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Veeresh

Department of Pharmacognosy,
Guru Nanak Institutions
Technical Campus, School of
Pharmacy (Autonomous),
Ibrahimpattanam, Ranga Reddy,
Telangana, India

Pramod Kumar

Dept. of Pharmacognosy,
V.L. College of Pharmacy,
Raichur,
Karnataka, India

A Lavanya

Department of Pharmacognosy,
Guru Nanak Institutions
Technical Campus, School of
Pharmacy (Autonomous),
Ibrahimpattanam, Ranga Reddy,
Telangana, India

P Suresh

Department of Pharmacognosy,
Guru Nanak Institutions
Technical Campus, School of
Pharmacy (Autonomous),
Ibrahimpattanam, Ranga Reddy,
Telangana, India

N Mounika

Department of Pharmacognosy,
Guru Nanak Institutions
Technical Campus, School of
Pharmacy (Autonomous),
Ibrahimpattanam, Ranga Reddy,
Telangana, India

Correspondence**Veeresh**

Department of Pharmacognosy,
Guru Nanak Institutions
Technical Campus, School of
Pharmacy (Autonomous),
Ibrahimpattanam, Ranga Reddy,
Telangana, India

Pharmacological potentials of *Trianthema decandra*- A review

Veeresh, Pramod Kumar, A Lavanya, P Suresh and N Mounika

Abstract

Trianthema decandra belongs to the family Aizoaceae, Subfamily Sesuvioideae. Genus. *Trianthema*, it is called in Hindi-Gadabani, Telugu-Tella galijeru, Sanskrit-Punarnavi, Bengali-Gadabani, Kannada - Phasartani, Tamil-Vellaisharunnai. The Plant is an exotic weed and native of tropical America, globally distributed in Indo-Malaysia, Burma and Australia. Within India, it is found in the Deccan Peninsula, Rajasthan and Uttar Pradesh up to Haryana.

Considerable research on Pharmacognosy, Phytochemistry and Pharmacology and Clinical therapeutics has been carried out on Ayurvedic medicinal plants. This review article will take a closer look at the various pharmacological activities of *Trianthema decandra* by providing numerous potential evidences. It has been used whole range of chronic and difficult to treat diseases such as cancer, cardiovascular diseases, immune modulator, hepatoprotective, diabetes, rheumatism, anti-inflammatory and analgesic, antimicrobial. Most developing countries have relied and will continue to rely on traditional natural medicines due to the difference of high costs of modern allopathic medicine.

Keywords: *Trianthema decandra*, anti-inflammatory, anti-oxidant, anti-cancer, diabetic

Introduction

Herbal medicine is the oldest form of health care known to mankind. Health had been used by all cultures throughout history. The plants provided food, clothing, shelter and medicine. Much of the medicinal use of plants seems to have been developed through observations on wild animals and by trial and error. As time went on, each tribe added the medicinal power of herbs in their area to its knowledge base. Many drugs commonly used today are of herbal origin. Some are made from plant extracts and others are synthesized to mimic a natural plant compound¹.

Trianthema decandra angular and striate, glabrous. Stems elongate, prostrate, not much-branched, Leaves subfleshy, 2-3.8 by 0.6-1.6 cm., the opposite pairs somewhat unequal, elliptic-oblong, rounded and usually apiculate at the apex; petioles 6-13mm., long but not enclosing the flowers. The root is aperients and said to be useful in hepatitis, asthma and suppression of the menses. A decoction of the root-brak is given as aperients. The root, ground up with milk and given internally, is said to be a specific in orchitis. The juice of the leaves dropped into the nostrils relieves one-sided headache². The plant is a good source of zinc and copper. In Andhra Pradesh, the roots are used in veterinary medicine as eye tonic for eye injuries and eye diseases in cattle³.

