

Medicinal Pteridophytes of Himachal Pradesh: Exploring Their Role in Alleviating Respiratory and Gastrointestinal Disorders

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Abstract

*Pteridophytes, comprising a diverse group of vascular cryptogams, have been widely used in traditional medicine for their medicinal properties. The therapeutic potential of different medicinal pteridophytes in treating gastrointestinal and respiratory conditions is investigated in this study. Their bioactive substances, including flavonoids, alkaloids, tannins, and saponins, which have anti-inflammatory, antibacterial, and antispasmodic properties, are highlighted by both traditional knowledge and recent research. Specific species, such as *Adiantum capillus-veneris* (maidenhair fern), have demonstrated efficacy in treating coughs and bronchial disorders, while *Pteridium aquilinum* is known for its application in easing digestive discomforts. By combining pharmacological research with ethnomedicinal knowledge, this study emphasizes the therapeutic potential of pteridophytes in treating gastrointestinal and respiratory conditions. The bioactive qualities of these plants are highlighted by examining their historic applications in conjunction with current scientific data, which makes them useful substitute agents in medicine. The focus is on conservation tactics and sustainable harvesting methods, which guarantee these species' long-term supply and protect biodiversity. To create efficient medication formulations, the study promotes combining conventional methods with contemporary approaches. Discovering the pharmacological potential of these little-known plants opens new therapy options by bridging the gap between traditional medical knowledge and modern medical developments. This strategy encourages ecological balance, cultural heritage preservation, and innovation.*

Keywords: Bioactive compounds, gastrointestinal disorders, medicinal plants, pteridophytes, respiratory disorders

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INTRODUCTION

The vascular cryptogams known as pteridophytes, which include ferns and their allies, are an ancient and important group of organisms that first appeared during the Silurian period more than 400 million years ago [1, 2]. These plants, which are distinguished by the lack of seeds and flowers, reproduce by spores and have true roots, stems, and leaves [3, 4]. Despite their widespread distribution throughout different ecosystems, pteridophytes are most prevalent in tropical and subtropical areas, where they flourish in montane habitats, streamside settings, and moist, shaded forest understories [3, 4]. Compared to flowering plants, the medicinal value of pteridophytes is still poorly understood, despite their ecological

significance and taxonomic diversity, especially considering contemporary phytomedicine and pharmacognosy [5, 6]. The ethnomedicinal potential of traditionally used plants has drawn more scientific attention in recent decades. Pteridophytes are one of these that have started to show promise as a useful but mainly unexplored source of bioactive substances [4]. For generations, ferns and their allies have been used by many indigenous and tribal communities in South America, Africa, Southeast Asia, and India to treat various human illnesses [7]. The use of particular pteridophytic species to treat respiratory and gastrointestinal disorders is frequently highlighted in field-based ethnobotanical surveys and traditional knowledge repositories [8]. These include digestive disorders – like diarrhea, dysentery, indigestion, constipation, and peptic ulcers – as well as common but crippling conditions like cough, cold, asthma, bronchitis, and pulmonary infections [9–11]. Many secondary metabolites, including flavonoids, terpenoids, tannins, alkaloids, saponins, phenolics, and glycosides, are thought to be responsible for these plants' pharmacological effectiveness [12]. Numerous of these substances have been shown to possess antimicrobial, anti-inflammatory, expectorant, and antispasmodic qualities, which give scientific justification for their long-standing uses in the management of gastrointestinal and respiratory disorders [12]. The relevance of species from the genera *Adiantum*, *Pteris*, *Dryopteris*, and *Lygodium* in respiratory therapy has been reinforced by reports of their strong bronchodilatory and antimicrobial properties [7]. The investigation of underutilized medicinal flora, including pteridophytes, has become critically urgent due to the rise of drug-resistant pathogens and the increasing need for plant-based therapeutic agents with few adverse effects [13, 14]. However, pteridophytes continue to be glaringly understudied in mainstream pharmacological research, despite their rich phytochemical diversity and promising ethnomedicinal applications [15]. Regarding the scientific validation, standardization, dosage formulation, and conservation status of medicinally significant pteridophytic taxa, there is a significant knowledge gap. The goal is to encourage the conservation and sustainable use of pteridophytes in herbal medicine while also advancing a wider understanding of their pharmacobotanical significance.

