ISSN: 2279 - 0594

Journal of Biomedical and Pharmaceutical Research
Available Online at www.jbpr.in
CODEN: - JBPRAU (Source: - American Chemical Society)
Volume 3, Issue 6, 2014, 104-110

REVIEW ARTICLE

Pharmacognostical, Phytochemical, Pharmacological and Toxicological Review on *Trichosanthesanguina Linn*

Amit J. Patil*[1], N. Kannapan[2]

[1]Research Scholar, Department of Pharmacy, Suresh GyanVihar University, Mahal, Jagatpura, Jaipur- 302025, Rajasthan, India.

[2]Reader in Pharmacy, Department of Pharmacy, Annamalai University, Chidambaram - 608002, Tamil Nadu, India.

Received 05 December 2014; Accepted 15 December 2014

ABSTRACT

Traditional medicine is widely spread globally and it is the almost exclusive source of primary health care for 80% of the world's population. Herbal medicines are regarded by the public and some health care providers to be gentle and safe, despite a paucity of scientific evidence to support such beliefs.*Trichosanthes anguina Linn.* (Cucurbitaceae) is widely distributed in Asian countries including Sri Lanka, India, Malay Penisula and Philippine. It is used as a tonic and to cure coughs and bilious attacks. The seeds are purgative, anthelmintic and used in the treatment of syphilis.Seeds are given in disorder of stomach. Unripe fruit is very bitter and dried capsule are given in infusion or in decoction with sugar to assist digestion. The observation of living plants in the field is useful for the assessment of various aspects of the habit of *Trichosanthes* because these aspects may be not clear from the herbarium specimens. Most species are perennial climbers, often with tuberous roots, and some are annual. Perennial female plants frequently die after fruiting (monocarpous), but new shoots may be produced by the tubers in some species. Pharmacognostical, phytochemical, pharmacological and toxicological activity of *Trichosanthes Anguina Linn* is briefly introduced in this review.

Key words: *Trichosanthes Anguina Linn,* Phytochemical, Pharmacological, Cucurbitaceae

INTRODUCTION:

Plant Name: *Trichosanthes anguina L.*
Family: Cucurbitaceae
Synonym: *Trichosanthescucumerina L.*

*Trichosanthes anguina*Linn is an annual, dioecious climber belonging to the family Cucurbitaceae. The whole plant including roots, leaves, fruits, seeds have medicinal properties. The root is used as a cure for bronchitis, headache and boils. The fruit is used as an anthelmintic in French Guiana. Both the root and fruit are considered to be cathartic. Externally, the leaf juice is rubbed over the liver to relieve liver congestion. The seeds are used for stomach disorders in Malabar Coast and are also considered antifebrile and anthelmintic. The aerial parts of *T. anguina*are used along with other plant materials for indigestion, bilious fevers, boils, sores, skin eruptions such as eczema, dermatitis, psoriasis, ulcers and diabetes[1, 2, 3].

Difference between Trichosanthes Species (T cucurmerina & Tanguina):

The importance of epidermal characters of leaves in angiosperms has been reviewed by several authors. The trichomes in Cucurbitaceae vary from unicellular to multicellular, conical to elongated, smooth to ridges, with or without flattened disk at base andcyctolithic appendages to without, thin to thick walled, curved at apices to blunt. Linnaeus (1753) established the species *Trichosanthesanguina* and *T. cucumerina*. Haines (1924) recognized *T. cucumerina L. var. cucumerina (L.)* as a wild variantwith short fruits and *T. cucumerina var. anguina (L.)* as a cultivated variant with elongated, snake-like fruits. Chakravarty (1982) treated *T. cucumerina* and *T. anguina* as two different species. Jeffrey (1980) recognized *T. anguina* as a variety of*T. cucumerina*[4,5].

Taxonomic Hierarchy:

Kingdom: Plantae (plantes, Planta, Vegetal, plants)
Subkingdom: Viridaeplantae – green plants
Infrakingdom: Streptophyta – land plants
Division: Tracheophyta – vascular plants, tracheophytes
Subdivision: Spermatophytina – spermatophytes, seed plants.