Ethnopharmacology

Trianthema decandra has been recognized in different system of traditional medicines for the treatment of diseases and ailments of human beings. It has been known since ancient times for curative properties and has been utilized for treatment of various ailments such as burns and wounds, known for antimicrobial properties many infectious condition and bacterial infections, fever, tooth ache, hepatoprotective, analgesic, anti-inflammatory, antidiabetic and other skin disorders. In the traditional systems of medicine such as Ayurveda, Unani *Trianthema decandra* Linn., and its species are used for anti-inflammatory, anti-hyperglycemic, hepatoprotective and antioxidant. A wide range of phytochemical compounds including terpenoid, alkaloid and flavanoids have been isolated from this genus and but not in this species¹. The juice of leaves is used in the treatment of headache. Roots are used in the treatment of hepatitis and asthma. Decoction of root bark is used as aperients. Root ground along with milk is used in orchitis. Leaves are used as vegetables^{4, 5}.

Plant Descriptions

The plant is grown at an altitude of 0-1000 mts. It requires the rainfall of 500-1500mm. The plant is grown at a temperature range of 10-15 °C, 35-40 °C and 20-25 °C and it requires full sun light and hot climatic conditions. The plant requires alluvial and red soil and the depth of the soil is 0.15-0.5mts. The soil is well drained and the pH of the soil must be slightly acidic - neutral (6.3-7.3). It is mostly propagated in the monsoon season by means of seeds. This crop is mainly rain feed.

Trianthema decandra is a prostrate weed with branches, glabrous with a firm tap root up to 2m long, leaves opposite, simple, those of the same pair very unequal in size, petiole 0.5 to 3cm long, ovate to oblong shaped, green color, stem is lobes with a long dorsal but almost apical mucro, unilaterally stigmatose throughout its length and seeds are reniform 1.5 to 2.5mm long with faint wavy ribs, seeds germinated between 20 °C to 45 °C with an optimum at 35 °C and sowing depth is 1cm. Plant is distributed in the tropical & sub-tropical regions of the world. The macromorphological evolution of aerial parts showed pale green color, odor is strong & characteristic and taste is bitter & disagreeable and Roots showed thin, slender, tapering, and tortuous, with lateral branching fibrous root, 4-12 cm in length; 0.2-1.8 cm in diameter, light yellow externally, creamish white internally, fractures fibrous. Odour is strong & characteristic and taste is bitter & disagreeable.

For transverse section studies magnifications were taken with Nikon Labphot 2 Microscopic Unit. For normal observation bright field was used. To study crystals, starch grains and lignified cells, polarized light was employed. Magnifications of the figures are indicated by the scale-bars. Descriptive terms of the anatomical features are as given in the Standard books (Easu, 1964).

The transverse section of leaf shows the typical anatomical characteristic as outer layer of epidermis covered by cuticle followed by mesophyll tissue and vascular bundles, each vascular bundle is conjoint, collateral and closed with an endarch xylem.

The transverse section of stem was found to be circular in outline and showed the following tissue differentiation from the periphery to the centre. Epidermis is the various layers of peripheral tissue with a cuticle on its outer surface. Cortex is differentiated into peripheral 2-3 layers of sclerotic hypodermis and a large space is occupied by parenchyma. Vascular bundles arranged in distinct concentric rings and complete alternating ring of Xylem and Phloem one after other and center part is called pith.

A thin transverse section of root of *Trianthema decandra* has shown the following tissues from the periphery to the center Epidermis. Root hairs are present. Cortex It is wide and extensively developed and massive portion of the root is made up of 15-20 layers of thin walled parenchyma cells with intercellular spaces and Endodermis is outer most layer of cortex.

STELE: It is distinguished into 3 parts, pericycle, vascular bundles, pith. Pericycle: It is present below the endodermis.

Vascular bundles: Vascular bundles are radial, polyarch with exarch xylem (protoxylem outside and metaxylem inside). These are more than 6 strands of xylem and phloem arranged separately on alternating radii in a ring around pith. Pith: Pith is extensively developed and consists of thin walled parenchyma cells^[6].

