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Review on Pharmacological Profile of Medicinal Vine: *Tinospora cordifolia*

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Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

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Review Article

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ABSTRACT

Tinospora is highly distributed in the tropical and subtropical region of India. This climbing deciduous shrub widely reported in China, Bangladesh and Srilanka. The plant is rich in many phytoconstituents that are useful in drug designing. It is highly used against cancer, tumour suppression, and act as an anti-allergic compound. It is commonly known as gudhuchi, belongs to the family Menispermeaceae. *Tinospora* is most valuable herb known for its medicinal properties from Vedic periods and cures various diseases such as malaria, asthma and urinary disorders. The genus *Tinospora* consists of many classes of chemicals such as alkaloids, diterpenoids lactones, steroids, aliphatic compounds and polysaccharides. It is the best remedy for both children as well as adults against respiratory tract diseases. The plant shows various antioxidant, anti-hyperglycemic, anti-neoplastic and hepatoprotective properties. In this review article medicinal property, chemical constituents and full description have been explored.

Keywords: Tinospora; gudhuchi; diterpenoids; antioxidant; anti-neoplastic; steroids.

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1. INTRODUCTION

Guduchi or *Giloya* is the most commonly used plant which contains a large number of valued products. It has a wide history in the Indian medicinal system and considered one of the best *Rasayana* and is unusual in its potent versatility. In recent years, significant progress has been attained for its biological activity and medicinal applications. It is a semi-woody climbing shrub that is deciduous and perennial. This herbaceous vine grows on hedges and trees described as "one which protects the body". It is often seen growing up Mango or Neem trees. Herbalist Sebastian Pole writes that "those growing up neem trees are said to be the best as the synergy between these two bitter plants enhances *guduchi*'s efficacy." It is indigenous to areas of India, Myanmar, and Sri Lanka [1, 36]. *Guduchi* typically grows in deciduous and dry forests at elevations up to 1000 ft. The leaves are heart-shaped (*cordifolia*) and mucilaginous. Its stems, when fresh, have a green succulent bark covered by a thin brown bark and are studded with warty lenticels. When dry, the stem shrinks and the bark separate from the wood. The roots are long narrow aerial roots that arise from the branches [36]. The stems, leaves, and roots are used in medicine. All three parts should be collected in the summer when the bitter qualities are most abundant and, if not used fresh, dried in the shade. *Guduchi* grows well without fertilizer or pesticide making it simple to grow. It is easy to recognize and can be propagated by cuttings. Guduchi is a large glabrous deciduous climbing shrub belonging to the family Menispermaceae [37]. It is distributed throughout tropical Indian subcontinent and China, ascending to an altitude of 300 m. In Hindi, the plant is commonly known as Giloya or Amrita which is a Hindu mythological term that refers to the heavenly elixir that has saved celestial beings from old age and kept them externally young [2]. The stem of *T. cordifolia* is rather succulent with long filiform fleshy aerial roots from the branches. The bark is creamy white to grey, deeply left spirally, the space in between being spotted with large rosette-like lenticel. The leaves are membranous and cordate. The flowers are small and yellow or greenish yellow [3]. In auxiliary and terminal racemes or racemose panicles, the male flowers are clustered and female is usually solitary. The drupes are ovoid, glossy, succulent, red and pea-sized. The seeds are curved and pea-sized [4]. Fruits are pear-shaped, fleshy, shiny turn red when boiled. Guduchi is used as a Rasayana due to its potency of enhancing longevity and vitality. It is widely used in ayurvedic for a variety of purposes associated with inflammation allergies, neurology and glucose metabolism, general debility, fever, diabetes, dyspepsia, urinary infection, jaundice and skin diseases. In today's world of modern medicine, it is also called a magical herb due to its property to treat a lot of diseases.

2. CLASSIFICATION

Kingdom : Plantae
Division : Magnoliophyta
Class : Magnoliopsida
Order : Ranunculales
Family : Menispermaceae
Genus : Tinospora
Species : cordifolia

2.1 Total Species

Some observers found that there are total 15 species and out of these some of the medicinally important species are *T. cordifolia*, *T. crispa*, *T. cordifoli, T. malabarica*, *T. tomentosa*, *T. uliginosa* etc [1].