*Corresponding author: Amit J. Patil | E-mail: amitpatil1111@gmail.com

Infradivision: Angiospermae – flowering plants, angiosperms,
Class: Magnoliopsida
Subclass: Dilleniidae
Superorder: Rosanae
Order: Cucurbitales.
Family: Cucurbitaceae
Tribe: Trichosantheae
Genus: Trichosanthes L.
Species: *Trichosanthes anguina*

VernacularName:
Common: Khyar, Pudal, Snake Gourd, Snake gourd
Sanskrit: Chichinda
Hindi: Chichonda, Janglipadvel, chachinga.
Marathi: Padwal
Guajarati: Pandola
Telugu: Potlakaaya
Tamil: Pudalankaai
Kannad: Paduvalakaayi[6]

Plant Description:

Figure 1: Whole Palnt of *Trichosanthes Anguina Linn*

Bark: Reddish brown, smooth.
Stems: Very long, slender, furrowed, sub-glabrous; tendrils 2-3-fid, green, 4-angled, slightly hairy, and faintly disagreeable in odor.
Leaves: Leaves alternate, simple; stipules absent; petiole 2–10 cm long, furrowed, succulent, scabrid hairy; blade slightly to deeply 5–7-lobed, 7–25 cm × 8–20 cm, cordate at base, margin dentate, pubescent.It is also somewhat hairy on both surfaces, rounded, 7 to 14 centimeters long and broad, 3- to 5-lobed, the lobes being broad, rounded or obtuse, the sinuses broad or narrow and rounded; and the base broadly heart-shaped.
Flower: Flowers are unisexual, regular, 5-merous, white; calyx tubular; corolla lobes fringed with hair like outgrowths; Male flowers in 5–many-flowered axillary racemes on 10–30 cm long peduncles, with 3 stamens bearing 8-15 flowers near the apex.Female flowers are axillary, solitary and sessile, with inferior, 1-celled ovary, long -hairy, stigmas 3.

1, flowering shoot; 2, top of female flower in longitudinal section; 3, fruit ; 4, seed.

close-up of flower

Figure 2: Flower& Seed of *Trichosanthes Anguina Linn*

Fruits: Fruit a very slender, long and cylindrical berry, often twisted, 30–180 cm × 2–10 cm, greenish-white when immature, dark red when mature, many-seeded.A fruit is ellipsoid, 3 to 4.5 centimeters long, 2.5 to 3 centimeters in diameter, green and mottled with longitudinal gray stripes when young, and orange-red when mature.

Seeds: Seeds flattened, 1–1.5 cm long, greyish-brown, sculptured, margin undulate, seedling with epigeal germination. Seeds are half-ellipsoid, somewhat compressed, undulate, hard, rugose, nearly 1 centimeter long, and imbedded in a soft, foetid, bitter and red pulp.

Roots: Roots are somewhat tuberous and whitish.

Other Characteristics: Staminate inflorescences are long-peduncled and axillary with 6 to 15 flowers. Calyx-tube is dilated above, about 1 centimeter long, green, and hairy. Petals are white, fimbriate, oblong, about 1.3 centimeters long. Pistillate flowers occur singly in the axils of the leaves[5].

Trichosanthes cucurmerina is a monoecious annual herb climbing by 2–3-branched tendrils upto 5 to 6 meters high or less. The stems are slender, green, 4-angled, somewhat hairy, and faintly disagreeable in odor. The roots are somewhat tuberous and whitish. The leaves are alternate, simple with no stipules. Leaves are scabrid hairy on both surfaces, rounded in outline, 7 to 14 centimeters long and broad, and 3 or 5-lobed, the lobes being broad, rounded or obtuse, and the sinuses broad or narrow and rounded. The base is broadly heart-shaped[7].