Leaf Constituents

The results of leaf constituents like Stomatal number is 2.5, Stomatal Index 25.55- 30.33, Vein islet -5 and Vein termination number 10.5 and Palisade Ratio 26.46^[7-9].

Phytochemistry

The crude extracts obtained from the pilot scale extraction were subjected to Phytochemical, screening, the results show the presence of Carbohydrates, Glycosides, Flavonoides, Alkaloids, Steroids, Saponins, Terpenoids^[10].

GC/MS Analysis^[11,12]

Essential oil was isolated from chloroform leaf extract and methanol extract of *Trianthema decandra* using column chromatography and analyzed by gas chromatography/mass spectrometry (GC/MS). 23 components were identified, representing 99.98% of oil. The major components of chloroform extract were Eicosane (18.81%), Tetracosane (16.17%), Hexadecane (14.84%), Dotriacontane (8.17%), Nonacosane (7.13%), Tetrapentacosane (5.61%), Henelcosane (4.34%), 2,4-Di-tert-butylphenol (2.92%), Bis (2-ethyl hexyl) phthalate (2.74%) and Phytol (2.19%). The oil has lower contents of 4,6-Dimethyldodecane (0.83%), 3,7-Dimethyldecane (0.77%), 3,4,5,6-Tetramethyloctane (0.64%), 3-Ethyl-3-methylheptane (0.35%), 3,8-Dimethylundecane (0.29%).

The methanol extract showed around major 20 compounds Ethyl alcohol, tescol, jaysol, alcohol, algrain, 2-Propanol, Isopropyl alcohol, propan-2-ol, Propol, Lutosol, Alcojel, Avantin, Imsol, Silane, dimethoxydimethyl, Dimethoxydimethylsilane, Sym-Tetramethyldimethoxysiloxane, Disiloxane, 1,3-dimethoxy-1,1,3,3-tetramethyl, alpha, Omega-Dimethoxytetramethyl, Cyclopentasiloxane, decamethyl, Hepamethyl-phenyl-cyclotetrasiloxane, Borazine, 2,4,6-triphenyl-1,3,5-tripropyl, Borazine, 2,4,6-triphenyl-1,3,5-tripropyl, n-Hexadecanoic acid, 9-Octadecenoic acid, Methyl ester, methyl oleate, Methyl cis-9-octadecenoate, Oleic acid methyl ester, Oleic acid.

Anti-inflammatory Activity^[13]

Anti-inflammatory activity of *Trianthema decandra* Linn. belongs to family Aizoaceae, was evaluated by In-vitro method i.e. HRBC membrane stabilizing activity. In this method the comparison between HRBC membrane stabilizing activity with chloroform and methanol extract, the Methanolic extract showed the better activity than the Chloroform extract. Both the extracts showed statistically significant ($P < 0.01$) values in the dose dependent manner when compared with standard Diclofenac sodium. The activity may be due to presence of secondary metabolites.

The chloroform extract of *Trianthema decandra* was also evaluated in acute and chronic models viz carrageenan, dextran and mediators induced models. Carrageenan induced oedema is commonly used as an experimental animal model for acute inflammation and is believed to be biphasic, first phase is mediated by the release of histamine and 5-HT followed by kinin release and then prostaglandin in the later phase. Significant anti-inflammatory activity showed by maximum inhibition of 58.36% at the dose of 200 mg/kg after 3 hrs of drug treatment in carrageenan induced paw oedema. Dextran induced paw oedema is known to be mediated both by histamine and serotonin^[14].

