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SHORT REVIEW

Exploring the Therapeutic Landscape of *Sorbaria tomentosa*: A Phytochemical and Pharmacological Perspective

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Abstract

Sorbaria tomentosa, commonly known as the Himalayan *Sorbaria*, is a deciduous wild perennial shrub belonging to the Rosaceae family. It has long been used in herbal treatments in many regions of Asia for its potential therapeutic benefits. From a phytochemical and pharmacological viewpoint, *S. tomentosa*'s biological constituents may have a wide range of properties, such as anti-inflammatory, antioxidant, antibacterial, antidiabetic, and anticancer benefits, according to preclinical research. The plant's phytochemicals exhibit a strong effect in cellular processes, including the control of oxidative stress pathways and the suppression of pro-inflammatory cytokines. Despite having these promising findings, very limited clinical data and detailed mechanistic insights have been found till now. This review aims to investigate *S. tomentosa*'s potential for medicinal use. Among the many bioactive substances of the plant, Flavonoids, tannins, terpenoids, and phenolic acids are thought to be responsible for its wide range of pharmacological effects. This will become a very important raw material for the food and pharmaceutical industries in the coming years. Its active substances, which are extracted from its stem and leaves, have significant potential as pharmacological agents for pharmacological use.

Major Finding: *Sorbaria tomentosa* is rich in bioactive compounds like polyphenols, flavonoids, alkaloids, and tannins. These compounds hold potential for use in the food and pharmaceutical industries.

Keywords: Food and Pharmaceutical Industries, Pharmaceutical Application, Pharmacognostical, Phytochemical, *Sorbaria tomentosa*

1. Introduction

Plants have been used as phytomedicines since antiquity. They contain primary and secondary bioactive substances. In the fields of chemistry and taxonomy, secondary metabolites are recognised as remarkably unique compounds. These metabolites are exploited across various sectors, including veterinary medicine, scientific research, agriculture, human therapy, etc. The World Health Organisation (WHO) estimates that around 80% of people in developing countries rely on traditional medicine to obtain potentially effective medications made from medicinal plants[1,2].

Sorbaria tomentosa (Lindl.), a large, woody, sprawling shrub locally known as "*Karee* or *Berre*," typically grows to a height of 1.5 to 3 meters. It features gloomy, obtuse buds approximately 2mm in size, tiny, creamy white flowers bloom from July to September, and fern-like leaves measuring 1 to 8cm long and 2 to 4cm wide[3].

In the Himalayas region, locals cultivate this shrub as a natural barrier to protect gardens

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Figure 1. *Sorbaria tomentosa* (Lendl.) Rehder plant[7].

and fields from animals. Due to its resistance to air pollution, it can also be utilised in urban environments for green walls that help improve air quality. Additionally, *Sorbaria tomentosa* is used as fuel and as an ornamental plant[4].

The whole plant is traditionally considered for treating a variety of disorders due to its hepatoprotective, anti-inflammatory, antitumor, analgesic, antioxidant, and anticancer properties[5]. In some cases, stem, leaves and fruits are, respectively, used to reduce the intolerance and inflammation[4].

The genus *Sorbaria* comprises four wild species all. Of which are utilised in medicinal and cosmetics applications. *Sorbaria tomentosa* (Lindl.) Rehder, also known as Himalayan *Sorbaria* is native to Pakistan and also found in Afghanistan, Tajikistan, Korea, China, northern India, and Nepal. It typically grows in cooler habitats, at altitudes ranging from 2,100 and 2,700 meters, often along water channels[6] as shown in Figure 1.

2. Botanical Description and Distribution

Plants of the *sorbaria* genus are: branchlets and rachis are barely juvenile with short and long simple hairs. Leaves are alternate and imparipinnate, comprising 9-19 leaflets, petioles length ranges from 1.5-9.4cm, overall blade outline spans 13-36cm. The leaflet possesses double serrate margins; the terminal leaflet measures 2.8–8.8 × 0.7–3.3cm, with 18-32 pairs of lateral veins. While the lateral leaflets are 5.0-11X1.1-4.0cm with 21-31 vein pairs. The abaxial leaflet surface is sparsely to moderately pubescent with long, simple hair along the nerves and in the angles formed by the nerves. Flowers are small with five petals, 1.5– 4.2mm long. Fruits are dehiscent follicles, 3.2-4.0X2.2-3.0mm each, releasing several ovoid seeds measuring 2.4-3.4X0.3-0.5mm[8]. *Sorbaria tomentosa* taxonomical hierarchy is shown in Table 1.

