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From Tradition to Science: A Review of *Trichosanthes tricuspidata* Medicinal Applications

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ABSTRACT:

The primary sources of chemical compounds with potential therapeutic benefits are medicinal plants. Many plant chemicals have been identified and are currently being used to treat a variety of medical conditions. The use of plants with medicinal properties to cure a variety of disorders is related to traditional medical practices around the world. *Trichosanthes tricuspidata* is a big genus that belongs to the Cucurbitaceae family. It is frequently employed in traditional treatments to treat a variety of human ailments, and it is also used as an ingredient in several food preparations. It is rich in phytochemicals and has a wide spectrum of biological functions. Steroids, triterpenoids, and flavonoids are the main chemical elements of this plant species. This plant possesses numerous therapeutic qualities, including anti-inflammatory, anticancer, antimicrobial, anti-fungal, and larvicidal action, anticonvulsant activity, gastroprotective activity, and others. *Trichosanthes tricuspidata's* bioactive components are responsible for its numerous therapeutic effects.This review focuses on the many different pharmacological qualities of Trichosanthes varieties and their future potential for improved use in treating a wide range of conditions. It is an underdeveloped species with enormous therapeutic potential. Given the importance of this plant, more investigation is needed to fully investigate this plant's potential.

Keywords: *Trichosanthes tricuspidata*, Pharmacological activities, Ethnomedicine, Phytochemicals.

Introduction:

Traditional medicinal systems are ingrained in Indian society. Today, the entire world is becoming more engaged in Indian ayurvedic and other ancient healing approaches. The acknowledgment of the non-narcotic nature, absence of side effects, and ease of distribution of many herbal medications is growing the need for medicinal plants in both developing and developed countries. The majority of therapeutic plants are obtained in the wild. Uncontrolled collecting has led to the extinction of numerous species as well as major concerns about the efficacy and quality of medical items derived from those plants (1). Plants, among every one of the life forms, play a critical role in the ecosystem by supporting all biological life forms. They also serve a possible function in the therapy of diseases, as evidenced by their use in all major medical systems. Trichosanthes is one such plant species.The

majority of these plant species include high levels of flavonoids, carotenoids, and phenolic chemicals. These species are important in the Vedic and Siddha systems of medicine because of their therapeutic properties, such as anti-HIV, cardioprotective, anti-ulcer, antidiabetic, hepatoprotective, antiinflammatory, and larvicidal activities (2–3).Tricuspidata has long been used to treat asthma, migraines, fever, diabetes, and carbuncles. The seeds are both emetic and purgative. The herb is used as an antifever cure, a laxative, an anthelmintic, and in migraine treatments in Thai traditional medicine (4). T. Tricuspidata leaf extract is used to treat snake bite poisoning in India. Recently, it became known that the leaf extract had an antipyretic effect as well as substantial free radical scavenging power (5–6). It was most likely domesticated in ancient India. Many countries in tropical regions, such as Asia and Africa, produce it as a vegetable. It has also been recorded from India to tropical Australia via Malaya. Trichosanthes species is an imported crop that is becoming increasingly important in various African countries, particularly Ghana and Nigeria. Trichosanthes is a genus of roughly 100 species, a handful of which have been cultivated in Asia. They are a diverse group of Trichosanthes species found throughout the region of Southeast Asia, the northern part of Australia, and the tropical regions of the countries of India, Nepal, Bangladesh, and Pakistan. Sri Lanka, Myanmar, Vietnam, Indonesia, Thailand, Malaysia, the Philippines, the northern Territory, Queensland, and Western Australia (7)

Fig. 1: Flowering stage of the plant

Scientific Classification:

Kingdom: Plantae

Family: Curcubitaceae

Genus: Trichosanthus

Species: Tricuspidata

Botanical description: Trichosanthes tricuspidata is a big woody tendril climber that can reach a height of 5–20 meters. It is occasionally monoecious, minutely hairy, and an early glabrescentrichosanthes. The fresh plant is green, but after drying, it turns brown. The petals are white, with visible cystoliths. The stem's older section is light gray in color, while the younger part is silky green and is 2-4 mm in diameter. Probract is elliptic or obovate (broadly). Tendrils have two or three branches. Palmately 3-5lobed dark green previously, translucent beneath black-colored round gland on the lower side; broadly ovoid or orbicular in outline, base cordate, mid-lobe

