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Distribution and Medical Significance of Betula Utilis in Nepal

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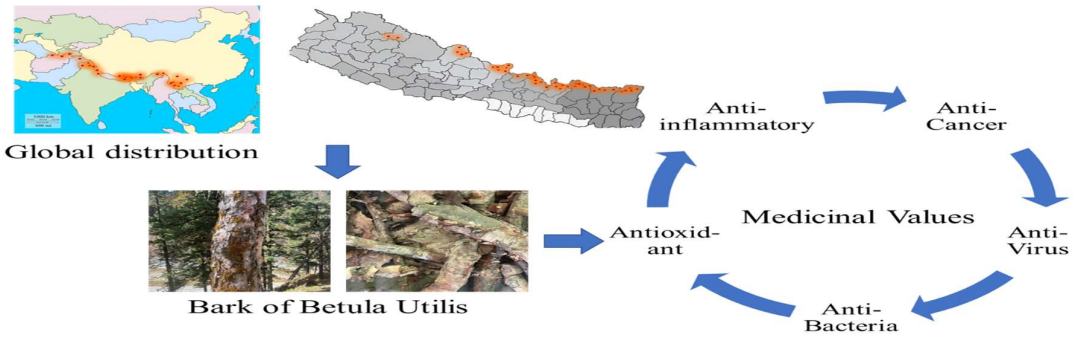
Abstract

This review article explores the distribution and medical significance of *Betula utilis* (Himalayan Silver birch) in Nepal. Across the Himalayan range, *Betula utilis* is found at elevations ranging from 2700 to 4500 meters. It is an important ecological component of alpine and subalpine habitats, stabilising soil and promoting biodiversity. The species is highly valued in culture and has long been used medicinally, treating infections, skin conditions, and diuretics. Its existence is, however, severely hampered by factors like habitat deterioration, overharvesting, and climate change. This review grants the investigation of the botanical description, distribution, and medicinal values of *B. utilis*, with emphasis on its therapeutic potential. Recognizing the plant's medicinal uses which have been in practice since years in Nepalese community could benefit drug development and conservation strategies in the Himalayan ecosystem. This review tends to focus on the miscellaneous applications of *B. utilis* and its possible contributions to health and leads for practices of its conservation. This paper summarizes what is now known about its pharmaceutical potential, ecological significance, distribution, and botanical individualities. It highlights the need for sustainable conservation strategies and further research to preserve this valuable species, ensuring its continued contribution to both environmental health and traditional medicine.

Keywords: Betula utilis, medicinal plant, Himalayan silver birch

Graphical abstract



1. Introduction

Betula utilis (Himalayan silver birch), commonly known bhojpatra in Indian sub-continent (Singh et. al., 2012), is found across the Himalayan range spanning from Afghanistan to south west china at an elevation range of 2700 to 4500 meters (Bobrowski et. al., 2017). Predominantly, it grows on the north facing slopes of subalpine forest, mixed with coniferous forest below and Rhododendron and Salix spp. in upper krummholz belt and forming a narrow belt of pure birch stand in between (Schickhoff, 2005). The plant belongs to the family Betulaceae and consists of medium size trees which can reach a height of up to 20m. It is characterized by its multiple branched structure and irregular trunk. Short, soft hair covers the shoot, young leaves and bracts of the plant. The leaves are ovate and have irregular serrations, and they are arranged alternately on the tree. The bracts of Betula utilis are wider than the wings of the nuts it produces. This tree blooms with flowers in May and June, and it bears fruit in the form of lenticular winged nuts arranged on a spike (Kala 2018). The bark is smooth, shiny in texture and appears reddish brown, reddish white or white with white horizontal lenticles, which gives a distinctive appearance. Additionally, the outer part of bark is composed of thin papery layers which exfoliates in broad, horizontal rolls (Kumaraswamy et. al., 2008).

Betula utilis has cultural, religious and medical significance. The use of Betula utilis has been recorded from ancient times. The tree being considered as sacred by Hindus was used to write scripture and texts in Sanskrit and to make amulets scribbled with mantras for protection from misfortunes (kala 2018). The bark is widely used in ayurveda medicine to treat different ailments and diseases such as skin disinfectant, diseases of the blood and the ear, convulsions, wound healing, bronchitis, leprosy. The leaf extract is used in treatment of infections in urinary tract and kidney and bladder stones (Khanam et. al., 2023) Additionally, the wood is also used for construction of houses and as firewood and foliage is used for fodder purposes (Wani and Pant, 2021).

