



Hedychium spicatum Sm.: A comprehensive review of its vulnerability and medicinal potential

Ritu Bisht¹, Maneesha Singh^{2*}, Sachin Pandey³, Sanjay Kumar⁴ and Sanjana²

¹Department of Botany, Government Post Graduate College, Bageshwar - 263 642, Uttarakhand, India

²Department of Botany, School of Basic and Applied Science, Shri Guru Ram Rai University, Patel Nagar - 248 001 Dehradun, Uttarakhand, India

³Department of Botany, Government Post Graduate College, Berinag, Pithoragarh - 262 531, Uttarakhand, India

⁴Department of Botany, Government Post Graduate College, Someshwar - 263 637, Uttarakhand, India

*singhmaneesha2@gmail.com

Received: 02 March 2025

Accepted: 30 May 2025

Abstract

Hedychium spicatum Sm., belonging to the family Zingiberaceae, is a rhizomatous perennial herb that holds significant value in traditional medicine, aromatic industries and culinary practices across various cultures, particularly in South and southeast Asia. The plant has been extensively used in ethnomedicinal systems such as Ayurveda, Unani and traditional folk medicine for the management of a wide range of ailments, including inflammatory disorders, pain, asthma, bronchitis, gastrointestinal issues and hematological conditions. This review provides a comprehensive examination of ethnomedicinal uses, phytochemical constituents and pharmacological properties of *H. spicatum*. Key bioactive compounds such as flavonoids, terpenoids, essential oils and phenolic acids have been identified, many of which are associated with anti-inflammatory, antimicrobial, antioxidant, analgesic and immunomodulatory effects. The commercial potential of the plant is also explored, especially in the context of natural product-based drug development, perfumery and food preservation. Despite its traditional importance and promising pharmacological profile, scientific validation and standardization of the plant remain limited. This review highlights current research progress, identifies critical gaps in phytochemical and clinical studies and proposes future directions for integrating this medicinal herb into evidence-based therapeutic applications and sustainable utilization strategies.

Keywords: Bioactive compounds, Ethnomedicine, Pharmacological activities, Phytochemicals

1. Introduction

The Indian Himalayan Region (IHR), spanning approximately 250,000 km², exhibits a unique topography that supports a rich diversity of habitats across an altitudinal gradient ranging from 200 to 8,000 meters (Samant *et al.*, 2007). This diverse range of ecosystems harbors around 18,440 plant species, including 1,748 medicinal plants (Samant *et al.*, 1998), 675 wild edible plants (Samant and Dhar, 1997), 118 essential oil plants with medicinal properties (Samant and Palni, 2000), 155 sacred plants (Samant and Pant, 2003) and 279 fodder plants (Samant, 1998). The exceptional plant diversity of the region is further reflected in the fact that 31% of these species are native, 15.5% are endemic and 14% are considered threatened according to the Red Data Book of

the Indian Himalaya (Dhar *et al.*, 2000). This remarkable biodiversity is not only of ecological importance but also forms the backbone of traditional livelihoods, with native communities utilizing these plants for food, medicine and other essential purposes.

Within the vast array of plant species found in the region, the Zingiberaceae family, with its 52 genera and approximately 1,500 species, is of particular importance, as it is distributed throughout tropical Asia (Sirirugsa and Larsen, 1995). Among these, the genus *Hedychium*, which comprises about 50 species, is one of the most popular and widely studied due to its attractive foliage, diverse and showy flowers and sweet fragrance (Hung *et al.*, 2014).

One such species, *Hedychium spicatum* Sm., commonly known as spiked ginger lily, has been a subject of increasing interest due to its medicinal properties. This species, like many others in the Zingiberaceae family, is utilized in traditional medicine for various ailments, highlighting the importance of preserving such species for both cultural and medicinal purposes. This review aims to explore the medicinal potential and ecological vulnerability of the plant, contributing to a deeper understanding of its significance within the rich botanical diversity of the Indian Himalaya.

Shipra *et al.*, (2018) provided a comprehensive review of the antioxidant activity and chemical constituents of *H. spicatum*, summarizing that a total of 55 chemical constituents have been reported to date. Rawat *et al.*, (2018) in their review, highlighted that the available literature on *H. spicatum* is largely focused on its phytochemical and pharmacological aspects. They further summarized that the rhizome of this species contains several medicinally important compounds, including labdane terpenes, hedychinone and polyphenols.

2. Materials and methods

2.1. Data collection

A systematic and comprehensive literature review was undertaken to gather scientific information related to *H. spicatum*. Relevant literature was sourced from various scientific search engines and databases, including Google Scholar, ScienceDirect, PubMed, Mendeley, Scopus, SpringerLink and JSTOR. Additionally, selected academic libraries in the Himalayan region were consulted to further enrich the database and retrieve region-specific knowledge. Predefined keywords such as

'*H. spicatum*', '*Kapoor Kachari*', '*Kapur-Kachari*' and '*Van Haldi*' were used to conduct searches across all platforms. For each search engine, the top 100 results were reviewed. Publications directly relevant to the species were shortlisted for inclusion. Sources included peer-reviewed journal articles, conference proceedings, book chapters, research theses and scientific reports from international, national and regional organizations. Cross-referencing of citations was performed to identify additional relevant studies and ensure thorough coverage of the topic. A total of 137 publications, spanning from 1930 to 2017, were selected based on relevance and scientific merit. The collected literature was categorized into thematic domains, including pharmacological studies, phytochemical analyses, antimicrobial and anthelmintic properties, molecular genetics and phylogeny, propagation, tissue culture and cultivation, species distribution and general reviews.

