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ETHNOMEDICINAL, PHARMACOLOGICAL, ANTIMICROBIAL POTENTIAL AND PHYTOCHEMISTRY OF *TRICHOSANTHES ANGUINA* LINN.-A REVIEW

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Abstract

The comprehensive information is provided in this review on *Trichosanthes anguina* (syn *T. cucumerina*) traditional uses, ethnobotanical aspects, phytochemistry and pharmacological uses. All-embracing literature survey given way to the promising pharmacological activities of *T. cucumerina* i.e. antibacterial, antifungal, anthelmintic, anti-fertility, antidiabetic, anti-inflammatory, antioxidant, anti-HIV, anti-arthritic, cytoprotective, antiovulatory, hepatoprotective, anti-diarrhoeal and analgesic. The therapeutic uses of *T. anguina* include its usefulness for treatment of wounds including boils, sores, skin eruptions such as eczema and dermatitis. It is a tropical or subtropical vine, raised for its strikingly long fruit, used as a vegetable, medicine. Roots are used for its antidiabetic, anthelmintic activities. Leaves juice rubbed over the liver in remittent fever, skin diseases, antispasmodic, emetic, hypoglycaemic activity. It has long been used as appetizer, laxative, aphrodisiac and blood purifier and also in cardiac failure. The stem is used for bilious disorders, skin diseases.

Keywords: *Trichosanthes anguina*, traditional medicine, antimicrobial potential, pharmacology, phytochemistry.

INTRODUCTION

About 3.4 billion peoples in the developing world depend on plant based traditional medicines natural products have been an integral part of the traditional systems of medicine (e.g. Ayurvedic) (Doughari *et al.,* 2009; Sarker and Nahar 2007). Plants have unlimited ability to synthesize secondary metabolites such as tannins, terpenoids, alkaloids, saponins, glycosides and phenols which have been found to have antimicrobial properties. It has been estimated that 14-28 % of higher plant species are used in medicinal purposes and that 74% of pharmacologically active plant derived components were discovered after following up on ethnobotanical uses of the plants (Borah *et al.,* 2012; Singh and Navneet 2016, 2017).

Trichosanthes anguina (syn *T. cucumerina*) Linn. is belongs to the family cucurbitaceae. It is one of the medicinal plants that are often used in Sri Lanka and Indian traditional systems of medicine for the preparation of several formulations used to treat a variety of disease conditions (Jayaweera 1980; Anonymous 2002). Common names include snake gourd (var. *anguina*), serpent gourd, chichinda, and padwal. *T. cucumerina* is an annual climber which is bitter in taste and is known to contain wide range of medicinal properties (Choudhary 1967). All the parts are being used as medicine. It is also used in Ayurveda, Siddha and Allopathy system of traditional medicine. *T. cucumerina* has been shown to possess antidiabetic (Arawwawala *et al.,* 2009), gastro protective (Arawwawala *et al.,* 2010a), anti-inflammatory (Arawwawala *et al.,* 2010b), antioxidant (Arawwawala *et al.,* 2011a), lipid lowering activities (Arawwawala *et al.,* 2011b), and antimicrobial activity (Ali *et al.,* 2011; Patil and Kannapan 2014). The therapeutic uses of *T. cucumerina* include its usefulness for treatment of wounds including boils, sores, skin eruptions such as eczema and dermatitis. It is a tropical or subtropical vine, raised for its strikingly long fruit, used as a vegetable, medicine. Roots are used for its anthelmintic (Nandkarni 2002), leaf juice rubbed over the liver in remittent fever (Kirtikar and Basu 2000), skin diseases (Chopra *et al.,* 1986), anti-spasmodic, emetic, hypoglycaemic activity (Kar *et al.,* 2003). It has long been used as appetizer, laxative, aphrodisiac and blood purifier (Shivarajan and Indira 1994) and also in cardiac failure (Pullaiah, 2006). The stem is used for bilious disorders, skin diseases. The fruit is considered to be antihelmintic, hepato-protective (Kumar *et al.,* 2009). The dried seeds are used for its anthelmintic, anti-diarrhoeal, antibacterial and insecticidal properties. The seeds possess anti-helmintic, antifibrile and haemoagglutinating activity (Chakravarty 1982). The whole plant used to prevent from infections and malignancies and anti-fertility (Kongtun *et al.,* 1999; Devendra *et al.,* 2009).