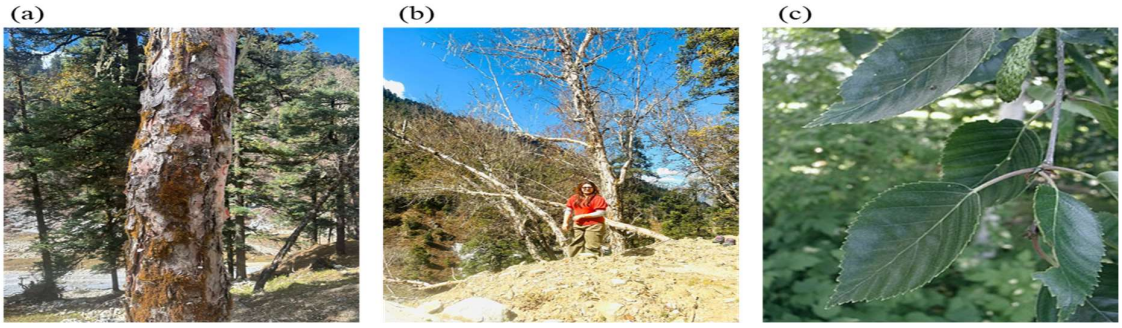
In this review we aim to provide a comprehensive overview of the current knowledge on Betula utilis, encompassing its botanical description, genetic diversity, distribution and some of the medicinal significance. Understanding the medicinal properties of BU could have implications for drug development, complementary therapies, and conservation efforts in the Himalayan ecosystem. By examining the available evidence, this review intends to shed light on the diverse medicinal properties of BU and its potential applications in human health.

Ultimately, Betula utilis stands as a valuable natural resource with the potential to improve global health and well-being.

1.1 Geographical Background

The genus Betula, commonly known as birch, belongs to phylum Tracheophyta, class Magnoliopsida, order Fagales and the family Betulaceae. It is a moderate-sized deciduous tree that can reach a height of up to 20 meters. The bark of BU is smooth, shining, reddish-white, or white, with distinctive white horizontal lenticels. The outer bark consists of numerous thin papery layers, which exfoliate in broad horizontal rolls (Kumaraswamy et al., 2008). The tree's multiple-branched structure, irregular trunk, and ovate leaves with irregular serrations, arranged alternately, contribute to its visual distinctiveness. BU blooms with pendulous spikes of flowers in May to June and is pollinated by wind (Kala, 2018). The tree prefers well-drained soil, including sandy, loamy, and heavy clay soils, and can grow in both semi-shade and no shade conditions (Rastogi et al., 2015).

Figure 1: *Figure showing various features of the Betula utilis species from Mugu district, Nepal.*



(a) A close-up of the trunk of Betula utilis, highlighting its distinctive peeling bark, which has a papery texture and reveals layers of reddish-brown to pale silver, (b) A full view of the whole Betula utilis tree, showcasing its typical slender form and silver-hued bark, which gives the tree a striking appearance in its natural subalpine environment. (c) A detailed image of the leaves of Betula utilis, displaying their oval shape, serrated edges, and vibrant green colour, which is characteristic of the species during the growing season.

1.2 Ecological role in the Himalayan ecosystem

Betula utilis plays a valuable role in ecological succession of upland ecosystems. The potential for utilization of white-barked birches in reforestation and restoration efforts is highlighted by the fact that they are good pioneer species and can quickly colonize cleared areas, reducing soil erosion and paving the way for the restoration of former forest cover. Numerous taxa are also able to tolerate low nutrient levels, damp environments like bogs, and thrive in sandy soils, which allows them to occupy ecological niches that other tree species find inappropriate (Beck et al., 2016). Numerous Betulaceae taxa play a crucial role in soil stabilization, watershed protection, and wild population conservation due to their capacity to grow at high altitudes.

