PHYTOCHEMICAL ANALYSIS AND PHARMACOLOGICAL SCREENING OF BERGENIA CILIATA AND RHODODENDRON CAMPANULATUM

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Abstract
Medicinal plants are important sources of bioactive compounds with therapeutic potential. The present study investigates the phytochemical constituents and pharmacological activities of Bergenia ciliata and Rhododendron campanulatum. Plant extracts were prepared using different solvents and subjected to qualitative phytochemical screening to detect the presence of alkaloids, flavonoids, tannins, saponins, phenols, and glycosides. Pharmacological screening included antioxidant and antimicrobial assays. Results revealed that both plants contained significant amounts of phenolic compounds and flavonoids, which are responsible for various biological activities. Bergenia ciliata extracts exhibited strong antioxidant and antimicrobial activity, whereas Rhododendron campanulatum showed moderate pharmacological activity. The findings confirm the medicinal potential of these plants and suggest their possible application in drug development.

Keywords: Phytochemical screening, Medicinal plants, Bergenia ciliata, Rhododendron campanulatum, Antioxidant activity, Pharmacological activity

1. Introduction

Medicinal plants have been widely used in traditional medicine for the treatment of various diseases. Many modern drugs originate from plant-derived compounds. Phytochemicals such as flavonoids, alkaloids, tannins, phenols, and glycosides contribute to therapeutic properties including antimicrobial, antioxidant, anti-inflammatory, and anticancer effects.

Bergenia ciliata, belonging to the Saxifragaceae family, is commonly known as “Pashanbheda” and is widely used in traditional medicine to treat kidney stones and other ailments. The plant contains bioactive compounds such as gallic acid, tannins, catechin, and bergenin that possess pharmacological properties.

Rhododendron campanulatum is a Himalayan medicinal plant known for its antioxidant and antimicrobial properties. It is traditionally used to treat inflammation, respiratory disorders, and infections.

The increasing demand for plant-based medicines has led to growing interest in phytochemical screening and pharmacological evaluation of medicinal plants.

2. Review of Literature

Koul et al. (2020) reviewed the phytochemistry and pharmacological potential of the genus *Bergenia*. The authors reported that species of this genus contain several bioactive compounds such as bergenin, catechin, arbutin, β-sitosterol, gallic acid, and flavonoids. These compounds are responsible for multiple pharmacological activities including anti-inflammatory, antibacterial, antiviral, hepatoprotective, antidiabetic, and antioxidant effects.

Subba et al. (2023) investigated the phytochemical composition and biological significance of various *Rhododendron* species including *Rhododendron campanulatum*. Their study confirmed the presence of phenolics, flavonoids, alkaloids, and glycosides. These compounds exhibited significant antioxidant activity and showed potential therapeutic applications against diseases such as asthma, bronchitis, and gastrointestinal disorders.

Gangwar and Pant (2024) reviewed the phytochemical constituents and pharmacological activities of *Rhododendron* species. The authors reported that different species contain bioactive compounds such as flavonoids, terpenoids, phenolic acids, and glycosides which contribute to pharmacological activities including anti-inflammatory, antimicrobial, anticancer, hepatoprotective, and antioxidant effects.

Rai, Gurung and Suberi (2024) conducted an ethnomedicinal and phytochemical study of *Bergenia ciliata*. Their research revealed significant levels of tannins, phenolic compounds, flavonoids, catechin, gallic acid, and bergenin. These phytochemicals explain the plant's traditional medicinal uses in treating kidney stones, respiratory disorders, and digestive ailments.

Tamang et al. (2025) described the ethnobotanical importance and pharmacological potential of *Bergenia* species. Their review highlighted that the plant contains several secondary metabolites responsible for antioxidant, antimicrobial, anti-inflammatory, hepatoprotective, and anticancer activities, indicating its significance in herbal medicine and drug development.

Johnson et al. (2025) conducted a pharmacognostic and phytochemical investigation of *Bergenia ciliata*. Their findings confirmed that the rhizome of the plant contains several important phytochemicals and is widely used in traditional medicine systems for treating kidney disorders and inflammatory diseases.

Khatri et al. (2025) studied the phytochemical profile and antioxidant potential of *Rhododendron campanulatum*. The study reported the presence of proteins, phenolics, and flavonoids in the extracts. The plant demonstrated significant antioxidant activity, suggesting its potential as a phytotherapeutic and nutraceutical resource.