Classification

Kingdom: Plantae
Division: Magnoliophyta
Class: Mangnoliopsida
Order: Cucurbitales
Family: Cucurbitaceae
Genus: *Trichosanthes*
Species: *cucumerina*

Habit and Habitat

T. cucumerina is a climbing annual herb. Leaves are hairy, dentate 10-25 cm in length and 15 cm in diameter. They emit foetid odour when damaged. Flowers are monoecious, axillary and white male flowers occur in long racemes with panicles up to 30 cm in length. The female flowers are solitary. Fruits are cylindrical with waxy surface, slender and tapering 4-120 cm in length and 4-10 cm in diameter (Tindall 1983).

Plant distribution

It is widely distributed in Asian countries including Sri Lanka, India, Malay Peninsula and Philippine. It is found distributed in India, Sri Lanka, Nepal, Australia and North America,

Nigeria and Pakistan. It is commonly grown in Asian countries including Sri Lanka, India, Malaysia, Peninsula, and Philippines (Ojiako and Igwe 2008; Devendra *et al.,* 2010).

TRADITIONAL MEDICINAL USES

In ancient medicine *T. cucumerina* was used for treating headache, alopecia, fever, abdominal tumours, bilious, boils, acute colic diarrhoea, haematuria, and skin allergy. It has a prominent place in medicinal systems like Ayurveda and Siddha (Liyanage *et al.,* 2016; Sandhya *et al.,* 2010). Plant parts are used as ethnomedicine among inhabitants of SBR (Simipal Biosphere Reserve). Leaves are used against microbial infections, roots against diabetic and fruits against killing of stomach worm. Young fruits are used as vegetables as well as medicine. *T. cucumerina* is one among the major constituents of important Ayurvedic preparations like gulgultiktakam kasayam, mahatiktaka ghratam, vajrakam kashayams and mahatiktaka kashayam (Gill *et al.,* 2012). It is used in the treatment of fever, alopecia, diarrhoea, tumours, skin allergy, malaria, cathartic, bronchitis, vermifuge, laxative, emetic and anthelmintic (Reddy *et al.,* 2010). The root is used as a cure for bronchitis, headache and boils. Both roots and fruits are considered to be cathartic. The fruit is used as an anthelmintic. The seeds are used for stomach disorders and are also considered as antifebrile and anthelmintic.

PHARMACOLOGICAL PROPERTIES

Antimicrobial activity

The chloroform fraction possesses antibacterial activities with the zone of inhibition value ranged from 7-13 mm. Among different fractions tested, chloroform fraction of the plant exhibited moderate inhibitory activity followed by n-hexane fraction (7-9 mm) whereas ethyl acetate fraction showed little or no activity on the tested microorganisms. The most sensitivity was observed in *Pseudomonas aeruginosa* (13 mm), *S. paratyphi* (11 mm) and *V. parahaemolyticus* (10 mm) by chloroform fraction of the plant (Bulbul *et al.,*2016). Choloroform extract of *T. cucumerina* leaves exhibited remarkable activity against *Bacillus cereus* (30mm/50µl inhibition zone) whereas it did not inhibit *Staphylococcus aureus* and *P. aeruginosa.* The chloroform extract of leaves was found to be effective against *Enterobacter faecalis, S. paratyphi, Escherichia coli, Streptococcus faecalis, Proteus vulgaris, Klebsiella pneumoniae* and *Serratia marcescens* (11-18mm/50µl inhibition zone). Ethyl acetate extract of leaves showed appreciable activity on all test bacteria (10-28mm/50µl inhibition zone) except *Pseudomonas aeruginosa.* The methanol extract of leaves inhibited the growth of all tested bacteria to a considerable extent (10-25mm/50µl inhibition zone) (Reddy *et al.,* 2010). A zone of inhibition ≥ 9-15 mm is an indication of strong antimicrobial activity (Rani and Khullar 2004). *E. coli* and *P. aeruginosa* were found to be most susceptible to *T. cucumerina* with an inhibition zone greater than 9 mm at a very low concentration (12.5 µg/disc) of both extracts. The antibacterial activity of the leaves of *T. cucumerina* was tested against *S. typhi*, *P. aeruginosa*, *S. aureus*, *E. coli* and *E. faecalis*. Both ethanol and aqueous extracts of the leaves of the plant were used for the study. The leaves of all the three plant species used for the test inhibited the growth of the microorganisms except *E. coli*. The inhibition zone ranged from 6.00±0.00 to 9.50±0.70 mm. Generally, the ethanol extracts had more inhibitory effect when compared with those of the aqueous extracts. The minimum inhibitory concentration of the extracts ranged from 2.00–5.50 mg/ml (Osuagwu and Ejikeme 2015).