Figure 2 shows the distribution of the *Sorbaria* genus in East Afghanistan, the Himalayas, India, and Pakistan. They occupy elevations of roughly 1,500–3,000m, favouring mesic to xeric slopes, open woodland margins, riverine thickets, and disturbed mountain sites.

3. Phytochemical Composition (Table 2)

3.1 Flavonoids

Flavonoids are a well-known class of polyphenolic chemicals that are abundant in *Sorbaria tomentosa* and are prized for their antioxidant, antibacterial, and anti-inflammatory properties. Studies have shown that

Table 1. *Sorbaria tomentosa* taxonomical hierarchy[8]

Shrubs height	1.5-3m
Leaves width	1-4cm
Leaves length	1-2cm
Leaves petiolate	Short
Flowers diameter	4mm
Flowers length	25cm
Flowers width	7cm
Buds colour	Brown
Buds shape	Ovoid
Buds' length	2mm

Kingdom	*Plantae*
Division	*Angiosperm*
Class	*Equisetopsida*
Subclass	*Magnoliidae*
Order	*Rosales*
Family	*Rosaceae*
Genus	*Sorbaria*
Species	*Sorbaria tomentosa*

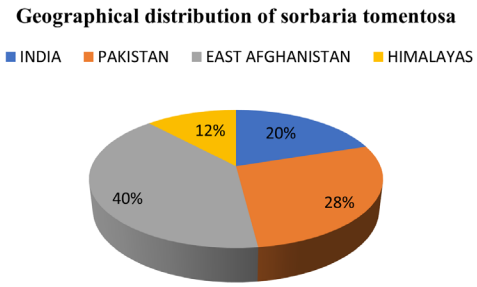


Figure 2. Geographical distribution of *Sorbaria tomentosa*[8].

some of the most significant flavonoids in the plant include quercetin, kaempferol, and their glycosides. They may help with inflammatory illnesses like arthritis since these substances have been demonstrated to scavenge free radicals, reduce oxidative stress, and alter inflammation pathways[8,9].

3.2 Tannins

Tannins are another broad family of phytochemicals that are present in *Sorbaria tomentosa* because of their astringent properties, Tannins offer antimicrobial and tissue-healing properties. Tannin-containing plant extracts are used in traditional medicine to treat burns, wounds, and dermatological disorders. Tannins have been seen to help integrate the plant into conventional topical treatments and to prevent the growth of bacteria, especially in wound infections[10,11].

3.3 Saponins

The roots and leaves of *Sorbaria tomentosa* are rich in natural surfactants known as saponins. These compounds exhibit various pharmacological properties, including anti-inflammatory, anti-cancer, and immunomodulatory effects. Research indicates that the plant's anti-inflammatory properties, which are often utilised in standard treatments for fever and pain, are enhanced by the presence of saponins that contribute to its antipyretic and anti-inflammatory benefits[12].

3.4 Phenolic Acid

Sorbaria tomentosa is known to contain phenolic acids, including gallic and ellagic acids, which are believed to contribute to the plant's antioxidant properties. Research has explored these compounds for their ability to prevent oxidative damage to cells and lower the risk of chronic diseases like heart disease and certain cancers. Due to this characteristic, it can be said that the plant not only has traditional medicinal uses as a general health tonic but also acts as an antioxidant.[10,13]

3.5 Terpenoids

Terpenoids have also been identified in *S. tomentosa*, albeit with less research. Medicinal herbs that have been used traditionally to treat infections and inflammatory diseases frequently contain these chemicals, which are well-known for their anti-inflammatory and

Table 2. Phytochemical present in *Sorbaria tomentosa* (Lindl.)

Phytoconstituents	Leaves	Stem Bark	Root	References
Flavonoids	Present	Present	Present	8,9
Tannins	Absent	Present	Present	10,11
Saponin	Present	Present	Present	10,12
Phenols	Present	Present	Present	10,13
Terpenoids	Present	Absent	Absent	10.14
Alkaloids	Present	Present	Present	10,15

antibacterial properties. According to preliminary studies, *Sorbaria tomentosa*'s terpenoid content may be in charge of some of its biological benefits, especially when it comes to treating respiratory infections[10,14].

3.6 Alkaloids

Alkaloids have been found in *Sorbaria tomentosa* during the first screenings of phytochemicals. The alkaloids have several documented pharmacological characteristics, such as analgesic, antibacterial, and anticancer actions. Even though the exact nature of several of the alkaloids found in *S. tomentosa* is still unknown, their existence suggests that the plant may have more widespread medicinal uses[10,15].

4. Pharmacological Activities

The *Sorbaria tomentosa* Lindl. Rehder plant's extract and a few of its divided metabolites show biological properties, primarily antioxidant and anti-cancer activity *in vitro* and also antidiabetic and hypoglycaemic activities *in vivo* (Table 3).