The staminate inflorescences are long-peduncled and axillary, with six tofifteen flowers. Flowers are unisexual, regular, and white in color with green and hairy calyx. Corolla is tubular in with lobes fringed and hairlike outgrowths. The male flowers are many-flowered with axillary racemes on 10–30 cm long peduncles. They are with 3 stamens but the female flowers are solitary and sessile with inferior, single celled ovary, long and with hairy stigmas. Fruits are very slender, long and cylindrical berry, often twisted, greenish-white when immature, dark red when mature. The seeds are half-ellipsoid, somewhat compressed, undulate, hard, rugose, nearly one centimeter long, greyish-brown, sculptured, margin undulate and imbedded in a soft foetid with red pulp[8].

CHEMICAL CONSTITUENTS:

Table 1: Different parts of the plant with various chemical constituents

Whole Plant	Flavonoids, carotenoids, lycopene, ascorbic acid and phenolic compounds[9].Cucurbitacin B, cucurbitacin E, isocucurbitacin B, 23,24- dihydroisocucurbitacin B, 23,24-dihydrocucurbitacin E,sterols 2 β-sitosterolstigmasterol.Low amount ofchemical substances like oxalate, phytates and tannins[10].The total phenolics and flavonoids content is 46.8% and 78.0% respectively[11]. The triterpenes found are 23, 24-dihydrocucurbitacin D, 23,24-dihydrocucurbitacin B, cucurbitacin B, 3β-hydroxyolean- 13(18)-en-28-oic acid, 3-oxo-olean-13(18)-en-30-oic acid and the sterol 3-O-β-D-glucopyranosyl-24ξ-ethylcholest- 7,22-dien-3β-ol[12].It also contain ascorbic acid while itsmineral and vitamin contents are calcium, magnesium,potassium, phosphorus, iron, substantial amount of carotene,little thiamine, riboflavin and niacin[13]. Plant contains conjugated trienes[14].
Root extract	Bryonolic acid, chondrillasterylglucoside, bryononic acid, cucurbitacin B, dihydrocucurbitacin B[15].
Seed	High oil content up to 42.5±5%, isoflavoneglucoside, 5,6,6'-trimethoxy-3',4'-methylenedioxyisoflavone7-O-beta-D-(2''-O-p-coumaroylglucopyranoside)[10, 16]. Novel glycoside 5,7- dihydroxy-6-methoxy flavones-5-O-α-L-rhamnopyranoside[16].Saturated and unsaturated fatty acids[14]
Aerial Parts	Polyphenols, flavonoids, tannins, alkaloids, steroids and saponins[17]
Flowers	High amount of free amino acids like glutamic and aspartic acids, arginine, asperagine, lysine and alanine[14].
Fruit pericarp	Palmitic acid has been found to be the major volatile organic acid for the fruit pericarp[14].The fruit is rich in Vitamin C and E[18].The fruit is usually consumed as a vegetable due to its good nutritional value.The nutritive value of immature fruits of snake gourd per 100 g edible portion (94%) is: water 92.9 g, energy 89 kJ (21 kcal), protein 0.5 g, fat 0.3 g, carbohydrate 4.1 g, fiber 1.7 g, Ca 26 mg, P 20 mg, Fe 0.3 mg, thiamin 0.04 mg, riboflavin 0.06 mg, niacin 0.3 mg, folate 15 µg, ascorbic acid trace[5].