2.2 Vernacular Names

Assamese : *Siddhilata, Amaralata*
Bengali : *Gulancha*
English : *Heartleaf moonseed*
Gujarati : *Galac, Garo*
Hindi : *Giloe, Gurcha*
Kannada : *Amrutaballi*
Kashmiri : *Amrita, Gilo*
Malayalam : *Chittamrutu*
Marathi : *Gulvel*
Oriya : *Guluchi*
Punjabi : *Gilo*
Sanskrit : *Amrit*
Tamil : *Seendal, Seendi Kodi*
Telugu : *Thippateega*
Urdu : *Abb-e-Hyat*

3. BOTANICAL DESCRIPTION

T. cordifolia is a large, perennial, deciduous, climbing shrub with the succulent stem. The stem is fibrous and having wedge-shaped wood bundles with large vessels. The bark is papery, creamish white in colour, left spirally and stem containing rosette-like lenticles. The leaves are simple, alternate and cordate in shape also consist of 7-9 nerves on the entire leaf [5]. Flowers are axillary, small, cymose, yellow-greenish in colour. Male and female flowers are

always originated on separate branches. Male flowers are present in cluster form while female flowers are in the solitary form [6]. The best time for the growth of flower is during summer [7]. Sometimes small yellowish flowers are also present on long spikes. Fruits of *Tinospora* are pea-shaped shiny, draping and become red when fully grown. Fruits are generally single-seeded and fleshy. The fruits get maturity in the winter season. Seeds are hooked or curved in shape. The root portion is aerial, thread-like, long, fleshy and is in branching form.

4. HABITAT AND DISTRIBUTION

T. cordifolia prefers subtropical and tropical for growth. For better cultivation, light-medium sandy loam soil rich in organic matter and with adequate drainage is suitable. This plant is highly grown tropical India, South Asia, Indonesia, Philippians, Thailand and China. The plant is also observed from the South East Asian continent such as Malaysia, Indonesia and Tamilnadu.

5. CLIMATE AND SOIL

The plants preferred subtropical and tropical conditions for proper growth. For better cultivation, light-medium sandy loam soil rich in organic matter and with adequate drainage is suitable. It shows low resistance towards high rainfall or waterlogged conditions. Stem cutting is the best method to enhance commercial use.

6. FLORAL AND FRUIT STUDY

Inflorescence starts in the summer season. The male flowers are small in size, yellow or green in colour, and occur in groups. While female flowers are usually green and solitary in nature. The fruit size and shape is like a pea pod and turns green to red when ripe in winter.

7. CHEMICAL CONSTITUENTS

A number of chemical constituents have been extracted from the different parts of *T. cordifolia.* These chemical constituents belong to different classes viz; alkaloids, diterpenoid lactones, steroids, glycosides aliphatic compounds, polysaccharides. The main constituents of this plant are tinosporone, tinosporic acid, cordifolisides A to E, syringe, berberine, gilonin [8]. The chemical constituents in different parts and its uses are given in the Table 2.

It also contains various other chemicals like flavonoids, glycosides, saponins and little amount of phytosterols. These chemicals show antioxidant activity when these are combined with other drugs. These main constituents which are present in a very high amount are alkaloids and terpenes. The leaves are the rich source of protein, calcium as well as phosphorus.

8. TOXICOLOGY

In human beings, toxic effects of *Tinospora* is very less known. But sometimes its high dose causes some harmful effects on the body. It might lower blood sugar level, use it carefully if anyone has diabetes, it also increases the symptoms of autoimmune symptoms. It is also advised to avoid the intake of *Tinospora* during pregnancy and breastfeeding time [16].

9. AYURVEDIC PROPERTIES

Ayurveda is one of the most ancient medical sciences of the world. Rasayana is one of the eight clinical specialities of classical Ayurveda [37]. The concept of Rasayana therapy is not a single drug. Treatment but it is a comprehensive and specialized regimen capable of producing healthful longevity and improved mental facilities. Several medicinal plants have been described as Rasayana in Ayurveda [17].

Table 1. Different part used and its benefits

Part	Part used	Benefits
1.	Leaves	Juice or decoction of leaves is taken orally with honey in case of fever.
2.	Whole plant	Anti-pyretic
3.	Roots	The roots are used as antidote to snake bite and scorpion sting after combining with other drugs.
4.	Stem	It is bitter in taste, stimulates bile secretion, stomachic, diuretic, removing burning sensations, vomiting and also cure jaundice.