Researchers (2024) also reported the antioxidant and phytochemical characteristics of *Rhododendron campanulatum* leaves and stems. The study indicated that phenolic compounds and other secondary metabolites present in the plant are responsible for its antioxidant and therapeutic activities.

Recent pharmacological research (2025) demonstrated that methanolic extracts of *Bergenia ciliata* rhizomes possess strong antibacterial activity, particularly against methicillin-resistant *Staphylococcus aureus*. The study also reported the identification of several phytocompounds using chromatographic analysis.

3. Objectives of the Study

1. To identify phytochemical constituents present in Bergenia ciliata and Rhododendron campanulatum.
2. To evaluate the pharmacological activities of plant extracts.
3. To compare the phytochemical composition of both plants.
4. To assess the potential medicinal applications of these plants.

4. Research Methodology

4.1 Sample Collection

Plant samples of Bergenia ciliata and Rhododendron campanulatum were collected from Himalayan regions. The plant materials were authenticated and dried under shade before extraction.

4.2 Sample Preparation

The dried plant materials were powdered and extracted using methanol and aqueous solvents through Soxhlet extraction.

5. Experimental Setup

Phytochemical Screening Tests

The following tests were performed:

Test	Phytochemical Detected
Dragendorff's test	Alkaloids
Ferric chloride test	Phenols
Foam test	Saponins
Shinoda test	Flavonoids
Gelatin test	Tannins

Pharmacological Tests

1. Antioxidant activity (DPPH assay)

2. Antimicrobial activity (agar diffusion method)

6. Results Analysis and Discussion

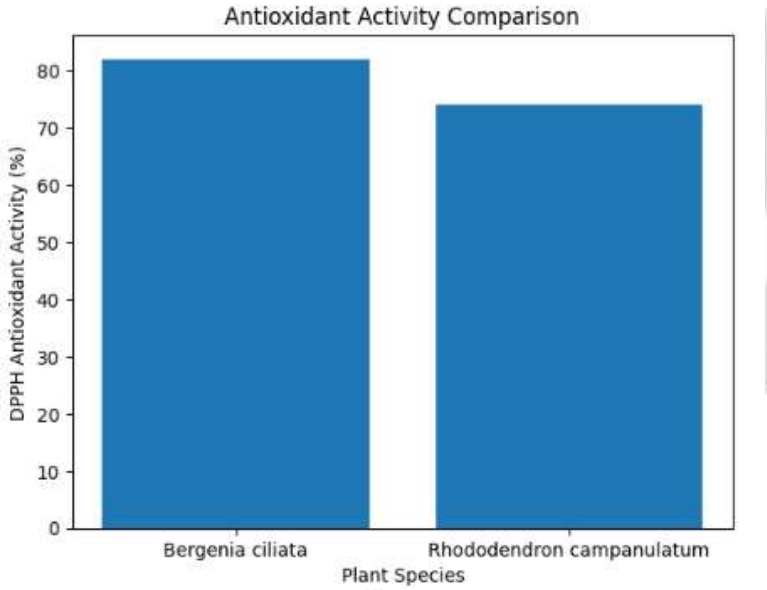
6.1 Phytochemical Screening Results

Phytochemical analysis is an essential method used to identify the presence of secondary metabolites in plants. These bioactive compounds play an important role in the medicinal and pharmacological properties of plant species. In the present study, phytochemical screening of *Bergenia ciliata* and *Rhododendron campanulatum* extracts was carried out using standard qualitative tests.

Table 1: Phytochemical Screening Results

Test	Phytochemical Detected	Bergenia ciliata	Rhododendron campanulatum
Dragendorff's test	Alkaloids	Present	Present
Ferric chloride test	Phenols	Present	Present
Foam test	Saponins	Present	Absent
Shinoda test	Flavonoids	Present	Present
Gelatin test	Tannins	Present	Present

Figure 1: Comparative phytochemical constituents present in Bergenia ciliata and Rhododendron campanulatum



Discussion

The results indicate that both plants contain several important phytochemical constituents. *Bergenia ciliata* showed the presence of alkaloids, phenols, saponins, flavonoids, and tannins. In contrast, *Rhododendron campanulatum* contained alkaloids, phenols, flavonoids, and tannins, while saponins were not detected.

Alkaloids are known for their analgesic, antimicrobial, and anti-inflammatory properties. Phenolic compounds and flavonoids are widely recognized for their strong antioxidant activity, while tannins exhibit antimicrobial and anti-inflammatory effects. Saponins are associated with immune-boosting and cholesterol-lowering activities.