STUDY AREA

The present study was conducted in the state of Himachal Pradesh, located in the northwestern Himalayas of India, between latitudes 30°22'40" N to 33°12'40" N and longitudes 75°45'55" E to 79°04'20" E. This region is characterized by a wide range of altitudinal gradients (ranging from 350 m to over 6,000 m above sea level), diverse climatic zones, and rich biodiversity, making it an ideal habitat for a wide variety of medicinal plants, including pteridophytes. The study particularly focused on forested and rural regions across selected districts, including Kangra, Mandi, Chamba, Kullu, Sirmour, Shimla, and Solan, which are known for their dense vegetation and rich ethnobotanical knowledge preserved by indigenous and rural communities.

These areas experience varying climatic conditions, ranging from subtropical in the lower valleys to temperate and alpine in the higher reaches, supporting a broad diversity of pteridophytic flora. Field surveys were conducted in collaboration with local herbalists, traditional healers (Vaidyas), and knowledgeable elders to document traditional uses of pteridophytes in treating respiratory and gastrointestinal ailments. The region's topographical variation, coupled with minimal industrial interference in many areas, contributes to the pristine natural habitat where these plants thrive, often growing in moist, shaded, and undisturbed forest understories, along streams, and on rocky slopes. This ethnobotanical landscape not only offers ecological richness but also reflects a deep-rooted cultural reliance on wild medicinal plants, especially among rural and tribal populations who continue to rely on traditional remedies as primary healthcare solutions. A total of 25 medicinal pteridophyte species belonging to 14 families were documented during the present study (Table 1). Representative medicinal fern species are illustrated in Figure 1, while photographs of the herbarium specimens and field survey are presented in Figure 2. The percentage of different plant parts used for medicinal purposes is shown in Figure 3, and the family-wise distribution of the recorded medicinal pteridophytes is depicted in Figure 4.

Table 1. Some medicinal pteridophytes of Himachal Pradesh.