Aerial parts of *T. cucumerina* can exert antibacterial activity. The antibacterial activity of a hot water extract and a cold ethanol extract of *T. cucumerina* aerial parts was evaluated by viable colony count and disc diffusion techniques against *S. aureus, S. pyogenes, E. coli* and *P. aeroginosa* of the two extracts tested, cold ethanol extract was found to exert consistently better antibacterial activity than hot water extract. In conclusion, *T. cucumerina* extracts exhibited antibacterial activity against gram positive bacterial strains such as *S. aureus, S. pyogenes* and gram negative bacterial strains such as *E. coli* and *P. aeroginosa* (Arrawwawala *et al.,* 2011c).

The antibacterial activity of stem, leaf, flower and seed extracts of *T. cucumerina* against disease causing bacteria. Antibacterial activity of different solvent extracts (aqueous, methanol, chloroform, petroleum ether, and acetone) of stem, leaf, flower and seed of *T. cucumerina* has been studied to find out their activity against nine pathogenic bacteria viz., *B. cereus, Micrococcus luteus, E. coli, P. vulgaris, K. pneumoniae, B. sphericus, S. typhimurium, P. aeruginosa* and *S. aureus*. The antibacterial activity of the extracts of different plant parts was done through well diffusion method and by measuring the inhibition zone around the disc. The seed extracts of *T. cucumerina* exhibited antibacterial activity against all the bacteria under study (Shyamsundarachary *et al.,* 2016).

Tripathy *et al*., (2014) reported antibacterial activity of four extracts of *T. cucumerina* leaves and root revealed that the methanol, acetone and aqueous extracts shown antibacterial activity against *S. pyogenes* (MTCC 1926), *S. mutans* (MTCC 497) and *S. enteric typhi* (MTCC 1252), *V. cholera* (MTCC 3906) and *Shigella flexneri* (MTCC 1457).

Anti-inflammatory activity

Devendra *et al*., (2010) evaluate the anti-inflammatory activity of chloroform and ethanol extracts of *T. cucumerina* seed in carrageenan induced paw oedema in wistar rats at the dose level of 200 and 400mg/kg administrated orally. Both the extracts exhibited significant anti-inflammatory activity. Kolte *et al.,* (1997) with hot aqueous extract of root tubers of *T. cucumerina* have investigated against carrageenin induced mouse's hind paw oedema and it exhibited significant anti-inflammatory activity.

Larvicidal activity

Rahuman *et al*., (2008) using the acetone extract of leaves of *T. cucumerina* showed moderate larvicidal effects.

Anti-diabetic activity

Kar *et al.,* (2003) reported that the crude ethanol extract of *T. cucumerina* showed significant blood glucose lowering activity in alloxan diabetic albino rats. Arawwawala *et al.,* (2009) using hot water extract of aerial parts of *T. cucurmerina* has noted to improve glucose tolerance and tissue glycogen in non insulin dependent diabetes mellitus induced rats. Study showed the drug possess anti-diabetic activity with improvement in oral glucose tolerance and glucose uptake in peripheral tissues (Kirana and Srinivasan 2008).