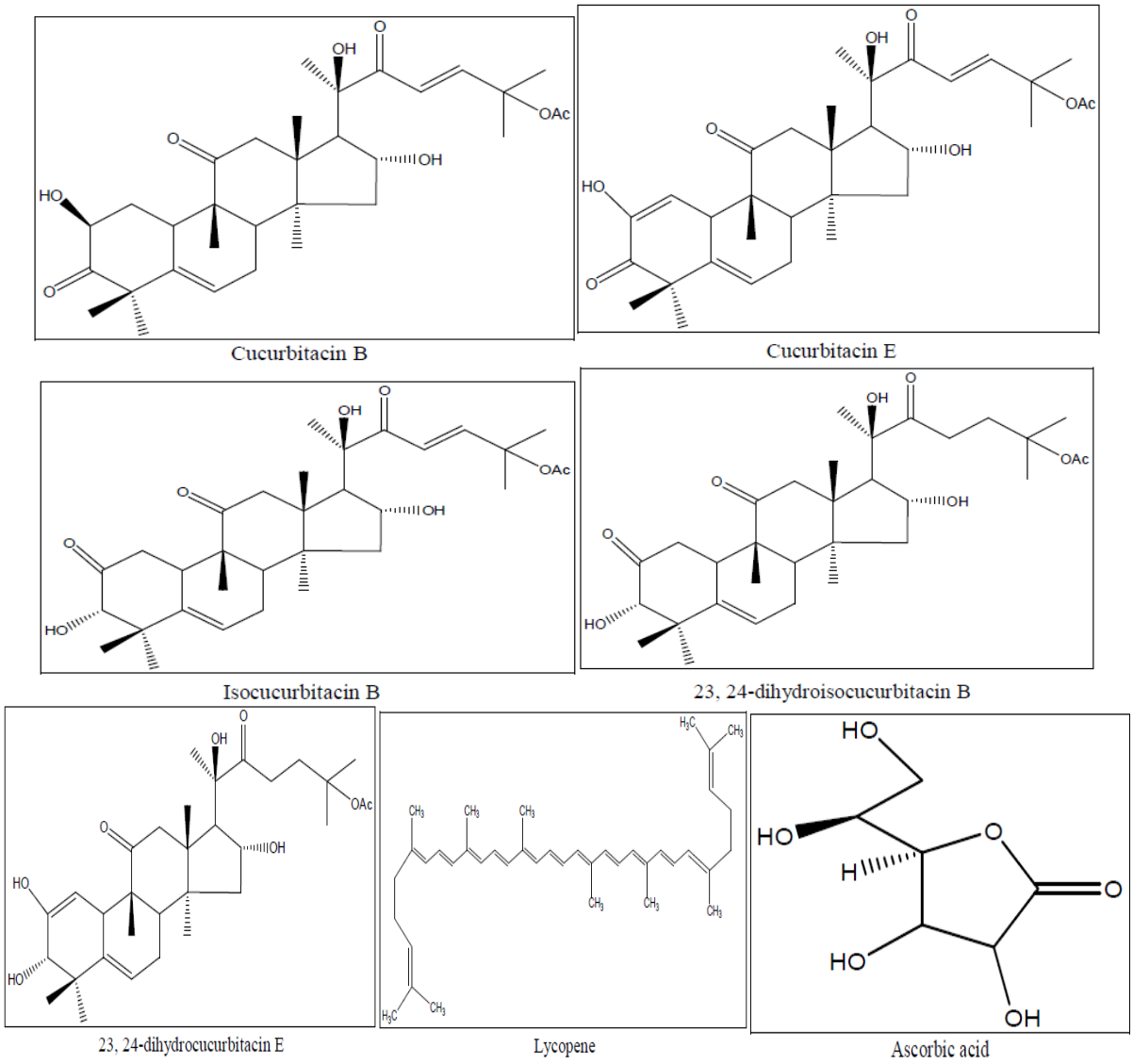

Figure 3: various chemical constituents with their structure

TRADITIONAL USES:

The plant is a cardiac and general tonic, antipyretic and emmenagogue; useful in boils and intestinalworms. Decoctionofleaves and stems is used in the treatmentofbilious disorders and skin diseases; for fever, the decoction is given withginger, chiretta and honey. The juice of the leaf is emetic. Ripefruitsaredrasticpurgative, antipyretic, alexiteric and stomachic; improveappetite and curebiliousness, bronchitis, asthma and itching. It is alsoconsideredanthelmintic and emetic. Seedsarecooling, antifebrile and anthelmintic. The root juice is cathertic; curesbronchitis; decoction is taken toexpelworms[14]. *Tricosanthescucumerina* is used in the treatment of head ache, alopecia, fever, abdominal tumors, bilious, boils, acute colic, diarrohea, haematuria and skin allergy. *T.curcumineria* is used as an abortifacient, vermifuge, stomachic, refrigerant, purgative, malaria, laxative, hydragogue, hemagglutinant, emetic, cathartic, bronchitisand anthelmintic.