S.N.	Botanical name	Family	Part used	Medicinal properties
1	<i>Actinopteris radiata</i> (Sw.) Link	Pteridaceae	Fronds	5–10 ml of decoction from fronds is used to drink daily for 15–20 days to treat tuberculosis.
2	<i>Adiantum caudatum</i> L.	Pteridaceae	Whole plant, Fronds	An infusion made from the whole plant is used to drink twice daily for one week to cure gastric problems. Tea prepared from the fronds is drunk daily once to cure bronchitis infection.
3	<i>Adiantum capillus-veneris</i> L.	Pteridaceae	Fronds	Decoction made from the fronds is used to cure asthma.
4	<i>Adiantum philippense</i> L.	Pteridaceae	Whole plant	Fresh or dried plant is boiled in water to prepare a decoction, which is then consumed orally two to three times a day to relieve asthmatic symptoms.
5	<i>Adiantum venustum</i> D. Don	Pteridaceae	Fronds	Fronds are used in the form of decoction or applied in warm preparations to help ease pain and inflammation associated with bronchial conditions.
6	<i>Adiantum lunulatum</i> Burm. f	Pteridaceae	Whole plant	An infusion prepared from the whole plant is used as a syrup to treat pharyngitis and asthma. Powder made from the fronds is mixed with lukewarm water and taken daily to cure digestion problems.
7	<i>Hemionitis leptolepis</i> (Fraser-Jenk.) Christenh.	Pteridaceae	Fronds	The plant material is either chewed raw or prepared as a decoction, which is consumed orally to relieve stomach discomfort, indigestion, and related digestive issues.
8	<i>Asplenium trichomanes</i> L.	Aspleniaceae	Rhizome	Rhizomes are boiled in water to prepare an infusion mixed with 3–4 drops of honey, which is consumed orally to relieve symptoms such as chest congestion, cough, and breathing difficulties.
9	<i>Hemionitis bicolor</i> (Roxb.) Christenh (<i>Cheilanthes bicolor</i> Fraser-Jenk.)	Pteridaceae	Fronds	Decoctions or infusions prepared from the fronds are often used to clear mucus congestion and soothe irritated airways. Powdered fronds of the plant mixed with lukewarm water are used to drink to alleviate stomach cramps and indigestion.
10	<i>Diplazium esculentum</i> (Retz.) Sw.	Aspleniaceae	Fronds	3–5 ml of decoction made from the fronds is used as a drink daily to cure cough, chest congestion, and breathing difficulties. The young fronds of the plant are traditionally consumed either as a green vegetable or roasted and taken as a remedy, soothing the digestive tract and controlling symptoms associated with dysenteric conditions.
11	<i>Dennstaedtia scabra</i> (Wall ex. Hook) T. Moore	Dennstaedtiaceae	Rhizome, Fronds	Rhizomes and fronds are typically boiled in water to prepare a decoction, which is administered orally to relieve symptoms such as cough, bronchial irritation, chest congestion, and breathing difficulties. Young fronds are cooked into vegetables, which helps to treat dysentery and stomach discomfort.
12	<i>Dryopteris juxtaopposita</i> Christ	Polypodiaceae	Rhizome	Powder made from the rhizome is taken with warm milk to treat functional dyspepsia, food poisoning, and peptic ulcers.
13	<i>Dryopteris cochleata</i> (D. Don) C. Chr.	Polypodiaceae	Rhizome	Rhizome prepared as a decoction and consumed orally to relieve symptoms such as stomach pain, diarrhea, and intestinal inflammation.
14	<i>Dryopteris wallichiana</i> (Spreng.) Hyl.	Polypodiaceae	Fronds	The fronds are usually boiled in water to prepare a decoction, which is taken orally to soothe the digestive tract and help to reduce abdominal cramps.
15	<i>Equisetum arvense</i> L.	Equisetaceae	Stem and Cones	Tea or decoction prepared from the stem is used to alleviate stomach discomfort, constipation, and indigestion. Ash from cones is used to cure gastric discomfort due to hyperacidity by mixing it with lukewarm water.
16	<i>Equisetum ramosissimum</i> Desf.	Equisetaceae	Whole plant	An infusion from the whole plant is traditionally prepared as a syrup and given in 2–3 ml doses, two to three times daily, to treat stomach disorders in children.
17	<i>Helminthostachys zeylanica</i> (L.) Hook.	Ophioglossaceae	Whole plant	Decoction or infusion prepared from the whole plant is administered orally to relieve persistent coughing, clear mucus, and soothe the digestive tract.

18	<i>Pteridium revolutum</i> (Blume) Nakai	Dennstaedtiaceae	Rhizome, Whole Plant	Infusion made from the whole plant is used as a syrup to treat persistent coughing and clear mucus. Powder made from the whole plant is used to treat all digestive diseases.
19	<i>Tectaria coadunata</i> (J. Sm.) C. Chr.	Polypodiaceae	Fronds, Rhizome	Crushed fronds mixed with a few drops of honey are used to treat throat infections. Powder made from the rhizome is mixed with lukewarm water and used to treat gastrointestinal disorders.
20	<i>Lygodium flexuosum</i> (L.) Sw.	Schizaeaceae	Fronds	Fronds are used to prepare tea or infusions to soothe the throat and improve respiratory function, indigestion disorders, and stomach pain.
21	<i>Marsilea minuta</i> L.	Marsileaceae	Whole plant	Decoction or infusion prepared from the whole plant and taken orally to relieve chest congestion, ease bowel movements, and soothe abdominal discomfort
22	<i>Nephrolepis cordifolia</i> (L.) C.Presl	Polypodiaceae	Whole plant	The dried plant is ground into a fine powder and taken with honey or warm water to relieve gastric discomfort like gas trouble, stomach ulcers, and acidity. Decoction is prepared by boiling the plant material in water, which is then consumed warm, two to three times a day, to treat sore throat and difficulty in breathing due to mucus.
23	<i>Odontosoria chinensis</i> (L.) J.Sm.	Lindsaeaceae	Fronds	Juice prepared from the fronds is used to treat gastric complaints.
24	<i>Polystichum squarrosus</i> (D.Don) Fée	Polypodiaceae	Whole Plant, Fronds	A decoction or infusion prepared from the whole plant is commonly administered to children and adults alike for stomach disorders, including gas trouble, acidity, stomach ulcers, and intestinal infections. The young fronds are eaten either cooked as a vegetable or roasted, believed to be beneficial in treating dysentery and improving overall digestive function.
25	<i>Pteridium aquilinum</i> (L.) Kuhn	Dennstaedtiaceae	Rhizome	A tea made from the rhizome is used in the treatment of stomach cramps, chest pains, internal bleeding, and diarrhea.