Analgesic Activity

Chloroform leaf extract of *Trianthema decandra* exhibits analgesic activity in hot plate and Acetic acid induced writhing response method. It shown dose dependent effect on chemical (acetic acid induce) and thermic (heat) painful stimuli, such an efficacy of these two stimuli is characteristics of central analgesic like morphine, while peripheral analgesic are known to be inactive on thermic painful stimuli. In acetic acid induced abdominal writhing, which is the visceral pain model, the processor release of arachidonic acid via cyclooxygenase and prostaglandin via synthesis plays a role in the neoceptive mechanism. It shows that all the doses produces significant anti-neoceptive effect and this effect may be due to inhibition of the synthesis of the arachidonic acid metabolite¹⁵.

Anti-diabetic Activity^[16]

Screening of plant extracts on α -amylase inhibition assay (non-pre-incubation method) was adopted for evolution of anti diabetic activity of *Trianthema decandra*. Petroleum ether, Chloroform and Ethyl acetate extracts prepared from *Trianthema decandra* were tested in the α -amylase inhibition assay. Which might be extrapolated to detect a potential anti-diabetic effect, using the non pre-incubation method. Chloroform extract was found to have most inhibitory effect on α -amylase with 60 % inhibition at 3 min. Ethyl acetate extract was found to have inhibitory effect on α -amylase with 47.48 % inhibition at 3 min. The assay showed that the extract contains α -amylase inhibitory compounds, since less starch was converted to maltose as seen by lower absorbance value in the experiment. This study could be helpful to develop medicinal preparations for diabetes and related symptoms.

Hepatoprotective Activity^[17]

The hepatoprotective activity of roots of *Trianthema decandra* aqueous extracts was evaluated against carbon tetrachloride induced hepatotoxicity. The hepatotoxicity was induced by the administration of carbon tetrachloride and olive oil in equal amounts intraperitoneally in male wistar rats of weight 150-220gm, once in a day for 7 days. The liver damage extent was estimated by biochemical parameters such as Alanine Amino Transferase (ALT), Alkaline Phosphatase(ALP), Aspartate Amino Transferase(AST), total protein and albumin in serum. The doses are 50mg, 100mg, 100mg and 200mg/kg. The standard used to compare was Silymarin (25mg/kg).The results shown that the *Trianthema decandra* roots aqueous extract at the doses 100 200mg/kg has controlled the liver damage caused by carbon tetrachloride.

Antibacterial Activity^[18]

The antibacterial activity of methanolic extract of *Trianthema decandra* roots was evaluated against *Staphylococcus aureus* (NCIM 2079), *Bacillus subtilis* (NCIM 2063), *Escherichia coli* (NCIM 2065), *Pseudomonas aeruginosa* (NCIM 2036) and *Proteus vulgaris* (NCIM 2027) at dose of 100 μ g/disc by using disc diffusion method. The standard used to compare was Chloramphenicol (30 μ g/disc). The extract showed significant Antibacterial activity and confirms the traditional therapeutic claim of *Trianthema decandra* root.

The antimicrobial properties of the synthesized nanoparticles were analyzed using the Kirby-Bauer disc diffusion method. There is an increasing commercial demand for nanoparticles due to their wide applicability in various markets, including medicine, chemistry and energy. In this report, a simple and

ecofriendly chemical reaction for the synthesis of gold and silver nanoparticles from *Trianthema decandra* (Aizoaceae) has been developed. On treatment of aqueous solutions containing chloroauric acid or silver nitrate with root extract of *Trianthema decandra*, stable gold or silver nanoparticles were rapidly formed. The kinetics of reduction of gold and silver ions during the reaction was analyzed by ultraviolet-visible spectroscopy. Field emission-scanning electron microscopy showed formation of gold nanoparticles in various shapes, including spherical, cubical, triangular, and hexagonal, while silver nanoparticles were spherical. The size of the gold nanoparticles was 33–65 nm and that of the silver nanoparticles was 36–74 nm. Energy dispersive x-ray and Fourier transform infrared spectroscopy confirmed the presence of metallic gold and metallic silver in the respective nanoparticles. Antimicrobial activity of the synthesized gold and silver nanoparticles was studied using eight different bacteria, namely *S. aureus*, *S. faecalis*, *E. faecalis*, *E. coli*, *P. aeruginosa*, *P. vulgaris*, *B. subtilis*, *Y. enterocolitica*, and a fungus *C. albicans*. Comparison of gold and silver nanoparticle sizes indicates the latter to be smaller than the former. We attribute the higher activity of silver nanoparticles to their small size. The smaller particles have greater antimicrobial effects. Further, the antimicrobial activity in the present study was much higher when compared with previous reports and silver nanoparticles¹⁹.