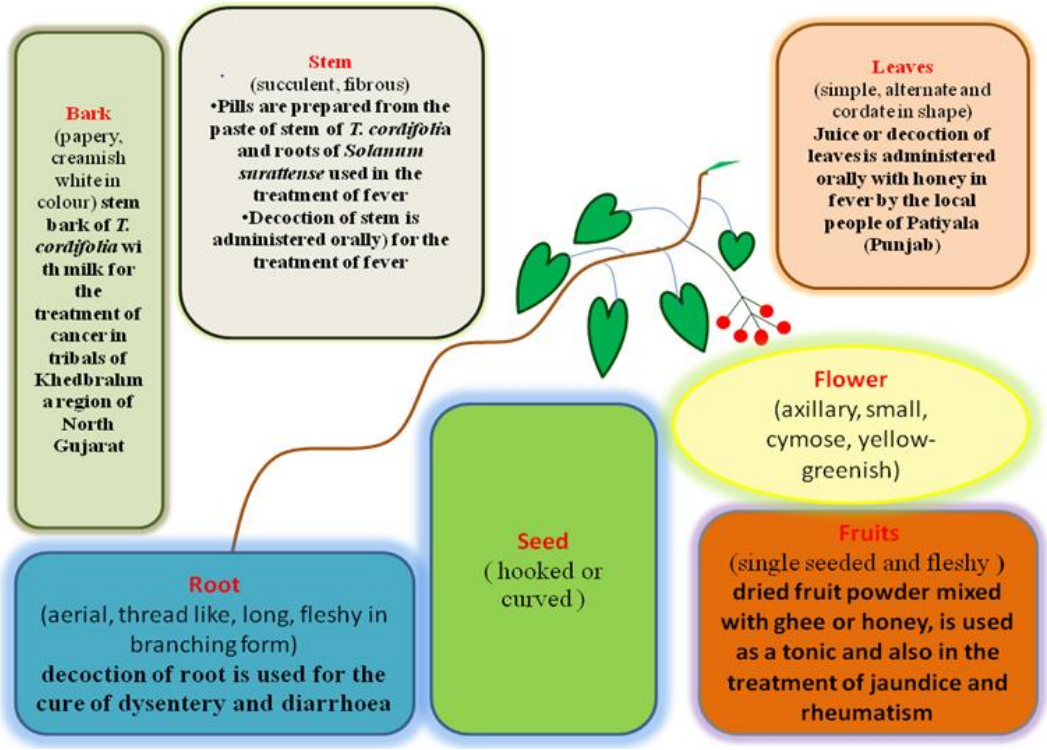

Fig. 1. Schematic representation of different parts of *Tinospora* plant and their folk uses