triangular or ellipsoid, apex acute, apex of side-lobes regularly down-curved, the margin whole coarsely dentate, petiole 3-7.5 cm long. Male flowers have a hairy raceme 7–16 cm long, a peduncle 5–11 cm long, and a rachis. Flowers are only one gender. Male flowers are in axillary racemes, with bracts that are roughly oval, nerved, fringed, and gland-spotted. Female blooms are axillary and solitary. When ripe, the fruits are glabrous crimson with 10 orange streaks; the outer layer of the fruit is leathery, smooth, and coarsely wrinkled; the pulp is green-black; and the fruiting pedicel is 1-2 by 0.3-0.4 cm. Dark brown seeds, many, silky obovate-elliptic or oval in shape, 9–10 × 5–6 × 1.5–2 mm, no margin, edge smooth or rounded, entire (8–10).

Vernacular names:

Indrayan is the common name for *Trichosanthes tricuspidata.* Red ball snake gourd in English; Mahakal, Indrayan in Hindi; Malayalam, Akkattonti; Telugu, Avaduta; Kannada, Avaguda, Hannu; Gujarati, Ratan indrayan; Sanskrit, Kakanasa, Shvetpushpi, and Dhvamksanasa(11).

Synonyms:

Trichosanthes palmata Roxb., Trichosanthes bracteata Lamb., Trichosanthes pubera Blume, or Modeccca bracteata are all species of Trichosanthes. In India, *Trichosanthes tricuspidata* and Trichosanthes bracteata are two different kinds.

Fig -2 fruiting stage of *T.tricuspidata*

PHYTOCONSTITUENTS:

Cucurbitane glycosides, cucurbitacin 2-O-b-glucopyranoside and 25-O-acetyl-cucurbitacin 2-O-b-glucopyranoside, khekadaengosides A-J, M-N, and cucurbitacin K are all found in fruit. Cucurbitacin and 2-O-b-glucopyranoside J 2-O-bglucopyranoside is a hexanorcucurbitaneglucoside (khekadaengoside K) and octanor cucurbitane khekadaengoside L (12). Fatty acids found in seeds include n-Hexadecanoic acid, Octadecanoic acid, 9,12-Octadecadienoic acid, 9-Octadecenoic acid, methyl ester, and (E) cis-vaccenic acid. N-acetyl-1-cyno-[1.,2.,3]triazole-4-carboxylic acid, cis-10-nonadecenoic acid, oleic acid, methyl ester ethanone, n-hexylamine, N-acetyl-1-cyno-[1.,2.,3]triazole-4-carboxylic acid, Butyl 9,12-octadecadienoate, Methyl 9,12-heptadecadienoate,

9,12-octadecadienoic acid, 2-Methyl-z,z3,13-octadecadienol 9-Octadecenal, and (z)-cyclopropaneoctanal, among other things. Trichotetrol, a tetrahydroxypentacyclic triterpenoid, is found in the root (14). Glyceryl 1-palmitate, glyceryl 1-stearate, 24 methyl palmitate, palmitic acid, suberic acid, -spinasterol 3-o-beta-D-glucopyranoside, -spinasterol, stigmast-7-en-3-beta-ol, stigmast-7-en-3-beta-ol-3-O-beta-D-glucopyranoside, 23,24-dihydrocucurbitacin D, bryonolic acid, cucurbitacin B, isocucurbitacin B, isocucurbitacin D, 3-epi-isocucurbitacin B, and D-glucose are the active ingredients in this compound. 11, 25(15). Trichosanthes tricuspidata leaves contain cyclotrichosantol and cycloeucalenol, as well as cycloartane glycosides known as cyclotricuspidosides A, B, and C (16). Cyclotricuspidosides A, B, and C are cycloartane glycosides found in the stem of *Trichosanthes tricuspidata* (17).

PHARMACOLOGICAL ACTIVITIES:

Trichosanthes plants have traditionally been utilized as edible and therapeutic plants all throughout the world, and they have demonstrated a wide range of pharmacological properties in traditional medicine. Several popular recent investigations have demonstrated this genus's medicinal value as a source of anti-inflammatory, cytotoxic, anticancer, and anti-tyrosinase compounds.