Anti-fungal Activity

To evaluate this activity from chloroform leaf extract of *Trianthema decandra*. Essential oil was isolated using column chromatography and analysed by gas chromatography/mass spectrometry (GC/MS). 23 components were identified, representing 99.98% of oil. The major components of *Trianthema decandra* oil were Eicosane (18.81%), Tetracosane (16.17%), etc., Essential oils are promising sources of antimicrobial activity. The selected microorganisms included bacteria *Staphylococcus aureus*, *Streptococcus faecalis*, *Enterococcus faecalis*, *E. Coli*, *P. Aeruginosa*, *Salmonella typhi*, *Vibrio cholera*, *Proteus vulgaris*, *Bacillus subtilis*, *Yersinia enterocolitica*, and fungi such as *Candida albicans* and *Cryptococcus neoformans*. It was observed that the essential oil showed the Diameter of Inhibition Zone (DIZ) ranging from 19 ± 0.01 to 24 ± 0.05 mm at a concentration level of 1 mg/disc in all the twelve strains tested. Chloramphenicol and Nystatin have shown DIZ ranging from 18 ± 0.05 to 23.6 ± 0.02 mm at a concentration of 30 μ g/disc. The minimal inhibitory concentration (MIC) of essential oil against bacterial and fungal strains was in the range of 625–1250 μ g/ml^[20, 21].

Aphrodisiac Activity Studies

The methanolic extract of *Trianthema decandra* tested for Aphrodisiac activity using experimental model viz, Sexual behavior on prolonged immobilization- induced stress in rats. The acute toxicity study of alcoholic extract of *Trianthema decandra* were carried out for determination of LD₅₀ up to the dose level of 2000mg/kg, extract was administered orally to rats as per the OECD guidelines no.425. The different dose were selected 1/20th, 1/10th, 1/5th dose of the lethal dose.. In prolonged immobilization-induced stress model, parameters like Mount latency, number of mounts and thrusting were recorded simultaneously by two investigators with light provided by a 40 watt red lamp. Alcoholic extract of *Trianthema decandra* showed Aphrodisiac activity in a dose dependant manner. The medium and high dose treated groups

showed significant increase in the number of mounts, thrusting and decrease in the latency. The results suggested the Aphrodisiac activity of aerial parts of *Trianthema decandra* and may be attributed to elevation of Testosterone, Adrenergic, Cholinergic & Dopamine levels [22].

Adaptogenic Activity

Evaluated Adaptogenic activity of the alcoholic extract of *Trianthema decandra* Linn., at various doses using experimental induced stress models in Mice and Rats. Methods: Anoxia stress tolerance, Swimming endurance, Cold restrained stress, Forced swimming stress models were used for study of Adaptogenic activity. *Withania somnifera* (100mg/kg, p.o) was used as reference standard. The parameters like Anoxia stress tolerance time and swimming endurance time were measured for anoxia induced stress and swimming endurance models respectively. However for other two models organ weight and biochemical marker levels were estimated in normal, stress control, standard and drug treated groups. Concomitant treatment with alcoholic extract at 100, 200, and 400 mg/kg showed marked increase in anoxia stress tolerance time and swimming endurance time as compared to control group in anoxia stress tolerance and swimming endurance tests. Similarly, concomitant treatment with alcoholic extract at different doses showed marked decrease in blood glucose, cholesterol, triglycerides, cholesterol, SGPT and SGOT level as compared to stress control in both cold restrained and forced swimming stress models. Weight of the liver, kidney and adrenal gland are markedly decreased but increased weight changes were observed in spleen in both the stress models. It was concluded that, the phyto fragments found during GC-MS analysis might also contributed to the Adaptogenic activity of alcoholic extract of *Trianthema decandra* [23].