Hepatoprotective activity

Kumar *et al*., (2009) found that the methanol extract of the whole plant of *T. cucurmerina* showed good hepatoprotective activity against carbon tetrachloride induced heapatotoxicity.

Anti-fertility activity

Devendra *et al.,* (2009) showed the antiovulatory activity of ethanol extract of whole plant in female albino rats.

Antioxidant activity

This study sought to compare the antioxidant properties [1,1-diphenyl–2 picrylhydrazyl (DPPH) and hydroxyl (OH) radicals scavenging abilities] and inhibition of $Fe2^{+}$-induced lipid peroxidation and two key enzymes relevant to type-2 diabetes (α-amylase and α-glucosidase) of *T. cucumerina*. Snake tomato (0.84 mg/g) had significantly ($P < 0.05$) higher total phenolic content than ESC (0.27 mg/g). The total flavonoid content of 0.48 mg/g, compared to *T. cucumerina* (0.27 mg/g) and ESC (0.15 mg/g). In consonance with the phenolic content, CER and *T. cucumerina* had higher DPPH and OH radicals scavenging abilities than ESC. *T. cucumerina* showed stronger inhibition of α-glucosidase [*T. cucumerina* (EC50 = 1.65 mg/ml), CER (EC50 = 1.32 mg/ml)] than α-amylase [snake tomato (EC50 = 2.15 mg/ml) activity. The antioxidant properties of snake tomato favourably compared with the cultivars of tomatoes, and its stronger inhibition of α-glucosidase activity than α-amylase activities suggests that

snake tomato could be an alternative or complement to the use of lycopersicon tomatoes (Ademosun *et al.,* 2013; Adebooye 2008).

Analgesic activity

Gill *et al.,* (2012) reported that the ethanol seeds extracts of *T. cucumerina* shown analgesic activity. Extract showed dose dependent analgesic activity using Eddy's hot plate method at medium dose 400 (mg kg $^{-1}$) and high dose (500 mg kg $^{-1}$) was found to be 7.92±0.8 and 8.4±0.10 at 90 min interval.

Antiulcer activity

Gill *et al.,* (2012) reported antiulcer activity of ethanol extract of *T. cucumerina* using ethanol induced model and DPPH radical induced model. The extract showed reduction in ulcerative index but only at highest dose i.e., 500 mg kg^{-1} and showed significant reduction in ulcerative index. Extract showed 60.1 and 72.1% inhibition of ulcer at dose 400 mg kg^{-1} and 500 mg kg^{-1} in 1,1-diphenyl-2-picrylhydrazyl radical induced model and 51.7 and 57.1% inhibition in ethanol induced model also at same dose.

Gastroprotective activity

Arawwawala *et al.,* (2010a) reported gastroprotective activity with hot water extract (HWE) of *T. cucurmerina*, showed a significant protection against ethanol or indomethacin induced gastric damage increasing the protective mucus layer, decreasing the acidity of the gastric juice and antihistamine activity. Dose dependent gastro-protective effects were observed in the alcohol model in terms of the length and number of gastric lesions mediated by alcohol in wistar stain rats.

Cytotoxic activity

Kongtun *et al.,* (1999) performed cytotoxic activity with the root extract of *T. cucumerina* and the fruit juice tested cytotoxicity against four human breast cancer cell lines, lung cancer cell lines and one colon cancer cell line. The root extract inhibited more strongly than the fruit Juice.

NUTRITIONAL VALUE

It is rich in protein and vitamin C. The use of the pulp of ripe fruits as a substitute for tomato paste is the major use. The edible part of the immature fruit is 86-98% per 100g edible portions, it contains water 94g, protein (0.6g), fat (0.3g), carbohydrate (4g), fibre (0.8g), Ca (26mg), Fe (0.3mg), P (20mg), Vitamin B1(0.02mg), Vitamin B2 0.03ng, Niacin 0.3mg, Vitamin C (12mg).

