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Review Article

# *Saccopetalum tomentosum*: Review of Its Botany, Medicinal Uses, Pharmacological Activities and Phytochemistry

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Abstract

Green medicine, or pharmaceuticals made from plants, has gained widespread interest since they are thought to be more trustworthy and safe than expensive synthetic drugs with side effects. Miliusa species include Saccopetalum tomentosum (*S. tomentosum*). Plants of *S. tomentosum* are abundant in tropical and subtropical areas, particularly in mainland Asia. In examining phytochemical and pharmacological features, more than ten Miliusa species were highlighted. *S. tomentosum* from Vietnam, Taiwan, and China was one of the main targets for phytochemical research. The isolation of numerous secondary metabolites has been successful. Alkaloids, flavonoids, terpenoids, styryls, and lactones are just a few of the chemical components obtained from *S. tomentosum*, but serial new derivatives of geranylated homogentisic acid may serve as biomarkers for differentiating Miliusa species. Simple, alternating, ovate, pubescent to glabrous, membranous leaves. Flowers solitary, fascicled or in cymes, extra-axillary or axillary, with oval or obovate bracts, monoecious, dioecious, or occasionally polygamous. Three sepals, valvate, Petals are arranged in two series, six in total, and are valvate in the buds. The outer petals resemble sepals in size and shape, while the inner petals are larger and thinner. Anthers are globose and extrorse, the connectives are slightly apiculate, and the stamens can be definite or indeterminate. Ovules 1–10, stigma club-shaped, style often short, and carpels indefinitely linear-oblong in shape. Numerous, stalked or subsessile, ovoid or rectangular, ripe carpels 1-2 or more seeds.

**Keywords:** *S. tomentosum*, Phytochemistry, Pharmacological activity, Ayurveda, Medicinal uses

## Introduction

According to estimates from the World Health Organisation (WHO), 80% of people in underdeveloped nations rely on traditional medicines, primarily plant-based pharmaceuticals, for their basic medical needs[1]. Plants continue to play a significant role in healthcare despite the significant advancements in modern medicine that have been seen in recent years. The majority of people in India rely on conventional medical practises for their physical and mental health needs. The conservation of medicinal plants and the question of whether their traditional applications are actually supported by pharmacological effects or are solely based on folklore have become the focus of significant research[2-4]. Herbal plants and the products they produce have been widely used for medical purposes by people all over the world. As is evident, due to their diverse traditional usage and potent pharmacological properties, aromatic medicinal herbs have undergone substantial research as a significant source of commercial pharmaceuticals[1]. Due to their tremendous structural variety and the fact that they are not accessible through synthetic pathways, natural products are also acknowledged to be among the richest sources for new medications and/or drug leaders[2]. About 40 species of the Annonaceae genus Miliusa thrive in the tropical rainforests of India, Thailand, South China, and North Australia[5]. The various Miliusa species are always small to large trees that can be found in a variety of rainforest communities. *S. tomentosum* are unique to Australia and contain two essential oils[6]. Folk medicine employs *S. tomentosum* to treat a variety of symptoms, including gastropathy and glomerulonephropathy[7]. Deciduous trees with a height of up to 10 metres, 20-25 mm thick, dark grey, fibrous bark, and thick branchlets. simple, alternating, palmately 3-5 lobed leaves with estipulate veins; Lamina 5-15 x 7-20 cm, base cordate, lobes, elliptic or elliptic-lanceolate, tips acute or acuminate, margin entire or crenate, serrate, glabrous above, densely white tomentose below, coriaceous; 5-7 nerved from the base, palmate; lateral nerves 7-10 in each lobe, parallel, prominent; intercostae scalariform, faint. Bisexual panicles with 7.5–10 cm-wide, bright yellow flowers are tomentose in colour. petals 5, 5 x 3 cm, obovate, deeply emarginate, contorted; stamens many, inserted on an eglandular disc, slightly connate at base into 8–10 clusters; sepals 5, 2.5 x 1.5 cm, unequal, obovate, densely tomentose; filaments Anthers are linear and open at the apex. The ovary is superior, globose, glabrate, and has many ovules. Styles are one to one and a half centimetres long and filiform. The stigma is somewhat lobed. Fruit is a capsule that is 6-8 x 4.5–5.5 cm, has five valves, and is oblong, pear-shaped, straight, leathery, and brown. The seeds are numerous, 6 mm long, black, curved, and buried in white cotton[3,4]. *S. tomentosum* oil has been discovered to have both antibacterial and analgesic effects in Chinese traditional medicine[8]. The ability to synthesize complicated chemical molecules will benefit from knowledge of the chemical components of plants [9]. Along with thirteen other alkaloids that are known, two new isoquinoline