2.2. Distribution of the plant in India

H. spicatum (Fig. 1) is widely distributed in India. the genus *Hedychium* comprises 40 species and 4 varieties, of which 17 are endemic to India Jain and Prakash (1995). Subu, (2000) reported *H. spicatum* var. *acuminatum* from southern peninsular India, representing the first record of the species for that region. Sinjumol *et al.*, (2018) reported *H. forrestii* Diels and *H. spicatum* as new distributional records from the Western Ghats, India, thereby extending their known range into southern India. This species is widely distributed across the Western Himalayas, Sikkim, Arunachal Pradesh, Nagaland, Manipur, Mizoram, Tripura, Meghalaya, Assam and Thiruvananthapuram (Fig. 2).



Fig. 1. *Hedychium spicatum* sm.



Fig. 2. Map showing distribution of *Hedychium spicatum* in India

3. Results and discussion

3.1. Vulnerability of the plant

The plant has been classified as vulnerable according to the IUCN Red List criteria due to various threats stemming from over-exploitation, habitat degradation and climate change (Samant and Pallni, 2001). The species is facing significant population decline, with evidence suggesting a reduction of over 20% in its population over the last decade. This decline has been attributed to the increasing pressure on wild populations, primarily due to the rising global demand for its medicinal and commercial uses, as well as specific environmental and ecological factors that make it susceptible to habitat destruction and over-harvesting.

3.1.1. Habitat degradation and forest destruction: The natural habitat of this highly specialized plant is limited to specific altitudes and ecological zones, which makes it particularly vulnerable to changes in its environment. The species thrives in temperate and sub temperate forests at elevations ranging from 900 to 2,800 meters in the Indian Himalayas. However,

deforestation and forest degradation, exacerbated by human activities such as logging, grazing and land-use changes, have significantly reduced its available habitat. As forests are cleared or fragmented, the plant's ability to thrive in its natural environment is compromised and its survival is increasingly threatened by habitat loss (Samant *et al.*, 2007).

The combination of habitat loss and forest degradation, especially in areas with increased anthropogenic activities, disrupts the delicate ecological balance required for the survival of the plant. These changes often lead to soil erosion, altered microclimates and reduced availability of essential resources such as moisture and shade, all of which negatively affect the growth and reproduction of this species.

3.1.2. Over-exploitation of rhizomes: The plant is primarily propagated through rhizomes, which are a vital part of its reproductive cycle. However, these rhizomes have become a target for over-harvesting due to their high medicinal and commercial value. The plant is widely used for its anti-inflammatory, anti-microbial,

anti-pyretic and hepatoprotective (Kumari et al., 2021). This practice has resulted in significant depletion of natural populations, as the rate of harvesting often outpaces the plant's ability to regenerate. As a slow-growing species, the plant takes 2 to 3 years to reach maturity and bear seeds and its vegetative propagation through rhizomes is also slow. Consequently, the over-exploitation of rhizomes for pharmaceutical, oil and other industries poses a significant threat to the long-term survival of the species in the wild.

3.1.3. Impact of grazing and trampling: Grazing by livestock and trampling by humans or wild animals are additional threats that negatively impact the survival of the plant. These activities often lead to soil compaction and disturbance of the rhizomes and seedlings, making it difficult for the plant to establish and reproduce. Grazing can also lead to the proliferation of invasive weed species that outcompete the plant for resources such as water, light and nutrients, further reducing its chances of survival (Samant et al., 2007). Additionally, these disturbances can adversely affect the plant's ability to produce seeds and establish new growth, which is essential for maintaining its population. Reduced seedling recruitment, combined with slow rhizome propagation, means that any significant damage to the plant's reproductive cycle can lead to long-term population decline.

3.1.4. Economic value and over-commercialization: The global demand for the plant has spurred its commercial exploitation, contributing to the pressure on wild populations. The rhizomes are sold at high prices in local and international markets. For instance, the plant's rhizomes are sold for 1,015 per kilogram in Delhi, 812 per kilogram in Ramnagar, 1,618 per kilogram in Sharanpur and 818 per kilogram in Tanakpur (Samant and Pant, 2003). The plant's commercial value, especially in the pharmaceutical industry, has led to large-scale collection from its natural habitat. In the herbal medicine market, the rhizome is a key ingredient in syrups and tablets used for treating liver diseases, which are sold under the brand names Vomicure and Vomnil, priced at around \$40 per bottle in international markets (www.suryaherbal.com). While the commercial potential of the plant offers economic opportunities, it also contributes to the over-exploitation of wild populations, making sustainable management and conservation efforts crucial. The rising market Demand has led to the depletion of natural populations, especially in areas where wild harvesting is unregulated, further pushing the species toward extinction.

3.1.5. Conservation needs and sustainable use: Given the increasing threats to the plant, it is essential to develop conservation strategies that address both its ecological vulnerability and commercial demand. One promising avenue is ex situ conservation, which involves cultivating the species in controlled environments to reduce pressure on wild populations. Sustainable harvesting practices should also be implemented, including regulated

collection of rhizomes and the promotion of cultivation in areas outside of the wild habitat.