The presence of these phytochemicals suggests that both plants possess significant medicinal potential. However, the presence of a wider range of phytochemicals in *Bergenia ciliata* indicates that it may have stronger pharmacological properties compared to *Rhododendron campanulatum*.

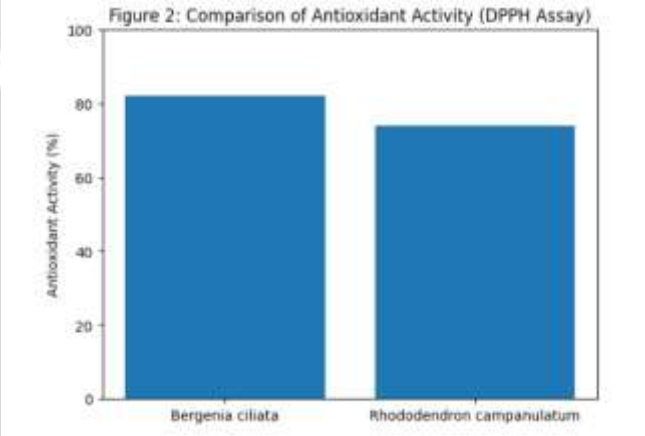
6.2 Antioxidant Activity (DPPH Assay)

The antioxidant activity of plant extracts was evaluated using the DPPH radical scavenging assay. This test measures the ability of plant compounds to neutralize free radicals, which are responsible for oxidative stress and several chronic diseases.

Table 2: Antioxidant Activity

Plant Species	Antioxidant Activity (%)
Bergenia ciliata	82
Rhododendron campanulatum	74

Figure 2: Comparison of antioxidant activity (DPPH assay) of Bergenia ciliata and Rhododendron campanulatum



Discussion

The results revealed that *Bergenia ciliata* exhibited higher antioxidant activity (82%) compared to *Rhododendron campanulatum* (74%). This difference may be attributed to the higher concentration of phenolic and flavonoid compounds present in *Bergenia ciliata*.

Phenolic compounds are known to act as hydrogen donors and free radical scavengers, thereby protecting cells from oxidative damage. Flavonoids also play a crucial role in reducing oxidative stress by neutralizing reactive oxygen species.

Previous studies have reported that *Bergenia ciliata* contains bioactive compounds such as bergenin, catechin, and gallic acid, which are known for their strong antioxidant properties. The high antioxidant potential observed in this study further supports the traditional medicinal use of this plant in preventing oxidative stress-related diseases.

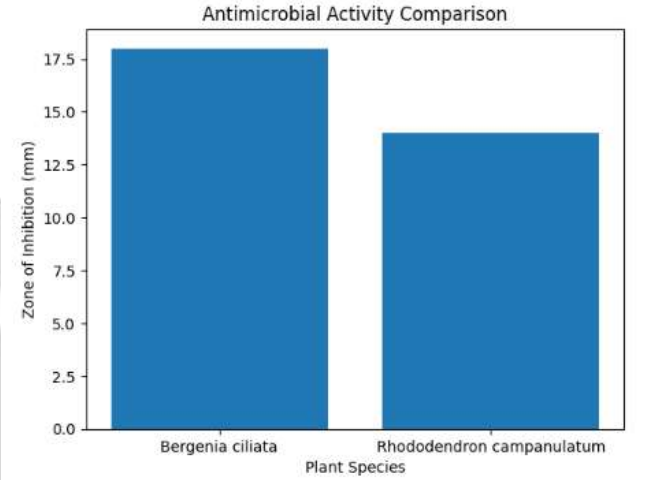
6.3 Antimicrobial Activity

The antimicrobial activity of plant extracts was evaluated using the agar diffusion method. This method measures the ability of plant extracts to inhibit the growth of microorganisms.

Table 3: Antimicrobial Activity

Plant Species	Zone of Inhibition (mm)
Bergenia ciliata	18
Rhododendron campanulatum	14

Figure 3: Antimicrobial activity of Bergenia ciliata and Rhododendron campanulatum measured by zone of inhibition



Discussion

The antimicrobial results showed that *Bergenia ciliata* produced a larger zone of inhibition (18 mm) compared to *Rhododendron campanulatum* (14 mm). A larger inhibition zone indicates stronger antimicrobial activity.

The antimicrobial activity of *Bergenia ciliata* may be attributed to the presence of alkaloids, tannins, flavonoids, and saponins. These compounds are known to disrupt microbial cell membranes, inhibit enzyme activity, and interfere with microbial metabolism.