alkaloids-2,10- dimethoxy3,11-dihydroxy-5,6-dihydroprotoberine and 1,9-dihydroxy-2,11-dimethoxy-4,5-dihydro-7- oxoaporphine were discovered[1]. Uvaria tomentosa Roxb and *S. tomentosum* Hk. F. &Th. are synonyms.

**Table 1: Scientific classification of *Saccopetalum tomentosum*[10]**

| | |
|---|---|
| Kingdom | *Plantae* |
| Subkingdom | *Tracheobionata* |
| Subdivision | *Spermatophyta* |
| Division | *Magnoliphyta* |
| Class | *Magnoliopsida* |
| Subclass | *Magnoliidae* |
| Order | *Magnoliales* |
| Family | *Annonaceae* |
| Genus | *Saccopetalum* |
| Species | *Saccopetalum tomentosum* |

**Common (Indian) Names are** Gujarati: umbh, Hindi: hoom, kari, Kannada: karihessare, wumb, Konkani: hum, Malayalam: kanakkaita, Marathi: humb, thoska, Telugu: barre duduga, buddaduduga, gadida lotta, peddachilukaduduga[10].

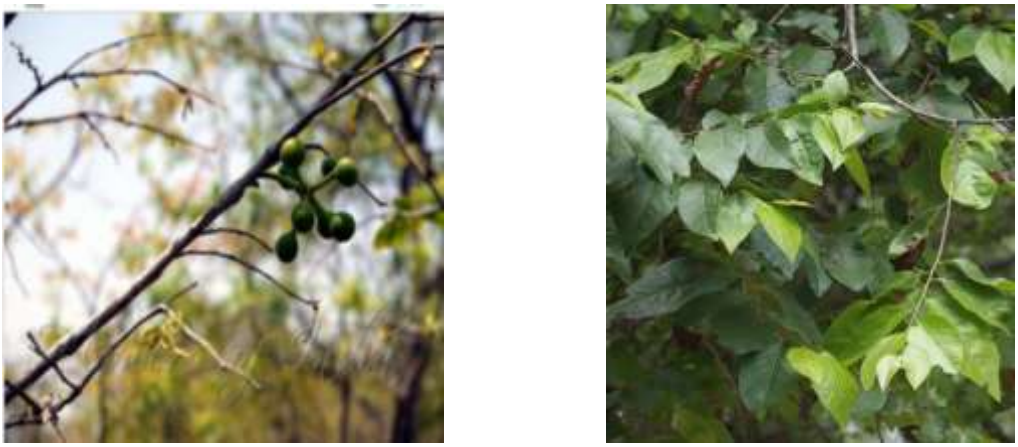

**Figure 1: *Saccopetalum tomentosum* (Roxb.)** [11]

## Research methodology

A review of the scientific literature from various sources, such as Google Scholar, Web of Science, SciFinder, Scopus, Science Direct, PubMed, Scielo, Springerlink, Google Patents, Espacenet, BioMed Central (BMC), and Medline, was put together to identify pertinent information on the botany, medical applications, phytochemistry, and biological activities of *S. tomentosum* . The terms biological activities, medicinal uses, ethnobotany, ethnopharmacology, medicinal, pharmacology, phytochemistry, and therapeutic value, as well as *S. tomentosum* Hook. ex. Stocks, were used as search terms to identify pertinent information. Books, book chapters, theses, websites, and conference proceedings were used to find more literature.