Anticancer Activity

The anticancer activity of methanolic extract of *Trianthema decandra* and *glinus oppositifolius* was investigated in ehrlich ascites carcinoma (EAC) cell line injected to swiss albino mice through intraperitoneally at the rate of 2x10⁶ cells/mouse. The mean survival time, life span, tumor volume, tumor cell count, haemoglobin content, RBC and WBC count were measured to determine the anticancer effect of both plants. The doses used are 100, 200 and 400mg/kg body weight. The standard used to compare was 5-fluorouracil at the dose of 2mg/kg body weight. The life span of the tumor bearing mice, total number of RBC and haemoglobin content were significantly increased. In differential count of WBC, percentage of lymphocytes was increased with decreased level of neutrophils in treated mice. The tumor volume and the percentage of viable cells in ascitic fluid were significantly reduced in treated mice. The extracts showed significant anticancer activity as compared with standard [24].

Antiulcer Activity

The antiulcer, antisecretory and cytoprotective effects of *Trianthema decandra* roots of petroleum ether extract, ethyl acetate extract, alcoholic extract and aqueous extracts prepared successively by using solvents had studied on rats for its ability to inhibit gastric secretion and to protect the gastric mucosa against injuries caused by pyloric ligation, swim stress, acetic acid and by cytodestructive agent ethanol. The extracts dose used was 200mg/kg and crude powder of its root at the dose of 2gm/kg p.o. The standard drug used to compare was Famotidine (20mg/kg p.o).

Ethyl acetate extract and crude powder only showed significant antiulcer and antisecretory effects in pyloric ligation, swim stress models and all four extracts and crude powder showed pronounced cytoprotective effect in ethanol induced gastric ulcer in rats and significant effect exhibited by ethyl acetate extract in acetic acid induced ulcer activity [25].

Anti Fungal and Antibacterial Activity

It has been reported that ethanol extract of *Trianthema decandra* showed potent antifungal and antibacterial activity and petroleum extracts are least potent. The successive extract was prepared by different solvents like petroleum ether, chloroform and ethanol by using soxhlet apparatus. The extracts were vacuum dried and subjected to antifungal viz fungus *C. albicans* and *A. Fumigatus* and antibacterial viz bacteria *B. cereus*, *S.aureus*, *K. pneumoniae* and *E.coli* and screening by agar disc diffusion method²⁶.

Anti-oxidant Activity

Antioxidant activity of *Trianthema decandra* was evaluated antioxidant activity viz Determination of Total phenolic content, Determination of DPPH free radical scavenging activity. Total phenol content was determined by the method adapted from Singleton and Rossi with some modifications using the Folin-Ciocalteu reagent. 1 ml of the extract was mixed with 1 ml of Folin-Ciocalteu's reagent for Determination of DPPH free radical scavenging activity. The scavenging effect of the extracts on DPPH radicals was determined according to the method adapted from Shimada *et al.* The results reveal that the ethyl acetate and methanolic extracts of roots and leaves of *Trianthema decandra* possess antioxidant activity. The results also revealed that the leaves have more antioxidant activity than the roots [27].

Discussion and Conclusion

Trianthema decandra is a widely traditionally used and potent medicinal plant. The present review article confirms that the therapeutic value of *Trianthema decandra* is much more. The presence of phytochemical constituents and pharmacological activities proved that the plant has a leading capacity for the development of new good efficacy drugs in future. Thus, a detailed and systematic medicinal study is required for identification and documentation of plant, which may provide a meaningful way for the promotion of the traditional knowledge of the herbal medicinal plants.

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