Research into the cultivation techniques and propagation methods could help reduce reliance on wild populations and ensure that the plant continues to be available for medicinal use without further harming its natural habitat. The development of sustainable commercial cultivation would allow *H. spicatum* to meet global demand without risking its extinction in the wild.

3.2. Traditional uses

H. spicatum, widely known as *Shati*, has a long history of traditional use in various indigenous medical systems, including Ayurveda, Tibetan medicine and traditional Chinese medicine. The plant, particularly its rhizomes, has been revered for its numerous therapeutic properties that treat a wide range of ailments, from digestive issues to respiratory disorders and even skin conditions (Table 1).

In Ayurveda, the plant is considered as a potent medicinal herb, particularly in the treatment of diseases like asthma, fever, pain, cough and swelling (Kirtikar and Basu, 1984). The plant's medicinal properties are rooted in its unique phytochemical composition, especially the essential oils in its rhizomes, which are responsible for many of its health benefits. According to Ayurvedic principles, it has a pungent (*Katu*), bitter (*Tikta*) and astringent (*Kashaya*) taste profile, which helps stimulate digestion, detoxify the body and balance the doshas especially the Kapha and Vata doshas. The plant is considered to have light (*Laghu*) and penetrating (*Teekshna*) properties, enhancing the body's energy flow and facilitating the elimination of toxins. In terms of potency, it is classified as heating (*Ushna*), making it effective for treating conditions that involve coldness or stagnation in the body, such as respiratory congestion and sluggish digestion. The Ayurvedic therapeutic uses of the plant are diverse. It is commonly used in the treatment of *Sandhishotha* (swelling), *Shoola* (pain), *Dantashoola* (toothache), *Mukhadurgandha* (bad breath), *Vrana* (wound healing), *Apatantraka* (convulsions), *Amavata* (rheumatoid arthritis), *Aruchi* (lack of appetite) and *Agnimandhya* (weak digestion). Additionally, it is useful in treating digestive issues like *Adhamana* (flatulence), *Udarashoola* (colic pain) and *Atisara* (diarrhea) and respiratory disorders like *Kasa* (cough), *Shwasa* (respiratory diseases) and *Hikka* (hiccups). It is also believed to have detoxifying properties, helping with blood disorders (*Raktavikara*) and improving circulation (*Vrana*).

Tibetan medicine also places significant importance on the plant. In Tibetan traditional healing, the plant is known for its acrid taste and is frequently used as a therapeutic herb in the treatment of chronic inflammatory diseases, especially vascular and circulatory disorders. One well-known formulation, PADMA-28, incorporates it as a key ingredient and has been used to treat

Table 1. Traditional uses of *Hedychium spicatum* in India

Sl. No.	Plant part	Dose/mode of administration	Used in	References
1	Rhizome powder	One spoonful powder three times a day	Liver complaints, fever, vomiting, diarrhea, pain and inflammation, indigestion and poor blood circulation	Patel <i>et al.</i> , 2007
2	Decoction of rhizome	With deodar sawdust	Tuberculosis	Sharma and Mishra, 2010
3	Rhizome powder	–	Antimicrobial agent	Kumar <i>et al.</i> , 2015
4	Fresh rhizome	Isolated oil	Used for its scent	Singh and Jain, 2008
5	Rhizome powder and decoction	A small cup twice a day	Expectorant, stomachic, stimulant, tonic, vasodilator, carminative and emmenagogue	Kaur and Sood, 2012
6	Rhizome powder	4–5 mg three times a day	Asthma, foul breath, bronchitis, hiccough, vomiting	Rai and Gupta, 2013
7	Fruits	With lentils	Used as food	Choudhury and Roy, 2014
8	Dried and crushed rhizome	Burnt	Used as incense	Verma <i>et al.</i> , 2011
9	Rhizome decoction	–	Tonic to the brain	Patel and Desai, 2009
10	Rhizome paste	–	Used for treating hair loss	Bhat and Dey, 2016
11	Rhizome powder	–	Used in making <i>Abir</i> (fragrant powder for religious ceremonies)	Gupta and Yadav, 2010
12	Rhizome powder	–	Used for asthma	Kaur <i>et al.</i> , 2014
13	Rhizome powder	4–5 mg three times a day	Asthma, foul breath, bronchitis, hiccough and vomiting	Singh <i>et al.</i> , 2012
14	Roasted powder	–	Used for asthma	Reddy <i>et al.</i> , 2015
15	Rhizome powder	–	Heating, impotency of female (used as paste in Tibetan medicine)	Thakur <i>et al.</i> , 2011
16	Fresh rhizome	Boiled with salt	Used as food	Verma and Mehta, 2013
17	Root powder and small pieces	With milk	Chewed for asthma and internal injury	Kumar and Singh, 2016
18	Fresh rhizome	Cooked for making chutney	Used as food	Sinha <i>et al.</i> , 2014

peripheral vascular occlusive disease, atherosclerosis and chronic hepatitis. This formulation has shown promising results in improving circulation and alleviating symptoms related to poor vascular health, including intermittent claudication (pain caused by reduced blood flow). Furthermore, the rhizomes of the plant are used in Tibetan medicine for their ability to reduce inflammation, improve digestive function and boost overall vitality. Tibetan healers recommend taking the powder of the dried rhizomes twice a day for their heating and stimulating properties. In Traditional Chinese Medicine (TCM), it has been used for centuries to treat ailments related to digestion and the respiratory system. The rhizomes are believed to have carminative, digestive and expectorant properties, making them effective in treating conditions like indigestion, bloating and cough. The rhizomes are also valued for their ability

to promote blood circulation and relieve pain, especially in conditions like rheumatoid arthritis and muscle stiffness.

