J, Van Damme P. Evaluation of selected pesticidalplantextracts against major cabbage insect pests in the field. Tropentag: "World Food System – A Contribution from Europe", ETH Zurich, Switzerland., 2010
58. Rahuman A, Gopalakrishnan G, Venkatesan P, GeethaK. Larvicidal activity of some Euphorbiaceae plant extracts against Aedesaegypti and Culexquinquefasciatus(Diptera: Culicidae). Parasitol Res. 2008; 102: 867-873.
59. Lirio L, Hermano M, Fontanilla M. Note Antibacterial Activity of Medicinal Plants from the Philippines. Pharm Biol. 1998; 36: 357-359.
60. Tiwari S, Singh A. Biochemical stress response in fresh water fish Channa punctatus induced by aqueous extracts of Euphorbia tirucalliplant. Chemosphere.2006; 64: 36-42.
61. Siddiqui M, Alam M, Trivedi P. Management of plant parasiticnematodes with latex bearing plants, Nematode management inplants. Scientific Publishers, India. 2003; 173-174.
62. Neuwinger HD. Plants used for poison fishing in tropical Africa. Toxicon. 2004; 44: 417-430.
63. Jurberg P, Cabral Neto JB, Schall VT. 1985. Molluscicide activity of the 'avelos' plant (Euphorbia tirucalli, L.) on *Biomphalariaglabrata,* the mollusk vector of schistosomiasis. Mem´orias do Instituto Oswaldo Cruz 80, 423-427.
64. Fridous AJ, Islam SNLM, Faruque ABM. Antimicrobial activity of the leaves of *Adhatodavasica*, *Clatropis gigantean*, *Neriumodorum* and *Ocimum sanctum*. Bangladesh J Bot. 1990; 227.
65. Betancur-GalvisL A, Morales GE, Forero JE, Roldan J. Cytotoxic and antiviral activities of Colombian medicinal plant extracts of the *Euphorbia genus. Memorias do Instituto Oswaldo Cruz.* 2002;97(4):541-546.
66. Jyothi TM, Shankariah MM, et al. Hepatoprotective and Antioxidant Activity of E.tirucalli. Iranian J Pharmacol Ther. 2008; 7: 25-30.
67. Valadares MC, Carrucha SG, Accorsi W, Qquiroz MLS. Euphorbiatirucalli L. modulates myelopoiesis and enhances the resistance of tumor bearing mice. Int Immuno Pharmacol. 2006; 6: 294-299.
68. Hsueh K, Lin P, Lee S, Hsieh C. Ocular injuries from plant sap of genera Euphorbia and Dieffenbachia. J Chin Med Assoc. 2004; 67: 93-98.
69. Joshi D, Shingal G. Ocular Injuries from Plant Sap in Army Soldiers. Med J Arm Force India. 2008; 64: 293-294.
70. Scott I, Karp C. Euphorbia sap keratopathy: four cases and a possible pathogenic mechanism. Brit. Med. J., 1996; 80:823.
71. Shlamovitz G, Gupta M, Diaz J. A Case of Acute Kerato conjunctivitis from Exposure to Latex of Euphorbia Tirucalli(Pencil Cactus). J Emerg Med. 2009; 36:239-241.
72. Eke T, Al-Husainy S, Raynor MK. The Spectrum of Ocular Inflammation Caused by Euphorbia Plant Sap. Arch Ophthalmol. 2000; 118: 13-16.
73. Roe FJC, Peirce WEH. Tumor Promotion by Euphorbia Latices. Cancer Res. 1961; 21: 338-345.
74. Mizuno F, Osato T, Imai S, Koizumi S, Aya T, Kinoshita T, Hirai N,Hirota M, Ohigashi H, Koshimizu K. Epstein-Barr virus enhancing plant promoters in East Africa. AIDS Res. 1986; 2: S151-S155
75. Furstenberger G, Hecker E. New highly irritant euphorbia factors from latex of Euphorbia tirucalliL. Experientia., 1977; 33: 986-8. 9)

76. Imai S, Sugiura M, Mizuno F, Ohigashi H, Koshimizu K, Chiba S, OsatoT. African Burkitt's Lymphoma: A Plant Euphorbia Tirucalli Reduces Epstein-Barr Virus-Specific Cellular Immunity. Anticancer Res. 1994; 14: 933-933.
77. Mac Neil A, Sumba OP, Lutzke ML, Moormann A, Rochford R. Activation of theEpstein- Barr virus lytic cycle by the latex of the plant Euphorbia tirucalli. Brit J Canc. 2003;88: 1566-1569.
78. Silva ACP, de Faria DEP, Borges NBD, de Souza IA, Peters VM, Guer MD. Toxicological screening of Euphorbia tirucalliL.:Developmental toxicity studies in rats. J Ethnopharmacol. 2007; 110: 154-159.
79. Cataluna P, Rates SMK. 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. 1999; 289-295.
80. Valadares MC, Carrucha SG, Accorsi W, Queiroz MLS (2006). Euphorbia tirucalliL. modulatesmyelopoiesis and enhances the resistance of tumour-bearing mice. Int Immunopharmacol. 2006; 6: 294-299.
81. Howes F. Fence and barrier plants in warm climates. Kew Bull. 1946; 1: 51-87.