Anti-inflammatory activity: The effects of *T. Tricuspidata* ethanol extract has been examined in vitro and in vivo. The extract reduced NO release and mRNA levels of inducible NO synthase (iNOS), TNF-β, and IL-6 in LPS-induced macrophages, as well as drastically reducing NF-B, MAPK, and JAK2 signaling by targeting Syk, Src, and IRAK1 protein kinase enzymes. In vivo investigations of this extract achieved similar results in HCl/EtOH-induced gastritis mouse models by suppressing cytokines that promote inflammation and the inflammatory response (18).

Anti-oxidant activity: Rodge et al. found antioxidant activity in *Trichosanthes tricuspidata* plant parts leaf and fruit. In this study, the fruit of *Trichosanthes tricuspidata* was found to have greater antioxidant activity than the leaf in a chloroform-based extract of *Trichosanthes tricuspidata.* When compared to the control, the root displayed higher antioxidant activity. The methanolic extract of *Trichosanthes tricuspidata l*eaves was found to have high antioxidant activity.

Anti-thyrosinase activity: Previous research on Trichosanthes plant extracts and ingredients indicated anti-tyrosinase action in the hunt for novel treatments for skin problems. Compound 100 was isolated from T. truncata, for example, was shown to inhibit ROS production in HaCaT keratinocyte cells dose-dependently without cell death in the concentration range of 0.2–20 M, and compounds 95–98 and 100 had additional potential anti-mushroom tyrosinase actions with IC50 values of 106.9–106.9 M.255.6 µM (19).

Furthermore, isolated compounds from T. Kirilowii fibers have been shown to have tyrosine acidase inhibitory action (20).

Anti-helmintic activity: Ethano: botanically, this plant has been utilized by tribals to treat intestinal worm infections, and it has been shown to have strong anthelmintic activity in an experimental laboratory setting. Dubey

investigated the anthelmintic action of *Trichosanthes tricuspidata*. The aerial portions of *Trichosanthes tricuspidata* were extracted with both ethanol and water in this study. When compared to the usual medicine, albendazole, both extracts were more active. Both extracts' antihelmintic efficacy was dose-dependent. *Trichosanthes tricuspidata* ethanolic extract was shown to be more active than aqueous extract.

Anti-diabetic activity: The presence of different phytochemical substances, including terpenoids from T. Tricuspidata extract was found to have a high anti-diabetic effect in a phytochemical investigation (21).

Anti-microbial activity: Each *Trichosanthes Tricuspidata* extract contained triterpenoids and saponin, which could have antibacterial action (22).

Larvicidal activity: *Trichosanthes tricuspidata* is a natural mosquito repellent that can be used in the home to kill mosquitoes, mice, and other pests. The fruit of *Trichosanthes tricuspidata* was reported to have larvicidal activity by Sonwalkar et al. In this study, two distinct solvents (methanol and petroleum ether) demonstrated considerably higher active mortality as compared to the control. Methanolic *Trichosanthes tricuspidata* fruit extract was shown to be more larvicidal than petroleum-based fruit extract.

Anti-bacterial and anti-fungal activity: Tannins were found in all the methanol-based extracts of *Trichosanthes tricuspidata* in this study. However, Tripathy et al. (2014) discovered tannin only in *Trichosanthes tricuspidata* fruit water extract and not in fruit methanol extract. Tannins have long been recognized as a substance that fights infections and cell deformities while also being antibacterial and antifungal (23).

Anti-pyretic activity: Tannins were identified in all of the *Trichosanthes Tricuspidata* methanol-based extracts were tested in this investigation. Tripathy et al. (2014), on the other hand, identified tannin only in *Trichosanthes tricuspidata* fruit extracts of water and not in fruit methanol extract. Tannins have been historically recognized as an antibacterial and antifungal chemical that fights pathogens and cell abnormalities.

Anti-convulsant activity: Epilepsy is considered a neurological illness in the absence of safer medications with improved anticonvulsant efficacy, as currently existing drugs fail to provide sufficient control of seizure activity in around one-third of patients. In pilocarpine-induced mice, assess the impact of *Trichosanthes tricuspidata* ethanolic extract (TTME) on epilepsy-mediated oxidative stress. When compared to the control group, the seizure was matched by an enormous spike in lipid peroxidation and hippocampus nitrite concentration in the pilocarpine group. Furthermore, superoxide dismutase, catalase, and glutathione levels were reduced in pilocarpine-treated groups. Methanolic extract injection reduced oxidative damage in the hippocampus, as evidenced by lower lipid oxidative degradation and nitrite-nitrate concentration, and maintained the level of catalytic antioxidant defenses. Histopathological study revealed the death of neuronal cells in the hippocampus CA1 and CA3 pyramidal regions, suggesting the function of free radicals during epilepsy. The findings significantly support the concept that TTME possesses anticonvulsant efficacy as well as a high antioxidant potential, which plays an important role in lowering the oxidative stress caused by seizures.