The fruit is usually consumed as a vegetable due to its high nutritional value. The plant is a rich source of functional constituents other than its basic nutrients such as flavonoids, carotenoids, phenolic acids, and soluble and insoluble dietary fibres and essential minerals, which makes the plant pharmacologically and therapeutically active [Yusuf et al., 2007]. The plant contains proteins, fat, fibre, carbohydrates, minerals, and vitamins A and E in high levels. The predominant mineral elements are potassium (121.6mg/100 g) and phosphorus (135mg/100 g) and also sodium, magnesium, and zinc are found in fairly high amounts (Ojiako and Igwe 2008).

The fruit pulp of *T. cucumerina* was higher in carotenoid (2053.33 mg/100g), flavonoid (861.67 mg/100g), cardiac glycoside (11.67 mg/100g), alkaloids (93.33 mg/100g), lycopene (118.5 µg/100g), tannin (555.00 mg/100g), oxalate (2.55 mg/100g) and quercetin (5.25 mg/100g) than Roma VF and Ibadan local. *T. cucumerina* had the highest values of crude protein and crude lipid (1.97% and 0.40%). The fruit pulp of *T. cucumerina* also had the highest ash and total carbohydrate contents (1.63% and 16.50%). Roma VF was significantly higher in crude fibre and moisture contents (1.77% and 89.40%) than other vegetables investigated (Ugbaja 2017).

PHYTOCHEMISTRY

The qualitative analysis of bioactive compounds present in leaves and root indicated its sound pharmacological values. Tannin, saponin, phenolic compounds and flavonoids were present in leaves and root extracts whereas Kumar *et al.,* (2013) reported the presence of polyphenolics and flavonoids. Murthy *et al.,* (2012) reported the presence of flavones, coumarins in MeOH extract of whole plant. Sandhya *et al.,* (2010) reported the phenolic compounds present in alcoholic extract, flavonoids present in water extract and saponin present in alcoholic and water extract of *T. cucumirina* leaves. Rahman *et al.,* (2010) reported the presence of phenolic compounds, flavonoid, terpenoids and sterols. Kage *et al.,* (2009) reported the presence of alkaloids, flavonoids, glycosides, lignin, sterols and tannin in ethanolic extract of whole plant.

Phytochemical investigations reveal that T. cucumerina extracts also contain tannins, saponins, flavonoids and alkaloids as major chemical constituents preliminary phytochemical investigations of leaves, stem, fruit wall and seed extracts have been carried out by using different solvents (methanol, petroleum ether, benzene, chloroform and aqueous) for the presence of various phyto-constituents. Phytochemical analysis of various solvent extracts of leaf, stem, fruit wall and seed had shown the presence of alkaloids. Glycosides were found to be present strongly in only leaf extracts followed by feebly in seed extracts. Tannins were absent in all the solvents extracts of stem and seeds. Flavonoids were found only in the leaf and stem. Sterols were absent in leaf, stem and fruit wall extracts. Whereas lignins were present in leaf extracts. Phenols were found in stem and fruit wall extracts. Lignins, saponins and quinines were absent in the solvents extracts of leaf, stem, fruit wall and seeds. Thus, the species of *T. cucumerina* contains alkaloids, glycosides, tannins, flavonoids, phenols and sterols which play a role in pharmaceutical industry (Shyamsundarachary *et al.,* 2013).

The major active constituents of the drug are triterpenoid saponins viz, cucurbitacins. The plant is richly constituted with a series of chemical constituents like flavonoids, carotenoids, phenolic acids which makes the plant pharmacologically and therapeutically active (Saboo *et al.,* 2012).

CONCLUSION

T. cucumerina exist in a significant place in the Ayurvedic medicine of India, Sri Lanka including tropical Asia and Africa. *T. cucumerina* depicted the piece of evidence that it is used as a cure for variety of ailments. It is fascinating to message that pure phytochemicals and crude extracts of leaves of *T. cucumerina* have been screened for some pharmacological activities and found to have antibacterial, antifungal, analgesic, anti-inflammatory, hepato-protective activity and stem bark of the plant have anti-diabetic activity, and juices are screened for hypocholesterolemic and antioxidant activity.

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Conflict of interest
Authors are no conflict of interest.

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