Root: Two ounces of root juice has a drastic purgative action. Roots are used for expelling worms. In China roots used for diabetes, skin swellings like boils and furuncles.Fresh root has anti-convulsant activity. Bulbous part of the root is used as a hydragogue and cathartic. Root is abortifacient, alexiteric, anthelmintic, anti-septic, astringent, diuretic and emetic.

Leaves: Leaf juice is rubbed over the whole body in remittent fevers. Dried leaf has anti-spasmodic property. An infusion of tender shoots and dried capsules is aperient, and the expressed juice of the leaves is emetic. The leaves and stems are used for bilious disorders and skin diseases and as an emmenagogue. Leaf is alexiteric, astringent, diuretic and emetic.

Fruits: The fruit is considered to be anthelmintic. The dried capsules are given in infusion or in decoction with

sugar to assist digestion the fruit a very violent purgative and an efficient emetic.

Seeds: The seed is said to be cooling. The dried seeds are used for its anthelmintic and anti-diarrhoeal properties. Seeds have anti-bacterial, anti-spasmodic, antiperiodic and insecticidal properties. It is used as abortifacient, acrid, aphrodisiac, astringent, bitter, febrifuge, purgative, toxic, trichogenous[19].

Habit

The observation of living plants in the field is useful for the assessment of variousaspects of the habit of *Trichosanthes* because these aspects may be not clear from theherbarium specimens. Most species are perennial climbers, often with tuberous roots,and some are annual. Perennial female plants frequently die after fruiting (monocarpous), but new shoots may be produced by the tubers in some species.

Sexual condition

Whether a species is monoecious or dioecious can be determined by the presenceof male flowers as well as female flowers or fruits on the same herbarium specimen, orpreferably by observing living plants. In other genera it may be variable but in*Trichosanthes*most species are dioecious, and only some are monoecious, e.g.*T. cucumerina.*

LITERATURE REVIEW OF THE SELECTED PLANT

The plant is richly constituted with a series of chemical constituents like flavonoids, carotenoids, phenolic acids which makes the plant pharmacologically and therapeutically active. Ithas a prominent place in alternative systems of medicinelike Ayurveda and Siddha due to its variouspharmacological activities like anti-diabetic, antibacterial, cytotoxic, anti inflammatory, larvicidaleffects, etc.[20]

The literature review of the selected plant showing ethno medicinal uses as well as preliminary pharmacognostic, phytochemical and pharmacological studies made on this plant and reported as follow:

PHARMACOGNOSTIC REVIEW:

The plants of Cucurbitaceae family are classified into 110 genera & 640 species. The most important genera are Cucurbita, Cucumis, Ecballium, Citrullus, Luffa, Bryonia, Momordica, Trichosanthes(more than 30 species)[21].Trichosanthes, a genus of family Cucurbitaceae is an annual or perennial herb distributed in tropical Asia, Polynesia, & Australia. Over 20 species are recorded in India of which two namely *T. anguina& T. dioica* are cultivated as vegetable. Other important species found in the world are *T. palmata, T. cordata, T. nervifolia, T. cucumerina, T. wallichiana, T. cuspida, T.incisa, T. laciniosa, T. kirilowiietc*[22]In *T. cucumerina*, trichomes are densely distributed throughoutthe surface, thin walled, irregular in shape and without flatteneddisk at base, however, some trichomes are slightly conical and end with acute apex (Figure 4(D)). In *T. cucumerina var.anguina*, trichomes are densely distributed, thin walled, irregularin shape, without flattened disk at base, slightly blunt apex(Figure 4(E)).