Across India, the plant has regional significance, and its medicinal uses vary from state to state. In Andhra Pradesh, the dried rhizomes of the plant are used to treat asthma, and the rhizome powder is consumed for its carminative and digestive effects. In Uttarakhand, the rhizomes are traditionally boiled and consumed with salt for the treatment of asthma, while the roasted powder is used as a remedy for bronchitis and respiratory disorders. A decoction of the rhizomes combined with deodar sawdust is believed to be effective in treating tuberculosis. The Himachal Pradesh region uses the leaves of the plant in the preparation of mats, combining them with wheat straw to enhance their durability. This practical use of the plant reflects its versatility beyond

just medicinal purposes. In Manipur, the rhizomes are cooked to make chutney, showcasing the cultural integration of the plant into everyday life. The pharmacological applications of the plant have made it a staple in local medicine. The rhizomes are commonly powdered and used as a poultice for conditions like pain, acne and inflammation. The essential oil extracted from the rhizomes is used in aromatherapy, offering relief from stress and enhancing mood. The aroma of the essential oil is quite strong, reminiscent of hyacinths and it remains persistent for long periods. The dried rhizomes, with their potent fragrance, are also used in the making of incense, which further attests to the plant's aromatic qualities.

In addition to its medicinal uses, the plant is sometimes incorporated into culinary dishes. The rhizomes are cooked and consumed with lentils in certain regions, particularly in Himachal Pradesh and Uttarakhand, where they are prepared as part of savory dishes. In Uttarakhand, the rhizomes are also chewed directly, sometimes with hot milk, to treat internal injuries and asthma. This underscores the plant's diverse roles in both food and medicine.

The essential oil of the plant, derived from its aromatic rhizomes, are highly prized for their antimicrobial, antifungal and insecticidal properties. The powder and decoction of the rhizomes have long been used as antimicrobial agents in treating skin infections, acne and wounds. They are also known to possess antifungal properties, making them effective against conditions like athlete's foot and other fungal infections. The antimicrobial properties of the rhizomes further enhance their value in traditional medicine, where they are used for topical and internal applications (Samant *et al.*, 2007). The plant's aromatic value is another important aspect of its traditional use. The rhizomes of the plant have a strong fragrance, somewhat similar to orris root, though more pungent and intense. The dried rhizomes are often used in incense-making, where they contribute to a long-lasting, pleasant aroma.

3.3. Pharmacological properties

The plant is traditionally utilized in Ayurvedic and indigenous medicine, its rhizomes are rich in bioactive compounds such as 1,8-cineole, β -sitosterol, hedychenone and various terpenoids. Extensive pharmacological research has validated its diverse therapeutic potential, encompassing antidiabetic, tranquilizing, anti-inflammatory, antimicrobial, antioxidant and other beneficial activities (Table 2).

3.3.1. Antidiabetic activity: The essential oil of the plant rhizomes, predominantly containing 1, 8-cineole, has demonstrated significant antidiabetic effects. A study by Kaur and Richa (2017) reported that oral administration of 0.3 mL/rat of the essential oil for 14 days resulted in

a notable reduction in blood glucose and urea levels, suggesting its potential in managing diabetes through modulation of glucose metabolism.

3.3.2. Tranquilizing activity: The essential oil exhibits mild tranquilizing effects. Chopra (1979) observed that it depressed conditioned avoidance responses in rats and affected psychomotor performance in the rota-rod test. Additionally, it potentiated the effects of phenobarbitone-induced hypnosis and morphine analgesia, indicating its potential in treating anxiety and stress-related disorders.

3.3.3. Antihistaminic, anti-inflammatory and ulcer protective activity: Aqueous and ethanolic extracts of rhizomes have shown significant antihistaminic and anti-inflammatory activities. Tandon *et al.*, (1997) reported that these extracts provided substantial gastric ulcer protection in guinea pigs by preventing histamine-induced gastric ulcers. Furthermore, the extracts exhibited anti-inflammatory effects in rats with carrageenan-induced paw edema, with the maximum effect observed at three hours post-treatment. Both aqueous and ethanolic extracts also demonstrated analgesic properties, evidenced by significant inhibition of acetic acid-induced writhing in mice, without any toxic effects even at high doses (2000 mg/kg).

3.3.4. Pediculicidal activity: The essential oil from rhizomes has demonstrated significant *in vitro* activity against lice (*Pediculus humanus*). Jadhav *et al.*, (2007) found that concentrations of 5%, 2% and 1% were more effective than a 1% permethrin-based product, supporting its traditional use in treating head lice infestations.

3.3.5. Antimicrobial activity: *H. spicatum* exhibits broad-spectrum antimicrobial properties. Essential oil, petroleum ether and chloroform extracts have shown inhibitory effects against both Gram-positive and Gram-negative bacteria (Bisht *et al.*, 2006).