Anti-cancer activity: Cucurbitacins are a class of natural triterpenoids found in the Trichosanthes genus that have long been utilized in traditional medicine (24–26). According to recent findings, these triterpenoids have the potential to be novel medications for cancer progression inhibition (27). Several cucurbitacins were found to have

anti-cancer therapeutic effects. Cucurbitacin B (16, for example) stimulates the cell cycle within human breast cancer cells; however, cucurbitacin E (26) restricts cell migration in human prostate carcinoma cells and disrupts the cytoskeleton structure (28–29). Furthermore, a lot of researchers have discovered that cucurbitacin D (17) causes apoptosis by reducing NF-B and Stat3 activation, produces apoptosis and autophagy in human T cell leukemia cells, and disrupts viability in MCF7, SKBR3, and MDA-MB-231 breast cancer cells (30–31).

Furthermore, trichosanthin, a 27-kDa protein extracted from T. Kirilowii tubers, promote apoptosis, and suppress malignancy cell proliferation in the two cell types and nude mice (32). Furthermore, numerous studies have demonstrated that Trichosanthes plants have anti-tumor properties. For example, an aqueous-alcoholic extract of T. Dioica root has been shown to have anti-tumor and oxidative stress-reducing potential (33–35). An effective example of converting this strongly cytotoxic natural product into potentially beneficial and less toxic anti-cancer drugs employing cellular degradable prodrug design was recently published. Two bioreductive prodrugs, 104 and 105, were produced from compound 16, and the study found that these prodrugs dramatically lowered toxicity against noncancerous cells while maintaining the original activities against cancer cells. The results also show that the prodrugs effectively released compound 16 in reductase-overexpressing MCF-7 cells. Among these, the prodrug 104 demonstrated considerable toxicity diminution in both in vitro and in vivo investigations, as well as tumor growth inhibition comparable with the results of tamoxifen in the 4T1 xenograft mouse experiment (36–37).

Gastro-protective activity: Kannan et al. tested *Trichosanthes tricuspidata* leaf extracts (Hexane, Chloroform, Ethanol, and Water) against the standard Ranitidine medication 35. When compared with the other extracts, the hexane extract showed much higher gastroprotective efficacy.

OTHER MEDICINAL USES OF Tricosanthes tricuspidata:

Tricuspidata is regarded as medicinally significant in a number of traditional systems. The fruits are used in Ayurvedic medicine to cure asthma, earache, and ozoena (intranasal crusting, atrophy, and fetid odor). The fruits are used in the Unani system of medicine as a carminative (an agent that relieves flatulence), a purgative, and an abortifacient, to minimize inflammation, cure migraines, and reduce heat of the brain, as a treatment for opthalmia (inflammation of the eye), leprosy (infectious disease caused by Mycobacterium leprae), epilepsy (episodic impairment or loss of consciousness, an abnormal motor phenomenon). The seeds have emetic properties. The herb is used as an anti-fever medication, a laxative, an anthelmintic, and in migraine treatments in Thai traditional medicine (38). The plant's roots are used to cure respiratory illnesses in cattle, as well as diabetic carbuncles and headaches. Gaur has reported using this plant to treat bronchitis and using seed paste to treat cattle hoof and mouth problems . The fruits are also used by vaidyas, or ayurvedic practitioners, to cure stomatitis. The oil derived from the plant's root is used to treat pain. The plant is used to treat snakebite poisoning in the Bastar District of Gujarat, India, and its juice is utilized externally to treat skin eruptions. The origins can be found in Nepal(39).