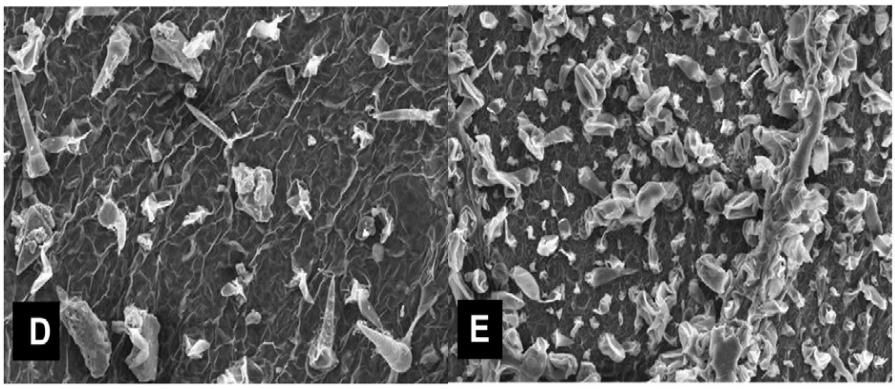

Figure 4: Trichomes of *Trichosanthes anguina*

The trichomes in Cucurbitaceae vary from unicellular to multicellular, conical to elongated, smooth to ridges, with or without flattened disk at base and cyctolithic appendages to without, thin to thick walled, curved at apices to blunt. Linnaeus (1753) established the species *Trichosanthesanguina* and *T. cucumerina*. Haines (1924) recognized *T. cucumerina L. var. cucumerina (L.)* as a wild variant with short fruits and *T. cucumerina var. anguina (L.)* as a cultivated variant with elongated, snake-like fruits. Chakravarty (1982) treated *T. cucumerina*and *T. anguina* as two different species. Jeffrey (1980) recognized *T. anguina* as a variety of *T. cucumerina*. From this study, we herein also recognized on the basis of similar pattern of trichomes morphology *T. anguina* as a variety of *T. cucumerina*[4].

PHYTOCHEMICAL REVIEW:

The Nutritive, Anti-Nutritive and Hepatotoxic Properties are present in *Trichosanthesanguina*(Snake Tomato) fruits from Nigeria. The results from this study indicate that T. anguina fruit contains important nutrients and will not be hepatotoxic unless consumed raw or unprocessed[19].

The results of one study show that the two morphotypes of *T. cucumerina* possess valuable nutraceutical properties. The fruit pulp contains ascorbic acid, lycopene, phenolics, flavonoids and antioxidant power that are comparable to that of Solanaceous tomato and are higher than those of most widely eaten members of Cucurbitaceae[10].

PHARMACOLOGICAL REVIEW:

Anti-inflammatory: Kolte RM, et al in 1997 with hot aqueous extract of root tubers of *Trichosanthescucumerina* have investigated against carrageenin induced mouse's hind paw oedema and it exhibited significant anti-inflammatory activity[23].

Cytotoxic activity: Kongtun S et al in 1999 with the root extract of *Trichosanthescucumerina L.* and the fruit juice tested cytotoxicity against four human breast cancer cell lines and lung cancer cell lines and one colon cancer cell line. The root extract inhibited more strongly than the fruit Juice[24].

Larvicidal efficacy: Rahuman.A.A. et al in 2008 using the acetone extract of leaves of *Tricosanthescucumerina* showed moderate larvicidal effects[25].

Anti-diabetic activity: Kar.A et al in 2003 with crude ethanolic extract of *Tricosanthescucumerina* showed significant blood glucose lowering activity in alloxan diabetic albino rats[26].M Arawwawala, et al in 2009 using hot water extract of aerial parts of *Trichosanthescucurmerina* has noted to improve glucose tolerance and tissue glycogen in non insulin dependent diabetes mellitus induced rats. Study showed the drug possess antidiabetic activity withimprovement in oral glucose tolerance and glucose uptake in peripheral tissues[27, 28].

Another study revealed that *Trichosanthesanguina* possess anti diabetic activity. The drug improved the oral glucose tolerance of NIDDM subjects. Increase in tissue glycogen content indicates the effect of the drug on the uptake of glucose by the peripheral tissue to reduce insulin resistance of NIDDM[29].

Hepatoprotective activity: SatheshKumar.S, et al in 2009 found that the methanolic extract of the whole plant of *Trichosanthes cucurmerina*showed good hepatoprotective activity against carbon tetrachloride induced heapatotoxicity[30].