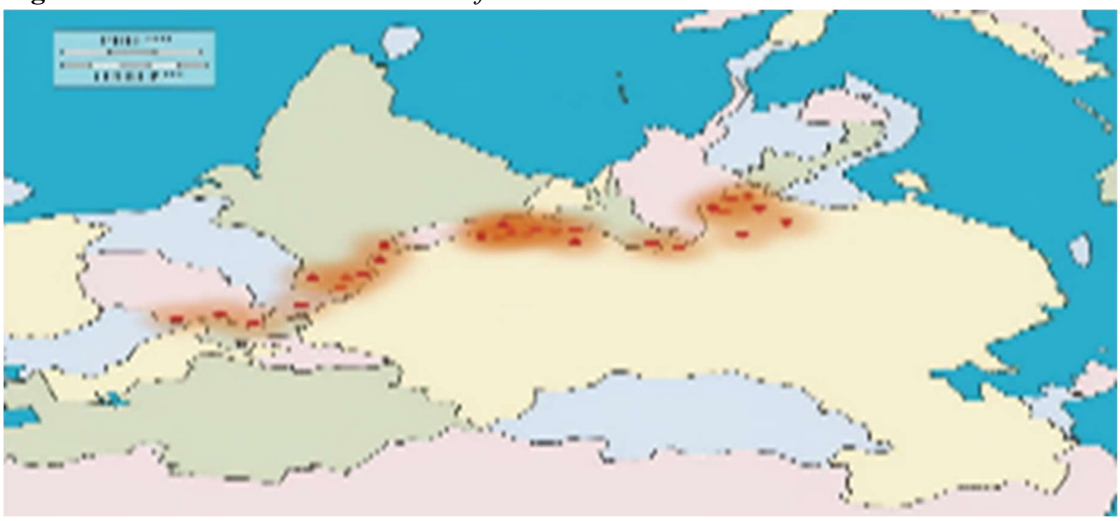
Within Nepal's alpine and subalpine environments, Betula utilis performs a significant ecological role. In delicate alpine settings that are prone to erosion, it frequently establishes pure stands near the upper tree line, aiding in soil stabilization (Chalise et al., 2019). The organic matter provided by the tree's bark, leaves, and litter helps the nutrient cycling in soils at high altitudes. In addition to providing lichens, mosses, and shrubs with a range of alpine flora and fauna to call home, Betula utilis also acts as a nesting site for birds and a shelter for small mammals (Kirichenko., 2017). The tree grows best in cold, damp climates; it is frequently found in areas with frequent heavy snowfall and brief growing seasons. Because of its resilience to severe weather, it is a keystone species in many habitats, contributing significantly to biodiversity conservation in regions where few other tree species can thrive.

1.3 Global Distribution

The natural distribution of Betula utilis spans a vast geographical range, primarily confined to the rugged terrains and high-altitude ecosystems of the Himalayas. This species is found across regions from Afghanistan in the west to southwestern China in the east, covering countries such as Pakistan, India, Nepal, and Bhutan (Singh et al., 2012). Thriving in elevations between 2700 to 4500 meters, Betula utilis is a quintessential component of the subalpine and alpine forest ecosystems in this region (Bobrowski et al., 2017). In its natural habitat, Betula utilis primarily grows on north-facing slopes within the subalpine forest, often intertwined with coniferous vegetation at lower elevations and the upper krummholz belt dominated by Rhododendron and Salix species.

An intriguing characteristic of Betula utilis is the formation of a narrow belt of pure birch stands amidst this diverse landscape (Schickhoff, 2005). Nepal has an abundant population of Betula utilis mainly due to its widespread mountainous topography, as the Himalayas cover a large portion of the country, providing vast and suitable habitats for the species (Bajracharya, 1996). The elevation range between 3,000 and 4,500 meters, which is ideal for the growth of Betula utilis, is widespread in Nepal's geography (Bobrowski et. al., 2017). Additionally, the country's varied microclimates, resulting from the different mountain ranges and valleys, create diverse environmental conditions that further support the growth and proliferation of this tree species. Moreover, Nepal's strong conservation efforts, with numerous national parks and conservation areas such as Sagarmatha and Langtang, play a significant role in protecting the forests where Betula utilis thrives, ensuring its continued abundance (Shrestha, N., & Shrestha, K. K., 2008).

Figure 2: *The worldwide distribution of Betula utilis*

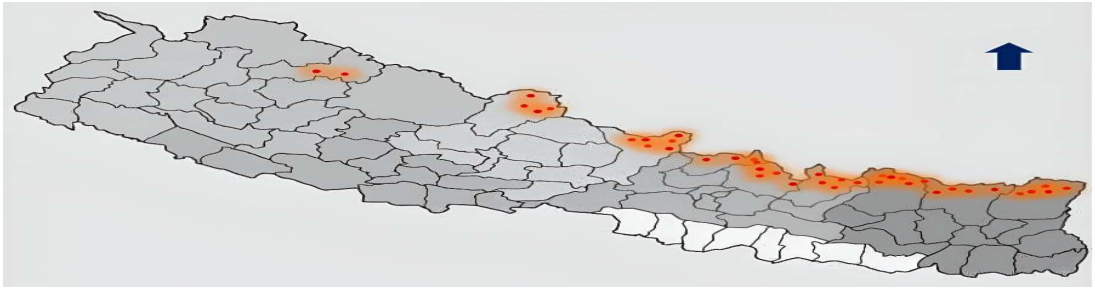


This map illustrates the worldwide distribution of Betula utilis, commonly known as Himalayan birch. The species is predominantly found in the Himalayan region of Nepal, where it exhibits the highest abundance. Other notable areas of Betula utilis presence include parts of China, Pakistan, Afghanistan, India and Bhutan.