Figure 1. Some ferns: (a). *Adiantum capillus-veneris* L., (b). *Adiantum venustum* D. Don, (c). *Asplenium trichomanes* L., (d). *Dennstaedtia scabra* (Wall ex. Hook) T. Moore, (e). *Polystichum squarrosus* (D.Don) Fée.



Figure 2. (a–d). Photographs of the Herbarium and (e). Picture during the field survey.

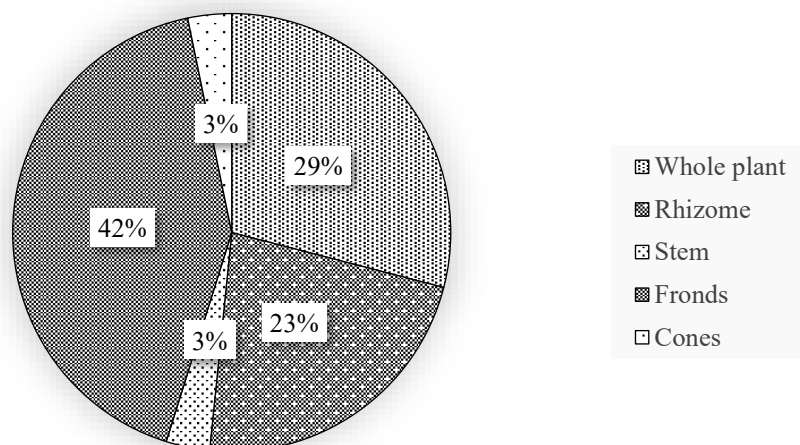


Figure 3. Percentage of different plant parts used for medicinal purposes.

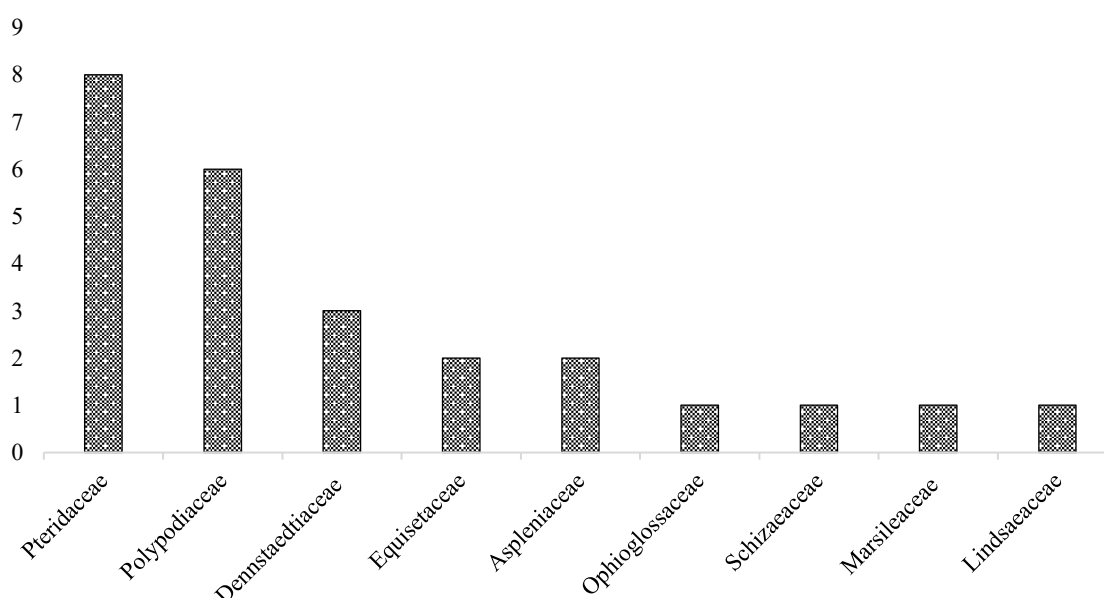


Figure 4. Showing the predominant families of the plants in the study area having medicinal properties.