## Occurrence and distribution

*S. tomentosum* is found in Bangladesh, Nepal, Sri Lanka, India, and Sri Lanka. States like Rajasthan, Bihar, Orissa, Maharashtra, Andhra Pradesh, Karnataka, and Tamil Nadu in India are home to it. Typically found in the Eastern and Western Ghats. Further in the tropical dry forests category moist deciduous forests, from deciduous to tropical. It can be found in the 200-400 m range of altitude. Western Ghats contain a more thorough spread. Kanara: The Belgaum district's Kurli, Talkat Ghat, and Padshapur. Forests with deciduous trees in Madhya Pradesh's Balaghat, Bilaspur, Hoshangabad, Indore, Jabalpur, Mandla, Raigarh, Rewa, Seoni, and Shahdol. Common in Maharashtra's humid deciduous woodlands. Common in forests, especially in Rajasthan's eastern regions. In Gujarat, it is sometimes found in dry deciduous forests and is frequently found in the south's moist deciduous forests. Andhra Pradesh, Bihar, Karnataka, Maharashtra, Odisha, Rajasthan, Tamil Nadu, and West Bengal local distribution. Asia's overall distribution: India, Nepal, and Sri Lanka[12]. Lambasingi (Vishakapatnam district), Maredumilli Hills (East Godavari district), Nallamalai Hills (Kurnool district), and Tirumala Hills (Chittoor district) are all located in the state of Andhra Pradesh. In Karnataka, the following districts are included: Belagavi, Uttara Kannada, Dakshina Kannada, Chamarajanagar, Chikkamagaluru, Kodagu (Coorg), Mysuru, and Tumakuru. The following districts are located in Kerala: Kasaragod, Wayanad, Malappuram, Palakkad, Thrissur, Idukki, and Kollam. Sambalpur, Angul, and Puri districts are in Odisha. Tamil Nadu: Villipuram district, Cuddalore district, Salem district, Tirunelveli district, Kanchipuram (Changalpattu-CGP) district, and Dharmapuri district.

## Morphology

Large, 15-20 m tall trees with brownish-black, longitudinally grooved bark that is 15 to 25 mm thick; the blaze is yellowish; and the young parts are *S. tomentosum*. Lamina 8-17 x 2-10 cm, ovate or oblong-ovate; base cuneate to round or subacute; apex acute; margin entire chartaceous; tomentose above when young; glabrous with age except midrib; S. tomentosum beneath; lateral nerves 8-10 pairs, pinnate, slender, prominent beneath, intercostae reticulate; intramarginal nerves present. Sepals 3, 5 x 1.5 mm, linear-lanceolate; petals 6 (3+3); outer petals sepalloid, linear-lanceolate, 4-7 mm long; S. tomentosum on both sides; inner petals ovate-oblong, saccate at base, obtuse; 1.5-2 x 0.5 cm; outer petal shorter than inner; flowers bisexual, greenish-yellow, solitary or in groups; leaf opposed or subtermin many stamens with apiculate connectives that do not cover the anthers; Brown S. tomentosum carpels are many, stalked, roughly oval, and contain 4-6 ovules in two rows with no style and a capitate stigma. Fruitlet size is 2.5 cm wide, tapering to the base, succulent, purple, stalk is thick and 1-1.5 cm long, and there are 4–5 seeds per fruitlet[13].

## Macroscopic and microscopic features

### Macroscopic

A tall tree with deep, longitudinally fissured, dark, blackish-brown bark. Deciduous woodlands, both wet and dry.

Leaves: Alternate, ovate-oblong, glabrous, petiolate leaves that are lustrous while young but become glabrous and harsh as they age.