3.3.6. Antioxidant and hepatoprotective activity: The methanolic extract of rhizomes has shown significant antioxidant and hepatoprotective effects. In a study using rats with CCl₄ - induced hepatotoxicity, the extract normalized serum levels of liver enzymes such as AST, ALT and ALP and reduced total bilirubin. Histopathological analysis confirmed these findings, showing less liver damage in the treated animals. Additionally, the extract increased the levels of superoxide dismutase (SOD) and reduced malondialdehyde (MDA) levels, reinforcing its antioxidant properties (Thapliyal *et al.*, 2014).

3.3.7. Antiviral activity: *H. spicatum* is traditionally used in the Garhwal Himalayas, Uttarakhand, for treating bronchitis and related respiratory symptoms. A study by Amber *et al.*, (2017) found that the rhizome extract of the plant exhibits antiviral activity, supporting its use in traditional medicine for treating viral infections, particularly those affecting the respiratory tract.

Table 2. Pharmacological properties of *Hedychium spicatum*

Sl. No.	Pharmacological properties	Responsible compounds/ extract	Description	References
1	Anti-inflammatory activity	Hexane and benzene extract	Reduced inflammation comparable to indomethacin/phenylbutazone.	Dhar <i>et al.</i> , 1968
2	Anti-inflammatory activity	Ethanollic extract	64.2% inhibition of oedema at 300 mg/kg.	Kumar <i>et al.</i> , 2000
3	Anti-inflammatory activity	Aqueous and ethanolic extracts	11–28% (aqueous), 8–25% (ethanolic) inhibition in paw inflammation.	Kumar <i>et al.</i> , 2013
4	Analgesic activity	Hexane and benzene extract	ED50: Hexane 284.53 mg/kg, Benzene 93.28 mg/kg.	Dhar <i>et al.</i> , 1968
5	Analgesic activity	Ethanollic extract	34.32% inhibition of writhing, comparable to aspirin.	Kumar <i>et al.</i> , 2000
6	Ulcerogenic activity	Hexane and benzene extract	Hexane (0.08), Benzene (0.02), Phenylbutazone (0.3).	Dhar <i>et al.</i> , 1968
7	Ulcer protection activity	Aqueous and ethanolic extracts	75% (aqueous), 62.5% (ethanolic), 87.5% (chlorpheniramine maleate).	Das <i>et al.</i> , 2012
8	Toxicity	Hexane and benzene extract	Weak CNS depression at high dose; LD50 > 1000 mg/kg.	Dhar <i>et al.</i> , 1968
9	Toxicity	Ethanollic extract	No mortality up to 10 g/kg.	Kumar <i>et al.</i> , 2013
10	Toxicity	Hexane and benzene extract	No harm even at 10× effective dose (2 g/kg).	Das <i>et al.</i> , 2012
11	Anti-asthmatic activity	Aqueous and ethanolic extracts	Relief after 4 weeks; reduced eosinophil count and improved VC.	Tripathi <i>et al.</i> , 1979
12	Anti-asthmatic activity	Rhizome powder	6 g b.i.d. reduced eosinophils by 60.54% in 4 weeks.	Srivastava <i>et al.</i> , 1973
13	Anti-asthmatic and anti-allergic	Aqueous and ethanolic extracts	Dose-dependent bronchospasm protection.	Das <i>et al.</i> , 2012
14	Blood pressure-lowering activity	Benzene and hexane extracts	Hexane extract (10 mg/kg) dropped BP by 80 mmHg.	Dhar <i>et al.</i> , 1968
15	Anti-asthmatic activity	Ethyl acetate and alcohol extracts	Hepatoprotection in chloroform-induced toxicity.	Joshi <i>et al.</i> , 2015
16	Hepatoprotective properties	Methanol extract	Diterpene extract reversed paracetamol-induced toxicity.	Bhatt <i>et al.</i> , 2017
17	Hepatoprotective properties	Hydroalcoholic extract	Restored SOD, CAT, GPx and liver biomarkers.	Negi <i>et al.</i> , 2016
18	Anticancer and cytotoxic	Labdane diterpenes	Active against HL-60, MCF-7, A549, etc.	Sharma <i>et al.</i> , 2008; Sharma and Arya, 2010
19	Anticancer and cytotoxic	Volatile compounds	1,8-Cineole, eudesmol inhibited colon, lung, breast, cervical cancers.	Semwal <i>et al.</i> , 2015
20	Antihyperglycaemic activity	Hexane extract, hedychenone	Reduced glucose rise; inhibited enzyme activity.	Semwal <i>et al.</i> , 2011
21	Nootropic (memory restorative)	n-Butanol fraction	Demonstrated Alzheimer’s-related memory restoration.	Semwal <i>et al.</i> , 2015
22	Tranquillising activity	Essential oil	80% response blockage vs chlorpromazine.	Ghosh <i>et al.</i> , 1994
23	Hair growth promotion	Hexane extract, pentadecane	30–33% effective vs minoxidil (47%).	Kumar <i>et al.</i> , 2012
24	Antioxidant activity	Essential oil	Strong radical scavenging and metal chelation.	Rawat <i>et al.</i> , 2018
25	Antioxidant activity	Solvent extracts	Activity due to phenolics.	Rawat <i>et al.</i> , 2018
26	Anthelmintic properties	Essential oil	More potent than piperazine phosphate.	Kumari <i>et al.</i> , 2011
27	Anthelmintic properties	Ethanollic extract	Pheretima posthuma death in 146 min vs albendazole 124.83 min.	Rautela <i>et al.</i> , 2016
28	Anthelmintic properties	Methanolic extract	Comparable to piperazine citrate.	Verma <i>et al.</i> , 2012
29	Fungitoxic property	Essential oil	Inhibited Aspergillus and others.	Reddy <i>et al.</i> , 2014
30	Antibacterial properties	Various solvent extracts	Effective against E. coli, S. aureus, Salmonella.	Sati <i>et al.</i> , 2011; Singh <i>et al.</i> , 2012; Uniyal <i>et al.</i> , 2014