Results and Discussions:

Trichosanthes tricuspidata possesses numerous therapeutic qualities, including antioxidant, anticancer, antibacterial, antifungal, larvicidal action, anticonvulsant activity, gastroprotective activity, and others. The

bioactive chemicals in *Trichosanthes tricuspidata* that are responsible for its varied therapeutic characteristics, as well as their molecular actions, need to be studied further.The extract of several *Trichosanthes tricuspidata* leaf extracts was prepared using soxhlet extraction, and the yield achieved was 11%. The extract was subjected to preliminary chemical screening, which revealed the presence of alkaloids, carbohydrate molecules, saponins, and proteins. According to the OECD 425 guidelines for acute poisoning, the extract did not cause any toxic symptoms or mortality in albino rats up to a dose level of 2000 mg/kg, and thus the drug was regarded as safer for further pharmacological screening. The LD50 of *Trichosanthes tricuspidata* was greater than 2000 mg/kg. To the best of our knowledge, we are the first to investigate this plant's anticancer potential. Cancer is distinguished by seven characteristics: unrestricted development of aberrant cells, self-sufficiency in growth signals, susceptibility to proliferation inhibitors, resistance to apoptosis, prolonged angiogenesis, an inflammatory microenvironment, and, eventually, tissue invasion and metastasis. A review of the literature indicated that no research on the curative properties of extracts of plant roots had been conducted on the cell lines of human cancer. Food antioxidant molecules serve a significant role in health protection. According to scientific evidence, antioxidants lessen the risk of chronic diseases such as cancer, heart disease, and other problems. An antioxidant's fundamental trait is its capacity to trap free radicals. Antioxidant substances such as phenolic acids and polyphenols, as well as flavonoids, scavenge free radicals such as peroxide, hydroperoxide, and lipid peroxyl, inhibiting the oxidative pathways that cause degenerative illnesses(40).

Conclusion:

The current review summarizes *Trichosanthes tricuspidata's* ethnobotanical and medicinal uses, chemical components, and pharmacological activity data. To substantiate the ethnomedical or historical claims of *Trichosanthes tricuspidata* for medicinal therapeutic purposes, the pharmacological characteristics of bioactive components in *Trichosanthes tricuspidata* are required. Steroids, triterpenoids, and flavonoids are the main chemical ingredients. These compounds displayed a wide range of biological properties, including anti-inflammatory, cytotoxic, anti-cancer, and anti-tyrosinase activity. This plant genus' natural and manufactured, or structurally modified, compounds may lead to the discovery of pharmaceuticals with different biological functions. Further pharmacological research is required to determine their potential applicability in natural product-based drug development.

References:

1. Vartak, V.D. and Gadgil, M., 1981. Studies on sacred groves along the Western Ghats from Maharashtra and Goa: Role of beliefs and folklore Glimpses of Indian ethnobotany, pp. 272-278.

2. Arawwawala, L.D.A.M., Thabrew, I., Arambewela, L.S.R., and Fernando, N. and Guruge, L.D., 2011. Antibacterial activity of Trichosanthes cucumerina Linn. extracts. Int J Pharm Biol Arch, 2, pp. 808–812.

3. Li, M.X., Yeung, H.W., and Pan, L.P. and Chan, S.I., 1991. Trichosanthin, a potent HIV-1 inhibitor, can cleave supercoiled DNA in vitro. Nucleic acids Research, 19(22), pp. 639–6312.

4. Dhale, D.A., 2013. Surface mycoflora of stored herbal medicine. Int. J. Pharma Bio Sci, 4(3), pp. 568–574.

5. Lala, N.L., Ramaseshan, R., Bojun, L., Sundarrajan, S., Barhate, R.S., and Ying-jun, L. and Ramakrishna, S.S., 2007. Fabrication of nanofibers with antimicrobial functionality used as filters: protection against bacterial contaminants. Biotechnology and Bioengineering, 97(6), pp. 1357–1365.

6. Sundarrajan, S.; Chandrasekaran, A.R. and Ramakrishna, S., 2010. An update on nanomaterial-based textiles for protection and decontamination. Journal of the American Ceramic Society, 93(12), pp. 3955–3975.

7. Saboo Shweta S., Thorat Priyanka, Tapadiya Ganesh G., and Khadabadi S. (2012). Distribution and ancient-recent medical uses of Trichosanthes species. International. Journal of Phytopharmacy, Vol. 2 (4), pp. 91–97.

8. Bhandari, S., Dobhal, U., and Sajwan, M. and Bisht, N.S., 2008. Trichosanthes tricuspidata is a medicinally important plant. Trees for Life Journal, 3(5), pp. 1–4.