Flowers: Greenish flowers, solitary or in pairs, are present opposite the leaf on thin pedicels. linear-lanceolate sepals. Petals: 6, outer sepaloid, inner oblong-obovate, in two whorls of three each.

Fruits: Subglobose, tomentose, stipitate, dark purple[14].

### Microscopic

Vascular bundles are present in the transverse sections of *S. tomentosum* roots. Periderm is visible in root sections of *S. tomentosum*, a perennial plant. In *S. tomentosum*, the cortex outside of the vascular bundles and around the vascular bundles both contains many masses of sclerenchyma[15]. Tetrarch vascular bundles make up each species. The *S. tomentosum* root has bigger xylem channels. The epidermal layer of *S. tomentosum* consists of a single layer of hexagonal parenchymatous cells with a thin cuticle layer. In the ridges, collenchyma cells (hypodermis), which are located just beneath the epidermis, have numerous layers of cells, whereas in the furrows, they only have a few layers[16].

## Phytochemical constituents

Alkaloids, geranylated homogentisic acids, favonoids, lignans, neolignans, terpenoids, acetogenins, styryls, lactones, phenolics, amides, alcohols, and derivatives of furfural were among the more than 200 compounds that were extracted. Miliusa plants have been known to produce novel miliusanes and bicyclic lactones. These plants' essential oils were also discovered, containing a significant proportion of caryophyllene. Ascorbic acid, Quercetin, Cynarine, 1,2,3,4,6-Pentagalloyl glucose, Syringaldehyde, Thymol, Ellagic acid, Isorhamnetin, and Benzoic acid are some of the compounds that make up myricetin. Quercetin, isorhamnetin, myricetin, and thymol are active compounds[17].

### Alkaloids

Alkaloidal chemicals were once well-known among substances found in natural products. It has been discovered that the amount of alkaloids strongly depends on the usual plant parts and environmental factors. For instance, Aniszewski (2007) claimed that higher plants contained a significant amount of alkaloids, up to 10–25%[1] . A rich source of alkaloids is also provided by *S. tomentosum*. The primary skeletons of *S. tomentosum* alkaloids include aporphine and oxo-aporphine backbones in the compounds asimilobine and 10-hydroxyliriodenine, respectively; tetrahydroisoquinoline and quinolone in the compounds coclaurine and N-methylcorydaldine; and azafluorenone in kinabaline. The fact that the leaf of the *S. tomentosum* species is probably a rich source of oxo-protoberberine alkaloids lends extra value to phytochemical studies using plants.

### Geranylated homogentisic acid derivatives

Both terrestrial plants and bacterial pathogenic strains frequently include homogentisic acid-type phenolic acids[14]. Homogentisic acids demonstrated considerable antioxidant and anti-inflammatory properties, however an excessive buildup of them in the body can result in the "alkapton" sensation.

### Flavonoids

Now that we have mentioned one class of *S. tomentosum* metabolites, it is important to note another. Studies on *S. tomentosum* 's phytochemistry demonstrated the presence of flavonoids as well. Nine different plants, including M. balansae, M. cuneata, M. fragrans, M. mollis, M. sinensis, M. smithiae, M. thorelii, M. umpangensis, and M. velutina, had flavonoids found in their leaves, twigs, branches, stems, or roots. The most significant finding from structural characteristics is that mono-flavonoid derivatives of isolated flavonoids from Miliusa species were produced. The carbon C-3 of the majority of isolated flavonols underwent the occurrence of methoxylation. Flavonols and flavanones are typically linked to hydroxyl and methoxyl groups at the carbons C-5, C-6, C-7, C-8, C-3', and C-4'[17].

### Lignans and neolignans

The following phytochemical profiles for the other class of isolated chemicals are regularly provided. Four lignans and twenty-four neolignans have also been isolated, with the primary goal being to discover biologically active compounds from the genus Miliusa. Additionally, the *S. tomentosum* plant produced these phytochemicals in three different parts: the leaf, stem, and twig. Chemical components of *S. tomentosum* leaves included geranylated homogentisic acids, oxo-protoberberine alkaloids, and flavonols in addition to the well-known lignan (+)-syringaresinol[7].