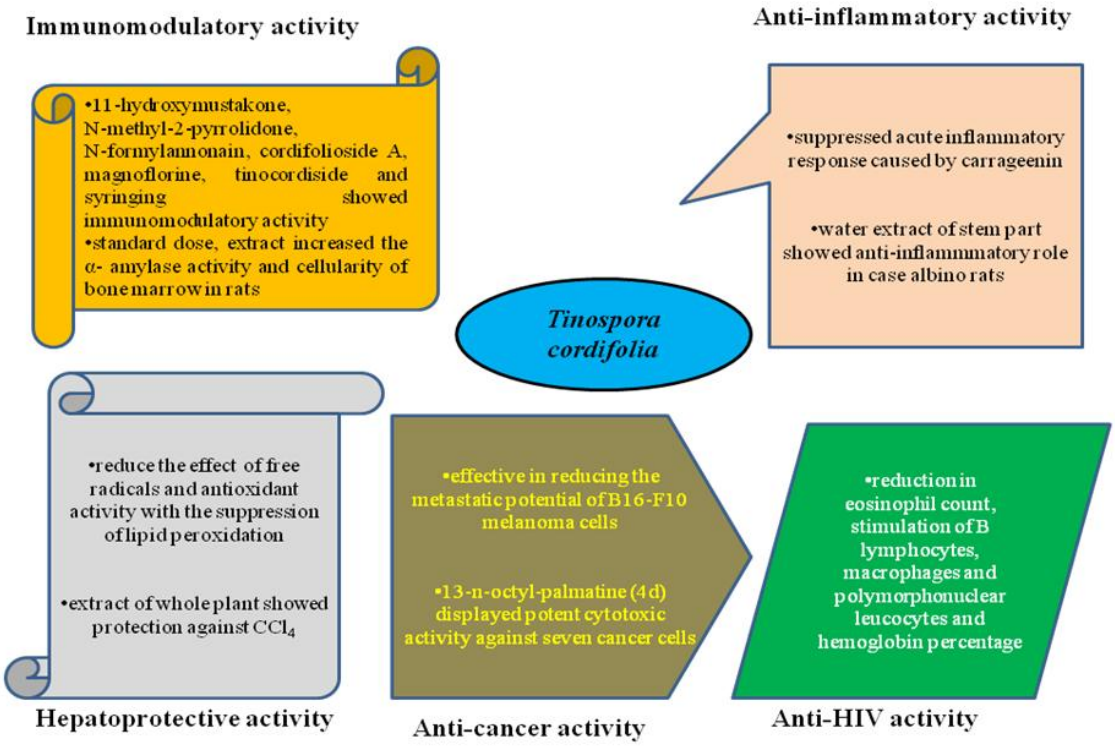

Fig. 2. Pharmacological property of *Tinospora cordifoila*

Table 2. Plant part used, chemical constituents and effect on humans

Sr. No.	Part	Chemical constituents	Uses	References
1.	Used Whole Plant	β-sitosterol, δ-sitosterol, 20-β-Hydroxy ecdysone, Furanolactone, Clerodane derivatives and [(5R,10R)-4R-8Rdihydroxy- 2S-3R:15,16-diepoxycleroda- 13 (16), 14-dieno-17,12S:18,1S-dilactone] and Tinosporon, Tinosporides, and Jateorine, Columbin, Octacosanol, Heptacosanol, Miscellaneous- Nonacosan-15-one3, (α,4-di hydroxy- 3-methoxy-benzyl)-4-(4- hydroxy-3-methoxy-benzyl)-tetrahydrofuran, Tinosporidine, Cordifol, Cordifelone, N-transferuloyl tyramine as diacetate,Giloin, Giloinin, Tinosporic acid.	➢ Anti-stress activity ➢ Antidote to snake bite and scorpion sting, ➢ Analgesic and neuro-pharmacological activities, Diabetes, Rheumatoid arthritis, Gout, cancer, high cholesterol content Anti-asthmatic and chronic cough treatment, ➢ Antipyretic and anti-inflammatory activity, Anaemia, jaundice, normalization of altered liver function, [9] ➢ Cardiac disorder, ➢ Anti-leprotic, [10] ➢ Gastrointestinal and anti-ulcer activity [11] ➢ Anti-fertility activity, Hepatoprotective activity	
2.	Root	3, (a,4-di hydroxy-3-methoxy-benzyl)-4-(4- compounds hydroxy-3-methoxy-benzyl)- tetrahydrofuran, Jatrorrhizine, Tinosporidine, Cordifol, Cordifelone, Giloinin, Giloin, N-transferuloyltyramine asdiacetate, Tinosporic acid. Berberine, Choline, Tembetarine, Magnoflorine, Tinosporin, Palmetine, Isocolumbin, Aporphine alkaloids, Jatrorrhizine, Tetrahydropalmatine, sitosterol	➢ Anti-neoplasmic [12] ➢ Anti-oxidant ➢ Anti-stress	
3.	Stem	Tinocordifolin18-norclerodane, glucoside, Furanoid diterpene, glucoside, Tinocordiside, Tinocordifolioside, Cordioside, Cordifolioside, Syringin, Syringinapiosylglycoside, Pregnane glycoside, Palmatosides, Cordifolioside A, B, C, D and E, Glycosides Sesquiterpenoid Berberine, Choline, Tembetarine, Magnoflorine, Tinosporin, Palmetine, Isocolumbin, Aporphine, alkaloids, Jatrorrhizine, Tetrahydropalmatine,	➢ Respiratory tract infections ➢ Skin diseases ➢ Antidote to snake and scorpion sting ➢ Anti-hyperglycemic ➢ Enhance immune response ➢ Anti-carcinogenic ➢ Anti-inflammatory	[13]
4.	Shoot	β–sitosterol, δ-sitosterol,20 β-hydroxyecdysone, Ecdysterone, Makisterone A, Giloinsterol Steroids β–sitosterol, δ-sitosterol, 20 β-hydroxyecdysone, Ecdysterone, Makisterone A, Giloinsterol	➢ Anti-carcinogenic ➢ Anti-pyretic	Singh et al. 2003
5.	Bark	Tinosporofuranol, tinosporafurandiol, tinosporaclerodanol and tinosporaclerodanoid, β- sitosterol	➢ Anti-inflammatory ➢ Antioxidant	[15]