4.1 Anti-cancer Activity

According to the research conducted methanolic extract of *Sorbaria tomentosa* has shown anti-tumour effects and phytotoxic activity, whereas its ethanolic extract exhibits notable antioxidant properties and can help preserve sunflower oil[16]. The methanolic extract, along with its n-hexane and ethyl acetate fractions, was found to be the most effective against the lung A-549, hepatocellular Hepg2, and urinary bladder EI-138 cell lines[17]. The anticancer activity of the sub-fractions from the EtOAc fraction of S. tomentosa was linked to the significant presence of phenolic compounds. These phenolic compounds, characterised by their polyhydroxy groups in the aromatic ring, have demonstrated strong antioxidant properties through mechanisms such as oxidant filtration, metal chelation, oxidation inhibition, and serving as cofactors for antioxidant enzymes[18]. Four fractions, Solid Phase Extraction (SPE 1–4), were obtained through SPE using an Ethyl Acetate (EtOAc) solution. Cytotoxicity tests conducted with the MTT method revealed that SPE-2 exhibited the highest efficacy against cancer cell lines. The bioactive phenolics identified in the SPE-2 fraction included trans-p-snappily-β-D-glucopyranoside, dunnianoside F, linoside A, and asplenetin, which were analysed using semi-preparative and analytical High Performance Liquid Chromatography (HPLC), followed by Liquid Chromatography – Mass Spectrometry (LC-MS) analysis.

Table 3. Summary of pharmacological study on *Sorbaria tomentosa*

S. No.	Study on *Sorbaria tomentosa*	References
1	Anti-cancer activity	18
2	Antidiabetic and hypoglycaemic activity	19,20
3	1. GC-MS analysis	20
4	Anxiolytic and nootropic effects	21
5	Antioxidant activity and oil stabilisation	22
6	Viral host potential	23,5
7	Comparative analysis with natural antioxidant	22

4.2 Antidiabetic and Hypoglycaemic Activity

Antidiabetic agents lower blood glucose levels by targeting carbohydrate-digesting enzymes and preserving pancreatic β-cell function. Research evaluated *S. tomentosa* extracts for *in-vitro* inhibition of α-glucosidase and α-amylase using standard assays[19]. Gas Chromatography-Mass–Mass Spectrometry (GC-MS) analysis of the methanolic extract confirmed multiple secondary metabolites. The methanolic extract exhibited significant α-glucosidase inhibition (IC_{50} = 530 µg mL^{1}), while both the chloroform and methanolic extracts showed more potent α-amylase inhibition (IC_{50} = 27 and 40 µg mL, respectively).

For *in vivo* assessment, an alloxan-induced diabetic rat model was employed. Alloxan selectively destroys pancreatic βcells, inducing hyperglycemia. Oral administration of the methanolic extract at 150mg kg produced a progressive decline in fasting blood glucose levels over 28 days: 529.16, 446.66, 348.00, 269.33, and 165.50 mg dLon days 1, 7, 14, 21, and 28, respectively. A higher dose (300mg kg) further reduced glucose to 111.83mg dL^{-1} by day 28.

Ethanolic root extract of *S. tomentosa* was also evaluated in a larger animal model (50kg body weight), in which pancreatic insulin release is compromised.

Phytoconstituents in the extract are believed to protect βcells from degeneration, stimulate their regeneration, and enhance endogenous insulin activity[20]. Plant extracts exert antihyperglycemic effects by activating insulin receptors—thereby improving peripheral glucose uptake—or by directly stimulating β-cell insulin secretion. The antidiabetic action of the ethanolic root extract may thus derive from both insulinotropic effects and scavenging of reactive oxygen species generated under hyperglycemic conditions[19].

4.3 Anxiolytic and Nootropic Effect

Sorbaria tomentosa has demonstrated promising anxiolytic and nootropic properties, largely attributed to its rich polyphenolic profile. In a comprehensive phytochemical analysis, Mahnashi *et al.*, quantified 21 phenolic compounds in the crude methanolic extract (St.Cr) using HPLC– Diode Array Detector (DAD), with apigenin-7-glucoside (291.6 mg/g), quercetin (122.1 mg/g), quercetin-3-feruloylsophoroside-7-glucoside (52.6 mg/g), and ellagic acid (42.7 mg/g) being among the most abundant constituents. Similarly, the ethyl acetate fraction (St.EtAc) was found to be particularly rich in 3,5-dicaffeoylquinic acid (177.4 mg/g) and 5-hydroxybenzoylquinic acid (46.9 mg/g). Other fractions, n-hexane (St.Hex), butanol (St.Bt), and chloroform (St.Chf) also exhibited notable phenolic contents.