### Acetogenins and lactones

The group of isolated acetogenins was one source of some of the positive phytochemical outcome. As is well known, the family Annonaceae is currently renowned for its acetogenins and their analogues[17]. Except for goniothalamusin, isolated acetogenins were found in the bark, stem bark, flowers, and leaves of M. velutina species. They were novel substances. The ability of these isolated compounds to generate up to one or two triple bonds in a lengthy aliphatic side chain ending by a -hydroxy (or -methoxyl)-lactone unit, methyl group, or double bond is their most notable characteristic.

### Styryls

Most secondary metabolites of interest to chemists indicated that *S. tomentosum* included styryl derivatives. The polar extract of the leaf and branch of the shrub tree S. tomentosum , which is widely distributed in Vietnam and China, was subjected to chromatographic analysis, and two new mono-styryls-3,4-dimethoxy-6-styryl-pyran-2-one and (2E,5E)-2-

methoxy-4-oxo-6-phenyl-hexa-2,5-dienoic acid methyl ester—were produced. When it comes to isolated compounds of the bis-styryls type, the cyclobutyl nucleus serves as a general indicator of the chemical structure, and the side chains are made up of phenyl rings, -pyrone rings, and,-unsaturated ketones[15].

### Terpenoids and phenols

The main focus of phytochemical studies on plants belonging to the Miliusa genus appears to be *S. tomentosum*. Norsesquiterpenoids of type megastigmanes, mono-phenols, and their glycosides have been identified as characteristics of the genus Miliusa, particularly *S. tomentosum* species, after the use of several chromatographic techniques. Here, disaccharide units of type D-apiofuranosyl-(1-6)-O-D-glucopyranosyl, and monosaccharide units of type D-glucopyranosyl components are used.O-glucopyranosyl, D-glucopyranosyl, and xylopyranosyl-(1–6)O-glucopyranoside, L-rhamnosyl, and (1,6)While aglycones of terpenoids and phenols are mostly structurally produced by phenylethanoid nucleus, --D-glucopyranosyl moieties are glycone components related to these compounds[17].

### Amine, amide, alcohol derivatives and miscellaneous types

According to a phytochemical study done by Yu and colleagues in 2009, *S. tomentosum* leaf from China was also made up of one amine, adenine riboside. These chemicals were initially isolated as single compounds from the genus Miliusa, despite the fact that they are presently present in wild plants. Three tyramine derivatives, including N-trans-caffeoyltyramine, were chromatographically isolated using silica gel (63–200 m) and sephadex LH–20 columns[16].

### Essential oils

Studies on *S. tomentosum* plants' essential oils are scarce. So far, there have only been three reports. The primary ingredient Z-citral attained the maximum proportion of 41.2% among the 46 members of the Vietnamese M. baillonii species from fresh leaves in Quang Binh[18]. The M. sinensis species, which was found in Nghe An, Vietnam, is probably a significant source of essential oils. Sesquiterpene hydrocarbons made for 67.1% of the 95.1% of essential oils from this plant[18]. Significantly, the primary constituents of the oils of these two could be identified as -humulene and -caryophyllene.

### Cultivation

The blooms of *S. tomentosum* are fully developed, bisexual, and functionally male (androecium) and female (gynoecium), including stamens, carpels, and ovaries. Entomophilous, or carried out by insects, pollination occurs when a plant has male (staminate) flowers on one plant and female (pistillate) blossoms on another. Polygamous, or having some male flowers on female plants and some female flowers on male plants, pollination occurs when a plant has both male and female flowers. Miliusa species have fully developed functional male (androecium) and female (gynoecium) flowers, which include stamens, carpels, and ovary. Entomophilous, or dependent on insects, pollination occurs when plants have male (staminate) flowers on one plant and female (pistillate) blooms on another plant, or when the plants are polygamous, or dependent on both male and female flowers, respectively. March-May/May-July-flowering and fruiting[18].