Table 3. Various chemical constituents, partly used, active components and biological roles of *Tinospora cordifolia* in humans

Sr. no.	Active component	Compound names	Effects in humans	Part used	References
1.	Alkaloids	➢ Berberine ➢ Choline ➢ Palmatine ➢ Tembetarine ➢ Magnoflorine ➢ Tetrahydroplamatine ➢ Tinosporin ➢ Isocolumbin ➢ Jatrorhhizine ➢ Aporphine alkaloids	Anti-cancer, antiviral infections, Inflammation, and immune-modulatory roles Neurological, Psychiatric Conditions Anti-diabetes	Stem, root	[10] [18] [19] [20]
2.	Glycosides	➢ 18-norclerodane glucoside ➢ Furanoid diterpene glucoside ➢ Tinocordiside ➢ Tinocordifolioside ➢ Cordioside ➢ Palmatosides	Treats neurological disorders like ALS, Parkinsons', dementia, motor and cognitive deficits, and neuronloss in spine and hypothalamus. Immunomodulation: IgG increase and macrophage activation. Inhibits NF-κB and act as nitric oxide scavengers to show anti-cancer activities	Stem	[21] [22]
3.	Steroids	➢ β-sitosterol ➢ hydroxy ecdysone ➢ Ecdysterone ➢ Giloinsterol	IgA neuropathy, glucocorticoid induced osteoporosis in early inflammatory arthritis, induce cell cycle arrest in G2/M phase and apoptosis through c-Myc suppression. Inhibits TNF-α, IL-1 β, IL-6 and COX-2. Activates NF-κB	Stems, aerial parts	[23] [24]
4.	Aliphatic compounds	➢ Octacosanol ➢ Heptacosanol ➢ Nonacosan-15-one dichloromethane	Anti-nociceptive and anti-inflammatory. Protection against 6-hydroxydopamine induced parkinsonism in rats. Down-regulate VEGF and inhibits TNF-α from binding to the DNA	Whole plant	[25] [26]

Sr. no.	Active component	Compound names	Effects in humans	Part used	References
5.	Diterpenoid lactones	➢ Furanolactone ➢ Clerodane derivatives ➢ [(5R,10R)-4R-8R-dihydroxy-2S-3R: ➢ 15,16-diepoxy-cleroda-13 (16), ➢ 14-dieno-17,12S: 18,1S-dilactone] ➢ Tinosporides	Vasorelaxant: relaxes Norepinephrine induced contractions. Inhibits Ca^{++}influx. Anti-inflammatory, anti-microbial, anti-hypertensive, anti-viral. Induce apoptosis in leukemia by activating caspase-3 and bax, inhibits bcl-2	Whole plant	[27] [28]
6.	Others	➢ 3, (a,4-di hydroxy-3-methoxy-benzyl)-4- ➢ (4-hydroxy-3-methoxy-benzyl)-tetrahydrofuran ➢ Jatrorrhizine ➢ N-trans-feruloyl tyramine ➢ Giloin ➢ Tinosporic acid	Protease inhibitors for HIV and drug resistant HIV. Tyramine is a neuro-modulator. Used to treat anxiety and depression by inactivating neurotransmitters	Root	[29] [30]

Abbreviations: NF-κB-Nuclear factor-kappa-B, VEGF-Vascular endothelial cell growth factor, TNF-Tumor necrosis factor, IL-Interleukin, COX-Cyclooxygenase, ALS-Amyotrophic, Lateral Sclerosis, IgG-Immunoglobulin G, IgA-Immunoglobulin A

Guduchi is considered one of the best Rasayans and it is unusual potent versatility. Guduchi is known to be a rich source of trace elements (Zinc & Copper) which act as antioxidants & protects cells from the damaging effects of oxygen radicals generated during immune activation. Rasayan effect of Guduchi can be used to heal & prevent infections. Rasayana used as a universal vaccine for any diseases. Rasayana chikitsa is mainly used to maintain the health of individuals although it can be used for diseased also.