All solvent fractions demonstrated dose-dependent free radical scavenging activity in DPPH and ABTS assays, with St.Chf, St.Bt, and St.EtAc showing the most potent antioxidant effects (IC_{50} values of 298.1, 580.1, and 606.47 µg/mL, respectively). These extracts also exhibited significant Acetylcholinesterase (AChE) and Butyrylcholinesterase (BChE) inhibitory activities, particularly the chloroform fraction (BChE inhibition of 59.14%), indicating a potential mechanism for enhancing cholinergic neurotransmission and cognitive performance.

In vivo behavioural assays further supported these findings. Oral administration of *S. tomentosa* extracts at doses of 50–100 mg/kg in rodents significantly reduced anxiety-related behaviours in the open field, elevated plus maze, novel object recognition, and light–dark box tests. Additionally, nootropic effects were evident from improved memory retention and spatial working memory in Y-maze and related cognitive function tests. These findings suggest a dual role for *S. tomentosa* in modulating neurochemical pathways linked to both anxiety and cognition, positioning it as a promising candidate for future neuropharmacological research[21].

4.4 Antioxidant Activity and Oil Stabilisation

Potential and stabilisation of antioxidants investigations into Sunflower oil 9.9 ± 0.01 per cent was the percentage yield of the plant extraction in ethanol. When *S. tomentosa* extract was examined for phytochemicals, the main phytochemicals found were alkaloids, tannins, flavonoids, polymers, saponins, and phenols; proteins and cardiac glycosides were found in trace amounts. All of these phytochemicals are bioactive substances that have anti-inflammatory, anti-microbial, and antioxidant properties. Flavonoids and phenols are considered to possess antioxidant properties[5,22].

4.5 Viral Host Potential

In Himachal Pradesh's natural plant vegetation in the northwest of the Himalayas, *S. tomentosa* plants exhibiting leaf mosaic symptoms were found during a viral survey. Certain antibodies were used in ELISA to check for viruses in symptomatic leaves. When using antibodies specific to the potyvirus group (Agdia), positive findings were achieved. Leaf samples were analysed using a universal potyvirus primer pair that amplifies a portion of the coat protein gene and the 3′-UTR of the viral genome to confirm the identified virus group[24]. Since *Myzus persicae* and *Rhopalosiphum rufiabdominalis*, two aphid species, have been known to infect comparable *Spiraea spp*. in Himachal Pradesh, this plant may be considered a possible source of Potato Virus Y (PVY). Growers are asked to, if at all possible, remove virus-affected *Sorbaria* plants

from the immediate area of crop fields since *False spiraea* grows along the edge of farming fields and is a plausible natural reservoir host for PVY and its aphids' vectors[23].

4.6 Comparative Analysis with Natural Antioxidant

A significant amount of protein (23.80%) and carbs (52%) are found in *S. tomentosa* plants. There was a minor amount of moisture, fat, and ash present—6.25%, 2.02%, and 0.20%, respectively. Carbon (44.92%) was

the most abundant element, followed by hydrogen (6.16%), nitrogen (5.17%), and sulphur (0.43%), based on elemental analysis. Five substances were identified by GC-MS analysis of the n-hexane fraction of *S. tomentosa*: 2,4-dimethyltetradecanoic acid, 2,4-heptadecadienoic acid; ethyl ester, 2-butyl cyclopropane dodecanoic acid, heptadecanoic acid; ethyl ester, and 3,13-dimethylpentadecanoic acid. Further isolation and characterisation of *S. tomentosa's* active ingredients may validate the finding of new plant drugs[20].

5. Traditional Uses

Sorbaria tomentosa has a rich history of traditional use, particularly in the Himalayan and adjacent regions. Traditionally, it has been used for its anti-inflammatory and analgesic properties, with local healers preparing poultices or decoctions from the leaves to alleviate joint pain, swelling, and muscle aches. The plant is also known for its diuretic effects, where a tea made from the dried leaves is consumed to promote urine flow and reduce water retention. In addition, leaf infusions have been used as a febrifuge to help reduce fever during infections. For gastrointestinal relief, decoctions of the bark or roots are traditionally taken to soothe stomach discomfort, dyspepsia, and mild diarrhoea. Furthermore, the plant has been applied topically in the treatment of wounds, where crushed leaves are used to accelerate healing and prevent infection. *S. tomentosa* is also used in the treatment of respiratory ailments; inhaling steam from boiled leaves or drinking the resulting decoction is believed to help ease coughs, bronchitis, and chest congestion. Additionally, the leaves have been used in topical applications for treating skin disorders such as eczema, rashes, and other inflammatory conditions. These traditional uses align with the plant's known bioactive compounds, supporting its potential for further pharmacological validation[22,23].