1.4 Geographical distribution in Nepal

Betula utilis is widely distributed across the Himalayan region of Nepal, occupying high-altitude zones where the environment is conducive to its growth. This species thrives between the altitudes of 3,000 and 4,500 meters, where the climate is cold, and the air is thin (Bobrowski et. al., 2017). These altitudes mark the transition from dense forest to alpine meadows, with Betula utilis often found growing near the tree line. It is especially common in the subalpine and alpine zones, making it a characteristic species of Nepal's upper Himalayan ecosystems.

Figure 3: T*he distribution of Betula utilis, commonly known as Himalayan birch in Nepal.*



This map illustrates the distribution of Betula utilis, commonly known as Himalayan birch in Nepal. The majority of this species is found in the Eastern region of Nepal primarily above 3,000-meter altitudes.

In Nepal, Betula utilis benefits from the protection afforded by national parks and conservation areas (Sujakhu et al., 2013). Efforts to conserve Nepal's rich biodiversity have

been crucial for the preservation of this species. In areas like Sagarmatha, Langtang, and Annapurna, strict conservation policies protect the forests, including Betula utilis populations, from deforestation and overexploitation.

However, challenges remain, especially concerning overharvesting for medicinal use, construction, and fuelwood in non-protected areas. With the growing demand for the tree's medicinal and traditional uses, there are concerns about its overharvesting in some regions. Continued conservation efforts, sustainable harvesting practices, and community-based conservation programs are essential to ensuring the long-term survival of Betula utilis in Nepal's Himalayan region.

The species is particularly abundant in Nepal's protected areas and national parks, which provide ideal conditions for its growth. Major regions where Betula utilis is prevalent include:

Table 1: *Distribution of* Betula utilis *in Major Protected Areas of Nepal*

S. N	Site	Co-ordinates	Places	Source
1	Sagarmatha National Park	27º.95′N, 86º.73′E	Tengboche, Dingboche	(Bobrowski et al., 2017)
2	Langtang National Park	28º.14′N, 85º.43′E	Langtang Valley	(Sujakhu et al., 2013)
3	Annapurna Conservation Area	28º.83′N, 84º.02′E	Manang, Muktinath, Annapurna Base Camp area, Nyishang	(Shrestha et al., 2007; Ghimire et al., 2022)
4	Manaslu Conservation Area	28º.58′N, 84º.65′E	Larkya La Pass region, Samagaun valley, Tsum	(Sujakhu et al., 2013)
5	Makalu-Barun National Park	27º.77′N, 87º.27′E		(Paudel et al., 2012)
6	Rara National Park	29º.52′N, 82º.12′E	Rara Lake	(Paudel et al., 2012)
7	Kangchenjunga Conservation Area	27º.70′N, 87º.95′E	Ghunsa	(Bobrowski et al., 2017; Dhamala et al., 2020)
8	Dhorpatan Hunting Reserve	28°33′ N, 83°11′ E	Rughakharka, Baglung, Myagdi	(Bista et al., 2021)

3. Medicinal Properties

The plant Betula utilis has several different applications. The specific epithet, utilis, refers to the various functions that the tree's various sections provide (Takahashi et al., 2005). The species is a rare source of betulinic acid, a phytochemical molecule with a wide range of biological functions. Research has demonstrated that betulinic acid suppresses the growth of lung and liver malignancies as well as malignant melanoma (Ali-Seyed et al., 2016). It has been demonstrated that several of these compound's derivatives block HIV-1 at a very early