Rasa- Tikta, Katu.

Guna**-** Laghu, Snigha.

Veerya**-** Ushna.

Vipaka- Madhura

Doshaghnata- Tridoshashashamaka

Rogaghnata- Kushtha, vatarakta, Netraroga

Karma- Kusthaghna, deepana, Sangrahi, Balya

Prabhava- Tridoshanara, Vishaghna, cure

Rasa- Taste appreciation of the substances by chemical receptors on the tongue, sweet, sour, salt, bitter, pungent and astringent.

Guna- Ten pairs of opposite or mirror image attributes, attribute or property of any substance.

Veerya- Potency, Ushna-hot, Sheeta-cold, Vipakaintestinal digestion and tissue metabolism, Madhuraneutral, Amla-acidic, Katu-alkaline, Prabhava-specification through specialized receptors.

10. MEDICINAL PROPERTIES

1. **Immunomodulatory activity:** The alcoholic extract of *T. cordifolia* showed significant immunomodulatory effects. At standard dose, extract increased the α-amylase activity and cellularity of bone marrow in rats. It had been observed by some researchers that some active compounds viz; 11-hydroxymustakone, N-methyl-2-pyrrolidone, N-formylannonain, cordifolioside A, magnoflorine, tinocordiside and syringing showed immunomodulatory activity [31]
2. **Anti-inflammatory activity:** The water extract of stem part showed anti-inflammatory role in albino rats. It has significantly suppressed acute inflammatory response caused by carrageenin extract when applied orally [15].
3. **Hepato-suppression:** The extract of the whole plant showed protection against CCl_4 because it causes hepato-cellular changes after forming proteins or by forming bioaction of CCl_4 and accelerated toxification. It also showed potential to reduce the effect of free radicals and antioxidant activity with the suppression of lipid peroxidation, therefore this plant considered as hepatoprotective agent [32].
4. **Anti-HIV activity:** TCE reduced the recurrent resistance of HIV virus and enhancing the therapeutic outcome [33]. Anti-HIV effects of TCE was revealed a reduction in eosinophil count, stimulation of B lymphocytes, macrophages and polymerphonuclear leucocytes and haemoglobin percentage thus, revealing its promising role of application in the management of the disease [34].
5. **Anti-cancer activity:** The anti-cancer effects of *T. cordifolia* are mostly studied in animal models. TCE has been shown to have a radioprotective role by significantly increase in body weight, tissue weight, testes-body weight ratio and tubular diameter and inhibit the harmful effects of sub-lethal gamma radiation on testes in male Swiss albino mice [35,36,37,38,39]. In pre-irradiating mice, TCE significantly affected radiation-induced rise in lipid peroxidation and resulted in the decline of GSH concentration in testes. Pre-treatment of HeLa cells by TCE has been shown to decrease the cell viability, increase LDH and decrease in GSH S-transferase activity [40].

11. CONCLUSION

The present study explores the detailed information of *T. cordifolia* and its therapeutic efficiency about the medicinal uses explained in medicinal systems. The phytochemical, pharmaceutical and biological investigation of *T.*

cordifolia reports the versatility and explains its diverse role. It is concluded that this miracle herb had been used traditionally among the various communities across the tribal region of worldwide for ailment of urinary, gastrointestinal, skin, pulmonary, hepatics, gynaecological, inflame-matory and infectious diseases. In addition to this, the species is also well known to treat allergy, tumour and cancer by the traditional and local medicinal practitioners. Almost all parts of the plant are used for curing different but the most frequent part used is rhizome followed by root. In recent times, the old traditional practices are at gradually decline very rapidly and under risk due to rapid modernization hence there is an urgent need for documentation of such tribal species and help to find innovative ways for untap its efficiency used for human welfare in future.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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