6. Future Scope

Sorbaria tomentosa is a medicinal plant with significant pharmacological potential, yet it remains underexplored in modern research. Traditionally used in herbal medicine, this plant is known for its diverse bioactive compounds, including flavonoids, tannins, and phenolics, which contribute to its therapeutic properties. Various studies have highlighted its potential antifungal, antibacterial, antioxidant, and anti-inflammatory activities, making it a promising candidate for drug development. However, comprehensive phytochemical analysis, mechanism-based pharmacological studies, and clinical evaluations are necessary to establish its efficacy and safety.

Future research should focus on isolating novel bioactive compounds, optimising extraction techniques, and exploring nano-based drug delivery systems to enhance their medicinal applications. Additionally, sustainable cultivation practices and commercial utilisation can contribute to the development of herbal formulations and pharmaceutical products. With growing interest in plant-based medicine, *S. tomentosa* holds potential for applications in pharmaceuticals, nutraceuticals, and cosmeceuticals, emphasising the need for further scientific validation and commercialisation.

7. Research Gap

For *Sorbaria tomentosa* to realise its potential medicinal uses, several critical gaps in existing research need to be addressed. While preliminary evidence indicates promising phytochemical and antifungal properties, the exact biochemical pathways responsible for such effects remain largely unexplored. The role of specific secondary metabolites, such as flavonoids, tannins, and saponins, in the pharmacological activities reported is not well understood. It needs more detailed investigations at the level of molecular mechanisms, in interaction with the fungal cell walls, immune response modulation, and possible synergistic effects with the known antifungal agents.

Furthermore, most of the studies are on crude extracts; hence, much work remains in isolating and characterising specific bioactive compounds responsible for antifungal and other medicinal properties. This makes it difficult to pinpoint the exact compounds exerting pharmacological effects and restricts their potential for drug development. Another major research gap exists in terms of toxicological assessments. The potential side effects, cytotoxicity, and long-term safety of *S. tomentosa* are not known since

there are no or very little comprehensive toxicological data available. In the absence of such studies, it cannot be completely evaluated as a feasible therapeutic agent.

Another major limitation of the included studies is the non-standardisation in extraction techniques, solvent selection, and bioassay methodologies. Such variation of methods in the studies makes comparison of results and establishment of consistency in pharmacological outcomes difficult. This inconsistency is important for the reproducibility and reliability of findings for further validation of the results for practical applications. The most essential gap in the research is that no clinical trial has been carried out. While *in vitro* and *in vivo* studies have shown preliminary evidence of its medicinal properties, no human trials have been conducted to affirm the efficacy, safety, and optimal dosage of this plant in real-world healthcare applications. Unless clinically validated, any potential use of *S. tomentosa* in modern medicine remains purely theoretical. Answering these questions with standardised, rigorous, and translational research will be important for the full medicinal potential of this plant to be realised.

8. Conclusion and Summary

The present study was on pharmacognostical and phytochemical investigation of *S. tomentosa*, hence, it showcases the strong bioactivity profile within the plant, where the compound groups that have depicted high medicinal values include flavonoids, tannins, saponins, phenolic acids, and alkaloids. These compounds are associated with noteworthy biological activities such as antioxidant, anti-inflammatory, antimicrobial, and analgesic activities. Moreover, ethnobotanical use in diseases such as inflammation, respiratory, dermatological, and gastrointestinal diseases increases its ethnomedicinal value. Moreover, preliminary pharmacological studies placed *S. tomentosa* among the potential candidate sources for antioxidant supplements, anti-inflammatory treatments, antimicrobial agents, and possible cancer therapies. More research, particularly *in vivo* and clinical studies, will be necessary to more fully elucidate its therapeutic efficacy and develop pharmaceutical applications. It is a groundwork for further research into *S. tomentosa* as a useful drug in herbal medicine.

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10. Author Contribution

Dr. Nidhi Gairola supervised the entire research process, provided guidance throughout the study, and critically reviewed the final manuscript. Priyam Joshi led the research work, including experimental design, data collection, analysis, and manuscript preparation. Vipin Kumar contributed to data analysis and interpretation. Navneet Singh worked on methodology development and literature review. Shailendra Rajpoot was involved in data organization and graphical representation. Himanko Gogoi assisted in manuscript drafting and reference management. All authors have read and agreed to the published version of the manuscript.

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