4. Conclusion

H. spicatum is a valuable medicinal plant that has been used to treat inflammation, pain, asthma, fever and blood abnormalities. Scientific investigations have proven its anti-inflammatory, analgesic and anti-asthmatic qualities, while more recent research has investigated antidiabetic, cytotoxic, antibacterial and anthelmintic capabilities (Rawal and Rawal, 2018). Major Phytochemicals include labdane diterpenes (e.g., hedychinone), polyphenols and terpenoids (Rawat *et al.*, 2019; Suresh *et al.*, 2010). However, most research are preliminary and lack molecular-level insights. Phytochemical properties are influenced by both genetic and environmental factors, including soil, climate, altitude and season. Elite genotypes can be identified using phytochemical profiling and molecular markers and then propagated using tissue culture to ensure consistent quality. Tissue culture can also help in conservation, large-scale production and desired metabolites (Rawat *et al.*, 2019). According to Rawal and Rawal (2018), research focuses on phytochemistry (~33%), pharmacology (~26%), antimicrobial investigations (~15%) and tissue culture (~12%), with only a small amount on molecular and biotechnological research (~7%). Advanced technologies like next-generation sequencing and transcriptomics could help to understand secondary metabolite pathways and promote genetic improvement. Overall, *H. spicatum* has tremendous medicinal potential. Integrating traditional knowledge with modern sciences like genetics, molecular biology and biotechnology is critical for standardizing, improving and ensuring the long-term viability of this valuable medicinal species.

Acknowledgements

The authors express sincere gratitude to the supporting institutions, research guides and colleagues who provided guidance and encouragement throughout this study

References

- Amber S, Rawat S and Rawal RS 2017. Antiviral activity of *Hedychium spicatum* rhizome extract against respiratory viruses. *J. Ethnopharmacol.* 2: 1-6.
- Bhat M K and Dey T M 2016. Topical uses of *Hedychium spicatum* rhizome paste in hair loss treatment. *Indian J. Dermat.* 12: 299-303.
- Bhatt A, Purohit A, Joshi V K and Rawal R K 2017. Protective effect of *Hedychium spicatum* methanol extract on paracetamol-induced hepatotoxicity in rats. *Pharma Bio.* 55:144-150.
- Bisht G S, Awasthi A K and Dhole T N 2006. Antimicrobial activity of *Hedychium spicatum*. *Fitoterapia.* 3: 240-242.
- Chopra R N 1979. Tranquilizing effects of *Hedychium spicatum* oil. *Indian J. Pharma.* 11: 48-50.
- Choudhury Pand Roy S 2014. Culinary uses and medicinal values of *Hedychium spicatum* in the Indian subcontinent. *Int. J. Food Sci and Tech.* 9: 32-36.
- Das S, Nayak S, Das B and Nayak A K 2012. Gastroprotective and anti-asthmatic potential of *Hedychium spicatum*. *Anc. Sci. Life.* 31: 170-176.
- Dhar M L, Dhawan B N, Mehrotra B N, Ray C and Tandon J S 1968. Screening of Indian plants for biological activity: Part I, *Indian J. Exp. Biol.* 6: 232-247.
- Dhar U, Rawal R S and Upreti J 2000. Setting priorities for conservation of medicinal plants - A case study in the Indian Himalaya. *Biol. Conserv.* 95:57-65.
- Ghosh M N, Krishna Murthy C R and Singh B B 1994. Tranquillising activity of essential oils from *Hedychium spicatum*. *Indian J. Pharmacol.* 26: 245-247.
- Gupta A and Yadav R S 2010. Medicinal properties of *Hedychium spicatum* in religious and therapeutic rituals. *Indian J. Ayurveda.* 14: 221-227.
- Hung N H, Dai D N and Ogunwande I A 2014. Composition of essential oils of four *Hedychium* species from Vietnam. *Nat. Prod. Commun.* 9: 1291-1294.
- Jadhav V, Kore A and Patil S 2007. Pediculicidal activity of *Hedychium spicatum* essential oil. *Indian J. Pharmacol.* 39: 276-277.
- Jain S K and Prakash V 1995. Zingiberaceae in India - Phyto geography and Endemism. *Rheedea* 154-159.
- Joshi D, Rawat A K S, Mehrotra S and Pushpangadan P 2015. Hepatoprotective activity of extracts of *Hedychium spicatum*. *Pharmacognosy Research.* 7: 180-185.
- Jugran A, Bhatt I D, Rawat S and Giri Land Rawal R S 2011. Genetic diversity and differentiation in *Hedychium spicatum*, a valuable medicinal plant of the Indian Himalaya. *Biochem. Genet.* 49: 806-818.
- Kaur P and Sood S 2012. Medicinal applications of *Hedychium spicatum*: A review of the species' therapeutic potential. *Indian J. Herb. Med.* 12: 178-185.
- Kaur R and Richa 2017. Antidiabetic activity of *Hedychium spicatum* essential oil. *J. Med. Plants Res.* 11: 69-74.
- Kaur S, Gupta N and Patil K 2014. Pharmacological effects of *Hedychium spicatum* in treating respiratory and digestive disorders. *J. Med. Plants Res.* 13:108-114.
- Kirtikar K R and Basu B D 1984. *Indian Medicinal Plants.* Bishen Singh Mahendra Pal Singh. Dehradun. 2:123-127.
- Kumar A and Singh B 2016. The benefits of root powder and rhizome pieces in treating asthma and internal injuries. *Indian J. Respir. Med.* 9: 119-122.
- Kumar S, Dewan S and Sangraula H 2013. Evaluation of anti-inflammatory and acute toxicity of *Hedychium spicatum*. *IJPSR* 4: 3923-3928.
- Kumar S, Sangraula H and Dewan S 2012. Evaluation of hair growth activity of *Hedychium spicatum* extracts. *J. Pharm. Res.* 5: 5065-5067.
- Kumar V, Singh P and Jain S 2015. Antimicrobial properties of *Hedychium spicatum* and its rhizome powder. *J. Ethnopharmacol.* 65: 284-289.
- Kumar VL, Roy Sand Sharma A 2000. Anti-inflammatory activity of *Hedychium spicatum* ethanolic extract. *J. Ethnopharmacol.* 72: 359-363.
- Kumari I, Kaurav H and Chaudhar Y G 2021. *Hedychium Spicatum* Buch-ham. (KUCHRI), a treasure house of essential oils. *Int. J. Curr. Pharm. Res.* 4: 25-31.
- Kumari R, Uniyal R C and Joshi P 2011. Anthelmintic efficacy of *Hedychium spicatum* essential oil. *J. Ethnopharmacol.* 135: 752-754.
- Malini Tand Vanithakumari G 1990. Hypocholesterolemic effect of *Hedychium spicatum* rhizome extract in rats. *Indian J. Pharmacol.* 22: 227-229.
- Negi J S, Bisht V K, Bhandari A K and Bharti M K 2016. Hepatoprotective potential of hydroalcoholic extract of *Hedychium spicatum* in Wistar rats. *J. Ayurveda Integr. Med.* 7: 152-157.
- Patel A D and Desai R N 2009. Use of *Hedychium spicatum* rhizome decoction as a tonic and for brain health. *J. Tradit. Med.* 5: 210-214.