DISCUSSION

Pteridophytes, which include ferns, are a primitive but pharmacologically powerful class of vascular cryptogams that have become well-known for their medicinal uses, particularly in traditional and indigenous medicine. Building on this understanding, this paper highlights the medicinal properties of pteridophytes, with a specific focus on their role in alleviating respiratory and gastrointestinal disorders. In this paper, the study reveals that 25 ferns from 14 different families were reported, as shown in Table 1. These plants are arranged in alphabetical order, according to their families, parts used, and medicinal uses. The use of fronds (42%) and whole plant (29%) is the highest use for gastrointestinal and respiratory disorders (Figure 1). Figure 2 illustrates the family-wise distribution of medicinal pteridophytes, shedding light on the diversity and prominence of different fern families in ethnomedicinal applications. The families Pteridaceae and Polypodiaceae emerge as the most dominant, with each contributing eight and six species to the medicinal plant inventory. Their frequent usage suggests a strong traditional reliance on these families, possibly due to the proven therapeutic efficacy of their species. The Dennstaedtiaceae family also holds a significant place, represented by three species, reflecting its moderate yet noteworthy contribution. On the other hand, families – like Aspleniaceae and Equisetaceae – are represented by only two species each, implying a more specialized

or lesser-known role in traditional healing practices. This contrast in representation may also be influenced by local availability, traditional knowledge systems, or bioactive compound concentrations in these species. It also highlights the potential for further exploration of underrepresented families for their hidden medicinal potential. Overall, the paper emphasizes the importance of certain pteridophyte families in sustaining indigenous healthcare traditions. The herbal parts of these plants are commonly prepared in the form of decoctions, infusions, pastes, or juices, which are either applied externally or administered orally. For instance, tea prepared from the fronds of *Adiantum caudatum* is consumed once daily to treat bronchitis; a similar result has been shown by Suman and Singh (2024) [16]. Similarly, decoctions made from the stem of *Equisetum arvense* are employed to relieve stomach discomfort, constipation, and indigestion, while ash derived from its cones is mixed with lukewarm water to alleviate gastric discomfort caused by hyperacidity. Similar results have been shown by Suman and Singh (2024) [16]. Furthermore, fronds of *Lygodium flexuosum* are used to prepare teas or infusions that help soothe the throat, enhance respiratory function, and address indigestion and stomach pain. Singh and Upadhyaya (2019) [17] have shown a similar result.

CONCLUSION

Local communities have long utilized many medicinal pteridophytes found in Himachal Pradesh's rich biodiversity to treat a variety of illnesses. This study demonstrates the medicinal value of several ferns and fern-allied species, especially for the management of gastrointestinal and respiratory conditions. In line with earlier research and supporting their place in conventional healthcare systems, species – like *Tectaria coadunata*, *Equisetum arvense*, *Lygodium flexuosum*, and *Adiantum caudatum*, etc. – have demonstrated encouraging ethnomedicinal value. The remedies, which are frequently made as infusions, decoctions, or teas, have noteworthy qualities like digestive, demulcent, antibacterial, and anti-inflammatory effects. In addition to providing rural communities with accessible and reasonably priced healthcare alternatives, these plant-based therapies also offer promising avenues for contemporary pharmacological research. However, medicinal pteridophytes are still not well understood in terms of scientific validation and conservation, despite their extensive use and pharmacological promise. To protect these priceless resources, systematic phytochemical screening, clinical research, and sustainable harvesting methods are desperately needed. In summary, Himachal Pradesh's pteridophytes offer a lot of unrealized medical potential, especially when it comes to treating gastrointestinal and respiratory conditions. As such, they merit more study and incorporation into larger healthcare plans.

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