Anti-fertility activity: Devendra N. Kage, et al in 2009 showed the antiovulatory activity of ethanol extract of whole plant of *Trichosanthes cucurmerinaL. var. cucumerina* in female albino rats[31].

Gastroprotective activity: Arawwawala LD et al in 2009 with hot water extract of *Trichosanthes 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 gastroprotective effects were observed in the alcohol model in terms of the length and number of gastric lesions mediated by alcohol in wistar stain rats[10].

Cardio-protective: Study of pretreatment of methanol extract of *T. cucumerina* fruit in Wistar rats showed reduction of doxorubicin-induced cardiotoxicity.

Bladder Toxicity Effects: Study of both low and high doses of a methanolic extract of T. cucumerina seeds used for the treatment of inflammation did not cause any significant effect on bladder weights and no histological aberration in the urinary bladder.

Antibacterial: Studies on extracts of the leaves of *Trichosanthes cucurmerina* screened for antibacterial activity against various pathogenic bacteria (B cerus, E faecalis, S paratyphi, S aureus, E coli, Strep faecalis, P vulgaris, K pneumonia, P aeruginosa and S marcescens) showed the ethyl acetate, chloroform and methanol extracts of T cucumerina leaves showed pronounced activity on all organisms tested with activity comparable to standard antibiotics. Results suggest the extracts can be used as a potential external antiseptic and incorporated into drug formulations[10, 14].

CONCLUSION:

Recently, many species of *Trichosanthes* have been reported to possess anti-viral compounds like Trichobetacin and Trichoanguin, which are used for the treatment of skin diseases, intestinal disorders, cough and tumors. *Trichosanthes anguina* L. is extensively cultivated for its long snake-like fruits which are used as one of the most nutritive cucurbit vegetables. The vegetable is constituted with proteins, carbohydrates, fiber, fat, vitamins A and E and minerals such as potassium, phosphorous, sodium, zinc and magnesium in trace. The plant has been used as medicine and it is known for its antidiabetic, hepatoprotective, cytotoxic, anti inflammatory and larvicidal properties.

REFERENCES:

1. Anonymous. The Wealth of India. The Dictionary of Indian Raw Materials and Industrial Products. Publication and Information directorate; 1976.
2. Anonymous. Compendium of Medicinal Plants. Vol. 2. A Publication of Department of Ayurveda. 2002; 2:146–150.
3. Jayaweera DMA. Medicinal plants (Indigenousand Exotic) used in Ceylon Part 2. Publication of the National Science Council of Sri Lanka. 1980:162–163.
4. Mohammad AA, Fahad MAA.Taxonomic significance of trichomes micro morphology in cucurbits. Saudi Journal of Biological Sciences. 2011; 18:87–92.