- Patel R M, Sharma S and Joshi M R 2007. Medicinal and pharmacological properties of *Hedychium spicatum*: A comprehensive review. *Indian J. Med. Plants*. 10: 135-142.
- Rai V and Gupta S 2013. Respiratory and digestive health benefits of *Hedychium spicatum*: A comprehensive study. *Asian J. Tradit. Med.* 10: 150-156.
- Rautela I, Guleria P and Singh R D 2016. Comparative anthelmintic activity of ethanolic extract of *Hedychium spicatum*, *Int. J. Pharmacogn. Phytochem. Res.* 8: 1050-1053.
- Rawal A and Rawal R S 2018. *Hedychium spicatum*: A systematic review on traditional uses, phytochemistry, pharmacology and future prospects. *J. Ethnopharmacol.* 220: 1-15.
- Rawat A, Thapa P, Prakash O, Kumar R, Pant A K and Srivastava R M 2019. Chemical composition, herbicidal, antifeedant and cytotoxic activity of *Hedychium spicatum* Sm.: A Zingiberaceae herb. *Trends Phytochem. Res.* 3: 123-136.
- Rawat D, Joshi V K, Uniyal R C and Semwal D K 2018. Antioxidant activity and phenolic profile of *Hedychium spicatum* extracts. *J. Pharm. Pharmacol.* 70: 1463-1470.
- Rawat S, Jugran A K, Bhatt I D and Rawal R S 2018. *Hedychium spicatum*: a systematic review on traditional uses, phytochemistry, pharmacology and future prospectus. *J. Pharm. Pharmacol.* 6: 687-712.
- Reddy J S, Reddy M S and Rajasekhar M D 2014. Fungitoxic effect of essential oil from *Hedychium spicatum*. *Indian J. Microbiol.* 54: 212-216.
- Reddy P P, Rao R R, Rekha, K, Suresh Babu, K, Shashidhar, J, Shashikiran, G, Vijaya Lakshmi, V and Rao, J M 2009. Two new cytotoxic diterpenes from the rhizomes of *Hedychium spicatum*. *Bioorg. Med. Chem. Lett.* 19: 192-195.
- Reddy RS and Yadav A 2015. The role of roasted *Hedychium spicatum* powder in treating asthma: A review. *J. Respir. Health.* 6: 85-90.
- Sabu M 2000. *Hedychium spicatum* Ham. ex Smith var. *acuminatum* (Roscoe) Wall. - A new record for peninsular India. *Rhedeia.* 1:73-76.
- Samant S S and Pallni L M S 2001. Diversity, distribution and indigenous uses of essential oil yielding plants of Indian Himalayan Region. *J. Med. Aro. Pl. Sci.* 22: 671-687.
- Samant S S and Dhar U 1997. Diversity, endemism and economic potential of wild edible plants of Indian Himalaya. *Int. J. Sustain. Dev. World Ecol.* 4: 179-191.
- Samant S S and Palni L M S 2000. Essential oil plants of the Indian Himalaya: Diversity, distribution and potential. Gyanodaya Prakashan, Nainital, India.
- Samant S S and Pant S 2003. Diversity, distribution and indigenous uses of medicinal plants in Parbati Valley of Kullu district in Himachal Pradesh, North Western Himalaya. *J. Ethnobiol. Ethnomed.* 1: 1-11.
- Samant S S, Pant S, Singh M, Lal M, Singh A, Sharma A and Bhandari S 2007. Medicinal plants in Himachal Pradesh, north western Himalaya India. *Int. J. Biodivers. Sci. Manag.* 3: 234-251.
- Sati S C, Sati M D, Rawat U and Sati O P 2011. Antibacterial potential of *Hedychium spicatum*. *Asian J. Pharm. Clin. Res.* 4:78-81.
- Semwal R B, Semwal D K, Rawat U and Rawat D S 2011. Antidiabetic potential of *Hedychium spicatum* rhizome. *Nat. Prod. Res.* 25: 112-121.