## Medicinal uses

Chinese traditional medicine uses *S. tomentosum* oil, which has been discovered to have both antibacterial and analgesic qualities. The *S. tomentosum* tree produces karee gum, a pale yellow gum that has been used traditionally and commercially. Some portions of India consume the fruit of the *S. tomentosum* tree. The wood is used to make beds and rafters, and the fruits are edible. Children are given fruits to increase their stamina, and they can also be used to treat respiratory conditions. It has been noted that this tree serves as the host plant for the larvae of different butterfly species. The butterflies are an essential part of the pollination process because they transport pollen from one flower to another. The secondary metabolites of plants known as phenolic compounds are some of the most prevalent molecules and are known to have antioxidant properties[16]. Congestive heart failure and cardiac arrhythmia are diseases that are treated with cardiac glycosides. These substances function by obstructing the Na+/K+ pump[17]. Triterpene saponins and steroid saponins are the two main families of saponins. Saponins are large molecular weight molecules in which a sugar molecule is linked with a triterpene or steroid aglycon. These have therapeutic value since they demonstrate cardiac glycosides' hypolipidemic and anticancer action [18] . Flavonoids serve as antioxidants and improve the effects of vitamin C. Biological activity against liver toxins, tumours, viruses, and other microorganisms is also known for them[19]. The solvent and plant material utilised affect the yield of extracts[20].

## Reported pharmacological activities

Anti-carcinogenic; issues with women's urinals; the gum that is collected from bark is used as a cough suppressant, sedative, and a cooling agent. It is applied to the management of gonorrhoea and coughs. Flowers and leaves that have dried are stimulants[11]. Chinese traditional medicine uses *S. tomentosum* oil, which has been discovered to have both antibacterial and analgesic qualities. *S. tomentosum* has not been widely used for traditional or commercial purposes, however some portions of India consume its fruits, and the tree produces karee gum, a pale yellow gum[12]. The wood is used to make beds and rafters, and the fruits are edible. Children are given fruits to increase their stamina, and they can also be used to treat respiratory conditions. It has been noted that this tree serves as the host plant for the larvae of different butterfly species. The butterflies are an essential pollinator because they transfer pollen from one flower to another[15].

### Cytotoxic activity

To the experimentally cytotoxic targets, the *S. tomentosum* plants included sets of variously beneficial isolated components. The cytotoxicity of M. velutina species constituents was previously reported by Jumana and colleagues in 2000. According to the LC90 results of the tested compounds, acetogenin A may have the lowest LC90 value (7.1 g/mL), followed by acetogenin B (14.1 g/mL), vincristine (15.0 g/mL), and goniothalamusin (20.0 g/mL) [5]. When compared to those of the reference chemical doxorubicin (IC50 0.46-1.05 M), nine new acetogenins cananginones A were found to have weak IC50 values of 16.6-129.7 M or to be inert in the cytotoxic experiment against three cancer cell lines KB, MCF7, and NCI-H187[16].

### Anticancer activity

Up till now, cytotoxicity has been linked to anticancer research. Three geranylated homogentisic acid derivatives, (+)-miliusate, (+)-miliusane I, and (+)-miliusol, displayed potential anticancer activity against the NCI-60 panel of human cancer cell lines, but were more active with the HCT116 cell line[13]. Their GI50 values ranged from 0.03 to 4.79 M. A thorough analysis strongly advised the creation of anticancer medications using (+)-miliusol, the primary component of Miliusa plants. The average size of the excised HCT116 xenograft mouse tumour decreased by up to 72.7% after 21 days of in vivo anticancer treatment with this

chemical (20.0 mg/kg), and the mechanism may be related to p21-dependent activation of cellular senescence rather than apoptosis[13].