9. Duyfjes, B.E. and Pruesapan, K., 2004. The genus Trichosanthes L. (Cucurbitaceae) is found in Thailand. Thai Forest Bulletin (Botany), 32, pp. 76–109.

10. Harborne, J.B., 1994. Indian medicinal plants. A compendium of 500 species. Vol. 1; edited by PK Warrier, VPK Nambiar, and C. Ramankutty. pp.208-445

11. Duvey, B.K., Goyel, R., Parashar, B., Verma, D., and Dhameja, H. and Sharma, D., 2012. Trichosanthes tricuspidata: exploration of its medicinal value. Asian Journal of Pharmacy and Technology, 2(1), pp. 26–28.

12. Kanchanapoom, T., Kasai, R. and Yamasaki, K., 2002. Cucurbitane, hexanorcucurbitane, and octanorcucurbitane glycosides from the fruits of Trichosanthes tricuspidata. Phytochemistry, 59(2), pp. 215-228.

13. Jayakumar, C., Mansa, D.V., Reddy, P.D.M., and Sridar, R., 2019. Oil Extraction from Trichosanthes tricuspidata Seed Using Conventional Soxhlet Apparatus. Asian Journal of Chemistry, 32(9).

14. Khare, C.P., 2008. Indian medicinal plants: an illustrated dictionary. Springer Science & Business Media. 2018 pp.1-23.

15. Bhandari, S., Dobhal, U., and Sajwan, M. and Bisht, N.S., 2008. Trichosanthes tricuspidata is a medicinally important plant. Trees for Life Journal, 3(5), pp. 1–4.

16. Kasai, R., Sasaki, A., Hashimoto, T., Kaneko, T., and Ohtani, K. and Yamasaki, K., 1999. Cycloartane glycosides from Trichosanthes tricuspidata. Phytochemistry, 51(6), pp. 803–808.

17. Khare, C.P., 2008. Indian medicinal plants: an illustrated dictionary. Springer Science & Business Media. 2018,

pp 1-50.

18.Ahuja, A., Jeong, D., and Kim, M.Y. and Cho, J.Y., 2019. Trichosanthes tricuspidata Lour. Methanol extract exhibits anti-inflammatory activity by targeting Syk, Src, and IRAK1 kinase activity. Evidence-Based Complementary and Alternative Medicine, 2019. pp 1-50.

19.Weng, I.T., Lin, Y.A., Chen, G.Y., Chiang, H.M., Liu, Y.J., Chen, C.J., and Lan, Y.H. and Lee, C.L., 2020. (-)-β-Homoarginine anhydride, a new antioxidant and tyrosinase inhibitor, and further active components from Trichosanthes truncata. Natural product research, 34(16), pp. 2262–2268.

20.Zhang, R., Hu, X., Zhang, B., Wang, Z., Hao, C., and Xin, J. and Guo, Q., 2020. Whitening activity of constituents isolated from the Trichosanthes pulp. Evidence-Based Complementary and Alternative Medicine, 2020. pp.1-8.

21.Kulandaivel, S., Bajpai, P., and Sivakumar, T., 2013. Antihyperglycemic activity of Trichosanthes tricuspidata root extract. Bangladesh Journal of Pharmacology, 8(3), pp. 305–310.

22.Barre, J.T., Bowden, B.F., Coll, J.C., De Jesus, J., Victoria, E., and Janairo, G.C. and Ragasa, C.Y., 1997. A bioactive triterpene from Lantana camara. Phytochemistry, 45(2), pp. 321-324.

23.Gupta, A. and Pandey, A.K., 2020. Antibacterial lead compounds and their targets for drug development. In Phytochemicals as Lead Compounds for New Drug Discovery, pp. 275-292. vol;393.

24.Ríos, J.L., Escandell, J.M. and Recio, M.C., 2005. New insights into the bioactivity of cucurbitacins. Studies in Natural Products Chemistry, 32, pp. 429–469.

25.Kaushik, U., Aeri, V., and Mir, S.R., 2015. Cucurbitacins—an insight into medicinal leads from nature. Pharmacognosy reviews, 9(17), p. 12.

26.Chen, X., Bao, J., Guo, J., Ding, Q., Lu, J., and Huang, M. and Wang, Y., 2012. Biological activities and potential molecular targets of cucurbitacins: a focus on cancer. Anti-cancer drugs, 23(8), pp. 777–787.