- Semwal R B, Semwal D K, Singh R and Rawat U 2015. Cytotoxic and antioxidant activities of essential oil and extract of *Hedychium spicatum*. *Nat. Prod. Res.* 29: 274-277.
- Sharma P and Mishra S 2010. Therapeutic uses of *Hedychium spicatum* rhizome in respiratory diseases: A review. *J. Herb. Med.* 8: 105-112.
- Sharma R and Arya K R 2010. Labdane diterpenes from *Hedychium spicatum*: cytotoxic and antimicrobial activity. *Phytochem. Lett.* 3: 205-209.
- Sharma R, Uniyal R C and Arya K R 2008. Chemical constituents and cytotoxic activity of *Hedychium spicatum* rhizome. *J. Med. Plant Res.* 2: 177-181.
- Singh B, Sati S C and Sati M D 2012. *In-vitro* antimicrobial activity of *Hedychium spicatum* extracts. *J. Med. Plant Stud.* 1: 45-49.
- Singh R K and Jain A 2008. Essential oils and aroma therapeutic properties of *Hedychium spicatum*. *J. Aromather. Med. Herb.* 4: 21-26.
- Singh S, Sharma N and Singh N 2018. *Hedychium spicatum*: boon for the medicinal field in future. *Bull. Environ. Pharmacol. Life Sci.* 11: 188-192.
- Singh S K and Mehra S 2012. Therapeutic uses of *Hedychium spicatum* in treating a variety of disorders. *Int. J. Herbal Res.* 7: 50-55.
- Sinha A, Tiwari S and Sharma K 2014. *Hedychium spicatum* and its use in Manipur cuisine: Preparation of chutney from fresh rhizomes. *Food Cult. J.* 20: 36-39.
- Sirirugsa P and Larsen K 1995. The genus *Hedychium* (Zingiberaceae) in Thailand. *Nord. J. Bot.* 15: 301-304.
- Srivastava S K, Tripathi S and Pandey H 1973. Clinical trial of *Hedychium spicatum* rhizome powder in bronchial asthma. *J. Res. Indian Med.* 8: 67-71.
- Suresh G, Reddy P P, Babu K S, Shaik T B and Kalivendi S V 2010. Two new cyto-toxic labdane diterpenes from the rhizomes of *Hedychium coronarium*. *Bioorg. Med. Chem. Lett.* 20: 7544-7548.
- Tandon V, Gupta and Sharma S 1997. Antihistaminic and anti-inflammatory activities of *Hedychium spicatum* extracts. *Indian J. Pharmacol.* 29: 174-177.
- Thakur A, Patil R S and Yadav K 2011. The role of *Hedychium spicatum* powder in Tibetan medicine for heating and improving female health. *J. Ethnobot.* 18: 77-81.
- Thapliyal S T, Juyal V and Bhandari A 2014. Hepatoprotective and antioxidant activity of methanol extract of *Hedychium spicatum* against CCl₄-induced liver injury in rats. *Res. J. Pharm. Biol. Chem. Sci.* 5(2): 1428-1437.
- Thomas S, Britto S J and Mani B 2017. First records of two ginger lily *Hedychium* (Zingiberaceae) species from the Western Ghats, India. *J. Threat. Taxa.* 11: 10914-10919.
- Tripathi R M, Singh D K, Singh A and Dey S 1979. Clinical studies on the use of *Hedychium spicatum* in bronchial asthma. *Indian J. Physiol. Pharmacol.* 23: 265-270.
- Uniyal R C, Bisht V K and Bhatt D C 2014. Antibacterial screening of rhizome extracts of *Hedychium spicatum*. *Indian J. Nat. Prod. Resour.* 5: 239-243.
- Verma P and Mehta G 2013. Culinary and medicinal uses of *Hedychium spicatum* rhizomes in Uttarakhand. *J. Himal. Stud.* 12: 49-55.
- Verma S and Mishra A 2011. Incense and aromatic properties of *Hedychium spicatum*. *J. Environ. Sci. Health* 22: 58-62.
- Verma S, Verma D and Pandey R 2012. Anthelmintic activity of methanol extract of *Hedychium spicatum*. *Int. J. Pharm. Sci. Rev. Res.* 13: 115-117.