5. Soladoye MO, Adebisi AA. Trichosanthes cucumerina L. In: Grubben GJH, Denton OA (eds.). Plant Resources of Tropical Africa (PROTA) 2: Vegetables. PROTA Foundation, Netherlands/Backhuys Publishers, Leiden, Netherlands/Technical Centre for Agricultural and Rural Cooperation (CTA) Wageningen, Netherlands; 2001: 532-534.
6. Available at: http://herbalnet.healthrepository.org/bitstream/123456789/2474/21/mpuas_vol.5_pg.269-276.pdf
7. Indian medicinal plants compendium of 500 species. Orient Longman Pvt. ltd. Chennai, 2002: 320-322
8. Kritikar KR, Basu BD. Indian medicinal plants, Vol II, International book distributors, New Delhi, 2006: 1112-1114.
9. Adebooye. Phyto-constituents and anti-oxidant activity of the pulp of snake tomato (*trichosanthes cucumerina L.*).Afr. J. Trad. CAM. 2008; 5(2):173-179
10. Sandhya S. An updated review on *Tricosanthes cucumerina L*. International Journal of Pharmaceutical Sciences Review and Research. 2010; 1(2):56-60.
11. Adebooye OC. Phytoconstituents and anti-oxidantactivity of the pulp of snake tomato (*Tricosanthescucumerina*). African Journal of Traditional, Complimentary and Alternative Medicines, 2008;5(2):173-179.
12. Jiratchariyakul W, Frahm AW, Cucurbitacin B and dihydrocucurbilacin B from *Trichosanthescucumerina*, J. Pharm. Sci., 19 (5), 1992, 12.
13. Bakhru HK. Herbs that heal, natural remedies for good health. Orient Paper Books; 1997:230.
14. Medicinal Plants of Bangladesh. Available on: www.mpbd.info
15. Available at: source_philippine medicinal plant
16. Yadava RN, Syeda Y. An isoflavone glycoside from the seeds of *Trichosanthesanguina*, Phytochemistry.1994; 36(6):1519-21.
17. Menuka A, Ira T, Lakshmi A. Evaluation of the toxic potential of standardized extracts (hot water extract and cold ethanolic extract) of *Trichosanthescucumerina* Linn. aerial parts. BoletínLatinoamericano y del Caribe de PlantasMedicinales y Aromáticas. 2011;10:11-22.
18. Ojiako OA, Igwe CU. The Nutritive. Anti-Nutritive and Hepatotoxic Properties of *Trichosanthesanguina* (Snake Tomato) Fruits from Nigeria. Pakistan Journal of Nutrition. 2008;7(1):85-89.
19. Nadkani KM. Indian material medica. Popular Prakashan, Mumbai; 2002:1235-1236.
20. Indian medicinal plants compendium of 500 species, Orient Longman Pvt. ltd. Chennai, 2002, 320-322.
21. Khare CP. Encyclopedia of Indian medicinal plants. Springer science business media; 2007.
22. The Wealth of India. A Dictionary of Indian medicinal plant's raw material and industrial products, 289-290.
23. Kolte RM, Bisan VV, Jangde CR, Bhalerao A. Anti-inflammatory activity of root tubers of *Trichosanthescucumerina* (LINN) in mouse's hind paw oedema induced by carrageenin. Indian Journal of Indigeneous Medicines. 1997; 18(2):117-121.
24. Kongtun S, Jiratchariyakul W, Mongkarndi P, Theppeang K, Sethajintanin I, Jaridasem S, Frahm AW. Thai, Cytotoxic properties of root extract and fruit juice of *Tricosanthes cucumerina*. J Phytopharm. 1999; 6(2):1-9.
25. Rahuman AA, Venkatesan P. Larvicidal efficacy of five cucurbitaceous plant leaf extracts against mosquito species. Parasitol Res. 2008; 103(1):133-139.
26. Kar A, Choudhury BK, Bandyopadhyay NG. Comparative evaluation of hypoglycaemic activity of some Indian plants in alloxandiabetis rats. Journal of Ethnopharmacology. 2003; 84(1):105-108.
27. Arawwawala M, Thabrew I , Arambewela L. Antidiabetic activity of *Trichosanthescucumerina* in normal and streptozotocin–induced diabetic rats. International Journal of Biological and Chemical Sciences. 2009; 3(2):56.
28. Kirana H, Srinivasan B. *Tricosanthescucumerina* improves glucose tolerance and tissue glycogen in non insulin dependent diabetis mellitus induced rats. Indian Journal of Pharmacology. 2008; 345-8.
29. Kirana H, Srinivasan BP. *Trichosanthes cucumerina* Linn. improves glucose tolerance and tissue glycogen in non insulin dependent diabetes mellitus induced rats. Indian J Pharmacol. 2008; 40(3):103-106.
30. Sathesh KS, Ravi KB, Krishna MG. Hepatoprotective effect of *Tricosanthescucumerina* L on carbon tetra chloride induced liver damage in rats. J Ethnopharmacol. 2009; 123(2):347-50.
31. Devendra N, Kage, Vijay KB, Mala S. Effect of ethanol extract of whole plant of *Tricosanthes cucumerina* Var. Cucumerina on gonadotropins, ovarian follicular kinetics and estrous cycle for screening of anti fertility activity in albino rats. Int. J. Morphol. 2009; 27(1):173-182.