stage of the virus's development (Takibayeva et al., 2023). Different alkaloids found in the plant are also well-known for their diverse medicinal properties. The plant Betula utilis produces the valuable ingredient betulin, which is a key component of medications that protect the liver, reduce inflammation, fight bacteria, and act as an antioxidant (Liu et al., 2014). Betula utilis bark is antiseptic and carminative and is also reported to contain karachic acid which is aromatic with antiseptic properties (Khan et al., 1974). When suffering from jaundice, heated water mixed with bark is utilized as earache relief drops. The extract made with betula bark is claimed to cleanse the blood and avoid metabolic disorder (Paniagua et al., 2024). A paste of the resin obtained from bark is applied to boils. People in the Kumaon region of Utter Pradesh, India, west of Nepal, use this resin for contraceptive purposes (Singh et al., 2012). Birch tar is an astringent ingredient in ointments for eczema and psoriasis (Stone, 2014). Locals have long utilized the particular fungus growth on select plant sections in traditional medicine (Singh et al., 2012). Birch leaves are used to make a diuretic tea for colds, dysentery and stomach ailments (Chumak et al., 2019). Additionally, betula leaves have been applied to the scalp to lessen dandruff and hair loss. Certain species, particularly Betula lenta, have methyl salicylate, often known as oil of wintergreen, which was once extracted and applied topically as an anti-inflammatory. Additionally, the plant's leaves demonstrate effectiveness in treating kidney and bladder stones as well as urinary tract infections (Shah et al., 2017).

Figure 4: *The medicinally valuable parts of the Betula utilis D. Don species, commonly known as Himalayan birch*

This figure illustrating the medicinally valuable parts of the Betula utilis D. Don species, commonly known as Himalayan birch. (a) Depicts the trunk of the Betula tree, from which the bark is harvested. (b) Shows the extracted bark, which is traditionally and pharmaceutically utilized for various medicinal purposes, such as anti-inflammatory, antimicrobial, and antiviral treatments. The bark is often processed to extract bioactive compounds widely used in traditional remedies and modern medicine.

4. Conservation Challenges

Despite historically thriving in its natural habitat, Betula utilis faces several challenges to its survival, mainly due to anthropogenic and environmental factors. The increasing demand for land for human settlement, agriculture, and infrastructure development has resulted in the degradation and fragmentation of its habitats. Unsustainable logging practices and illegal harvesting of trees for medicinal purposes have further exacerbated the decline of Betula utilis populations (). Moreover, the impact of climate change, including rising temperatures, altered

precipitation patterns, and shifting ecological dynamics, presents additional threats to the species in its native range. These environmental changes disrupt the delicate ecological balance that supports the growth and reproduction of Betula utilis, potentially leading to changes in its distribution and population dynamics (). In light of these challenges, conservation efforts are of utmost importance to preserve the genetic diversity and natural habitats of Betula utilis, ensuring its long-term survival. Comprehensive studies on its distribution and current population dynamics can inform targeted conservation strategies distribution in Nepal

5. Future Directions for Research and Conservation

There is a significant need for further research on Betula utilis to fully understand its ecological role, distribution dynamics, and potential vulnerabilities in the face of changing environmental conditions. More detailed surveys are needed to assess the current population status, genetic diversity and pharmacological potential of Betula utilis in different parts of Nepal, particularly in remote and less-explored regions. Understanding population dynamics, including reproduction and growth patterns, will help guide conservation efforts. To ensure the future of Betula utilis in Nepal, a multifaceted approach combining scientific research, sustainable resource management, community engagement, and policy development is crucial. Addressing research gaps, promoting sustainable harvesting, restoring habitats, and preparing for the impacts of climate change will help protect this valuable species for future generations. Conservation strategies must be proactive and adaptive, ensuring that Betula utilis continues to thrive in Nepal’s high-altitude ecosystems.

6. Conclusion

In Nepal's high-altitude areas, the Himalayan birch, Betula utilis, is an essential tree. In addition to providing habitat and medical benefits, it stabilizes ecosystems. The tree's medicinal relevance is highlighted by its widespread usage in traditional medicine and its potential pharmacological qualities; nonetheless, overharvesting is becoming a greater threat to the tree's population. Abundant populations of Betula utilis are found in important regions including Sagarmatha National Park, Langtang National Park, and the Annapurna Conservation Area. These locations benefit from conservation efforts that guard against destruction and overexploitation of these ecosystems. However, overharvesting and climate change threaten its survival. Research, community-based conservation, and sustainable harvesting are essential to the preservation of this important species. More investigation into the ecological importance, genetic variety, and therapeutic potential of this important species is necessary to protect it. Strategies for conservation must combine habitat restoration with sustainable use, informed by both conventional wisdom and cutting-edge research. We can guarantee that Betula utilis flourishes in Nepal's Himalayan landscapes and contributes to the wellbeing of the environment and the people who depend on it by encouraging cross-border cooperation and increasing public knowledge of its significance.

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