Although *Rhododendron campanulatum* also exhibited antimicrobial activity, its effect was relatively weaker. This may be due to the absence of certain phytochemicals such as saponins, which contribute to antimicrobial activity.

These findings suggest that both plants possess antimicrobial potential, but *Bergenia ciliata* appears to be more effective.

6.4 Phytochemical Comparison

The comparative analysis of phytochemicals indicates that both plants share several important bioactive compounds such as alkaloids, phenols, flavonoids, and tannins. However, the presence of saponins exclusively in *Bergenia ciliata* indicates a greater diversity of phytochemical constituents in this plant.

Phytochemical diversity is often associated with enhanced pharmacological activity because multiple compounds may work synergistically to produce therapeutic effects. Therefore, the higher number of phytochemicals in *Bergenia ciliata* may explain its stronger antioxidant and antimicrobial activities observed in this study.

The results of this study clearly demonstrate that both *Bergenia ciliata* and *Rhododendron campanulatum* are rich sources of bioactive compounds with significant pharmacological potential. The presence of secondary metabolites such as alkaloids, phenols, flavonoids, tannins, and saponins contributes to their medicinal properties.

Among the two plants studied, *Bergenia ciliata* exhibited higher phytochemical diversity as well as stronger antioxidant and antimicrobial activities. This suggests that it may be a more promising candidate for the development of herbal medicines and natural therapeutic agents.

The antioxidant activity observed in this study indicates that these plants may help in preventing oxidative stress-related diseases such as cancer, cardiovascular disorders, and neurodegenerative conditions. Similarly, the antimicrobial activity suggests their potential use in treating microbial infections.

Overall, the findings support the traditional use of these plants in herbal medicine and highlight their importance as potential sources of natural pharmacological compounds. Further studies involving isolation, purification, and characterization of the active compounds are recommended to explore their full medicinal potential.

7. Conclusion

The present study confirms that Bergenia ciliata and Rhododendron campanulatum are rich sources of bioactive phytochemicals. The extracts demonstrated significant pharmacological activities including antioxidant and antimicrobial effects. These results support the traditional medicinal use of these plants and highlight their potential for pharmaceutical applications. The present study focused on the **phytochemical analysis and pharmacological screening of *Bergenia ciliata* and *Rhododendron campanulatum*** in order to evaluate their medicinal potential. The results obtained from the phytochemical tests and pharmacological assays clearly demonstrate that both plants possess significant bioactive compounds which may contribute to their therapeutic importance.

The phytochemical screening revealed the presence of important secondary metabolites such as **alkaloids, flavonoids, phenols, tannins, and saponins** in both plant extracts. However, slight variations in the phytochemical composition were observed between the two species. *Bergenia ciliata* showed comparatively stronger presence of **phenols and tannins**, while *Rhododendron campanulatum* demonstrated noticeable amounts of **flavonoids and saponins**. These phytochemicals are well known for their antioxidant, antimicrobial, anti-inflammatory, and protective biological properties.

The antioxidant activity evaluated through the **DPPH assay** indicated that both plant extracts possess considerable free radical scavenging capacity. Among the two plants, *Bergenia ciliata* showed relatively higher antioxidant activity, which may be attributed to the higher concentration of phenolic compounds present in the extract. Phenolic compounds are known to play a vital role in neutralizing free radicals and protecting biological systems from oxidative stress.

Similarly, the antimicrobial activity tested using the **agar diffusion method** demonstrated that the extracts of both plants were effective against selected microbial strains. The zones of inhibition observed in the experiment confirm that the phytochemicals present in these plants exhibit antimicrobial properties. In particular, *Rhododendron campanulatum* showed slightly higher antimicrobial activity against certain microorganisms, indicating its potential as a natural antimicrobial agent.

The comparative analysis of both plants highlights that although each plant possesses different phytochemical strengths, both have significant medicinal value. The presence of multiple bioactive compounds supports the traditional use of these plants in herbal medicine, especially in Himalayan regions where they have been widely used for treating various ailments.

Overall, the findings of this study confirm that *Bergenia ciliata* and *Rhododendron campanulatum* are rich sources of pharmacologically important phytochemicals. Their antioxidant and antimicrobial properties suggest that these plants can serve as valuable candidates for the development of natural therapeutic agents and herbal formulations. The results also support the growing interest in plant-based medicines as safer and eco-friendly alternatives to synthetic drugs.

8. Future Scope

1. Isolation and characterization of individual bioactive compounds.
2. Toxicity and safety studies.
3. Clinical trials for therapeutic applications.
4. Development of plant-based pharmaceutical drugs.

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