**Antimalarial activity**

In contrast to the phenomenon of dioxane-cyclization between two hydroxyl groups at C-3′ and C-4′, it should be noted that among the four flavones, methylation at 5-OH and methoxylation at carbon C-6 can be responsible for promoting antimalaria, whereas hydroxylation and methoxylation at meta-position of caffeoyl unit induced the potential differences among the three amides[14].

**Antifungal and antimycobacterial activities**

The MeCOEt extract of *S. tomentosum* root shown inhibited rad 52. top 1 (IC12 2000 g/mL) in the search for natural products against DNA repair mutant in the yeast strain Saccharomyces cerevisiae, but failed to do so with rad 52 and rad+ (IC12 > 8000 g/mL) [4]. Meanwhile, the effectiveness of the novel alkaloid 10-hydroxyliriodenine (7) (IC12 72 g/mL) and the positive control camptothecin (IC12 >20 g/mL) in reducing rad 52 was superior to that of 10-methoxyliriodenine (14) (IC12 113 g/mL) [21].

**Anti-Inflammatory activity**

The complicated biological reaction of the body tissues to potentially damaging stimuli, such as radiation, physical injury, metabolic excess, or infection, can be considered as including inflammation[20]. Inflammation is now tightly linked to modern diseases, such as cardiovascular and neurological problems. It is acknowledged that reducing NO generation is an effective solution for this issue[22].

**Antiherpetic activity**

Methanol extracts from the stem and leaf of *S. tomentosum* demonstrated IC50 values of 60-80 g/mL against HSV-1 and HSV-2 at a dose of 100 g/mL[23].

**Antioxidant activity**

Although *S. tomentosum* species have not yet undergone comprehensive phytochemical examination, its ethanol leaf extract was found to be on par with or superior to positive controls in antioxidant assays. For instance, the *S. tomentosum* ethanol leaf extract's IC50 value of 465 g/mL in the DPPH assay was comparable to the values of the reference compounds BHT (570 g/mL) and BHA (615 g/mL); in the ferric reducing antioxidant test, the IC50 values for these three substances were 600 g/mL, 835 g/mL, and 870 g/mL, respectively[24].

**Enzyme acetylcholine inhibitory activity**

To date, only one study has examined the potential of Miliusa secondary metabolites in acetylcholinesterase inhibitory activity using chemical components from *S. tomentosum* species. The findings indicated that alkaloids, rather than flavonoids, were more promising agents (the inhibitory power of new oxo-protoberberines and known one achieved the significant range of 27.93%-50.17%).

**Cardiac activity**

A flavonol called Chrysosplenol C (77), which was isolated from *S. tomentosum*, was found to be crucial in inducing a favourable inotropic action on rat ventricular myocytes[12]. Comparing these results to those of the positive control omecamtiv mecarbil [59.3 2.60% at 400 nM and 80.4 2.89% at 10 nM, respectively], this compound increased the contractive percentage of ventricular cell and the active percentage of cardiac myosin ATPase up to 53.0 4.07% at 50 M and 28.1 1.20% at 10 M, respectively[12].

## Conclusion

*S. tomentosum* is a less popular tree species, and there aren't as many reviews of its commercial use, plantation methods, or methods for regeneration or propagation. As a promising and little-known species, this species should be given significance for commercial exploitation. Various pharmacological kinds have been applied to naturally occurring isolated chemicals and plant extracts of this species, although cytotoxic assay appeared to be the main focus of earlier studies. Additionally, it was discovered that functional groups have a crucial impact in the biological activation or inactivation of examined substances. Caryophyllene (10%–20%) was regarded as the main constituent of the extracted essential oils. Last but not least, ideas for plant growth, scientific evaluations, and extensive phytochemical discoveries on this important source should be open to potential therapeutic leads and future pharmaceuticals. The extracts from the leaves and stems suggest that they have the potential to be a source of bioactive compounds that could serve as the basis for new medications. To confirm their antibacterial, antihyperglycemic, anti-inflammatory, and anthelminthic effects, additional research is therefore necessary.

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