27.Bartalis, J. and Halaweish, F.T., 2011. In vitro and QSAR studies of cucurbitacins on HepG2 and HSC-T6 liver cell lines. Bioorganic and medicinal chemistry, 19(8), pp. 2757–2766.

28. Duangmano, S., Sae-Lim, P., Suksamrarn, A., and Domann, F.E. and Patmasiriwat, P., 2012. Cucurbitacin B inhibits human breast cancer cell proliferation through disruption of microtubule polymerization and nucleophosmin/B23 translocation. BMC complementary and alternative medicine, 12(1), pp. 1–12.

29.Duncan, K.L., Duncan, M.D., Alley, M.C. and Sausville, E.A., 1996. Cucurbitacin E-induced disruption of the actin and vimentin cytoskeletons in prostate carcinoma cells. Biochemical pharmacology, 52(10), pp. 1553–1560.

30. Ku, J.M., Kim, S.R., Hong, S.H., Choi, H.S., Seo, H.S., and Shin, Y.C. and Ko, S.G., 2015. Cucurbitacin D induces cell cycle arrest and apoptosis by inhibiting STAT3 and NF-κB signaling in doxorubicin-resistant human breast carcinoma (MCF7/ADR) cells. Molecular and Cellular Biochemistry, 409, pp. 33–43.

31. Kim, S.R., Seo, H.S., Choi, H.S., Cho, S.G., Kim, Y.K., Hong, E.H., and Shin, Y.C. and Ko, S.G., 2013. Trichosanthes kirilowii ethanol extract and cucurbitacin D inhibit cell growth and induce apoptosis through inhibition of STAT3 activity in breast cancer cells. Evidence-Based Complementary and Alternative Medicine, 2013. pp 1-9.

32. Nakanishi, T., Song, Y., He, C., Wang, D., Morita, K., Tsukada, J., and Kanazawa, T. and Yoshida, Y., 2016. Autophagy is associated with cucurbitacin D-induced apoptosis in human T-cell leukemia cells. Medical Oncology, 33, pp. 1–8.

33. Ku, J.M., Hong, S.H., Kim, H.I., Lim, Y.S., Lee, S.J., Kim, M., Seo, H.S., Shin, Y.C. and Ko, S.G., 2018. Cucurbitacin D exhibits its anti-cancer effect in human breast cancer cells by inhibiting Stat3 and Akt signaling. European Journal of Inflammation, 16.

34.Fang, E.F., Zhang, C.Z.Y., Zhang, L., Wong, J.H., Chan, Y.S., Pan, W.L., Dan, X.L., Yin, C.M., and Cho, C.H. and Ng, T.B., 2012. Trichosanthin inhibits breast cancer cell proliferation in both cell lines and nude mice by promoting apoptosis. 7(9).pp 1-10.

35. Bhattacharya, S., Prasanna, A., Majumdar, P., Kumar, R.S. and Haldar, P.K., 2011. Antitumor efficacy and amelioration of oxidative stress by Trichosanthes dioica root against Ehrlich ascites carcinoma in mice. Pharmaceutical Biology, 49(9), pp. 927–935.

36. Khandaker, M.; Akter, S. and Imam, M.Z., 2018. Trichosanthes dioica Roxb. A vegetable with diverse pharmacological properties. Food Science and Human Wellness, 7(1), pp. 34–48.

37. Sha, O.U., Niu, J., Ng, T.B., Cho, E.Y.P., and Fu, X. and Jiang, W., 2013. Anti-tumor action of trichosanthin, a type 1 ribosome-inactivating protein, employed in traditional Chinese medicine: a mini-review Cancer chemotherapy and pharmacology, 71, pp. 1387–1393.

38. Kanchanapoom, T., Kasai, R. and Yamasaki, K., 2002. Cucurbitane, hexanorcucurbitane, and octanorcucurbitane glycosides from the fruits of Trichosanthes tricuspidata. Phytochemistry, 59(2), pp. 215-228.

39. Chopra, R.N. and Nayar, S.L., 1956. Glossary of Indian medicinal plants. Council of Scientific and Industrial Research. Vol;117.pp 25-194.

40. Gaur, R.D., 1999. Flora of the District Garhwali, North-West Himalaya. Transmedia.vol;20.pp 1-27