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PRINSEPIA UTILIS ROYLE: A COMPREHENSIVE REVIEW

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Abstract : *Prinsepia utilis* Royle, commonly known as bhekal, is a wild-woody oil-yielding species belonging to the Rosaceae family. This perennial deciduous shrub thrives in diverse habitats, including farm boundaries, open barren areas, sacred groves, wastelands, and open sunny locations on dry hillsides and near water sources in the Indian Himalaya region. With densely branched growth, reaching 4–6 meters in height, the plant features cylindrically shaped stems adorned with rigid stout spines, forming clusters of profuse branches. The presented review is the first attempt to gather utmost information about the distribution, ethno-medicines, phytochemical analysis, pharmacology and toxicology of *P. utilis*. This review was designed with the aim to compile fragmented information about *P. utilis* in addition to explore its therapeutic potential and future research opportunities. A total of 39 research papers were reviewed using several data sources such as; Web of Science, Scopus, Google scholar, Science direct and PubMed. Results of this review revealed that *P. utilis* is being used to cure different types of ailments. Although among reported disorders *P. utilis* showed high potential in the treatment of thermal detoxification, anti-inflammatory effects, promotion of blood circulation, pain relief, assistance in digestion, oral cavity suppression, and treatment of enteritis. Decoctions from tender stems, leaves, and fibrous roots are employed for their anti-inflammatory and analgesic effects, particularly in relieving toothaches and throat inflammations. Additionally, bhekal serves diverse purposes in local communities, such as a bio-fence, apple grafting material, soap substitute, and cosmetic ingredient. The plant's termite-resistant wood finds applications in crafting handles, musical instruments, toys, household commodities, and various items. Furthermore, bhekal plays a role in ritualistic and holistic practices, reflecting its multifaceted significance in the ecological, medicinal, and cultural realms.

Key words: Medicinal uses, Photochemistry, Pharmacology, Shrub, Leaf extract

1. Introduction

Prinsepia utilis Royle, a deciduous shrub of the Rosaceae family, is perennial and primarily distributed in high-altitude areas of China and India (Kumar et al., 2021). It is the 19th most prominent family in the plant kingdom, with over 100 genera and 2830-3100 species (Joshi., 2022). The family is also known for common fruits like strawberries, almonds, cherries, and apples. *P. utilis*, belonging to the Prinsepia genus, has three related species. *P. utilis* has a wide distribution in India, including states like Jammu & Kashmir, Himachal Pradesh, and Uttarakhand (Wani et al., 2018) in various habitats, including along depressions and roadsides, and on mountain slopes or valleys (Zhang et al., 2015). Residents in Yunnan, China, commonly consume its parts as vegetables, and various components and using in traditional Chinese medicine for treating ailments such as skin-related diseases, fractures, and rheumatism (Zhang et al., 2015). Chemical analysis has identified

hydroxybutyronitrile glucoside, diterpene glucoside, hydrocyanic acid, triterpenoids, and more in *P. utilis* (Zhang et al., 2022). Beyond medicinal use, *P. utilis* has economic importance, with its edible seed oil and effective in treating conditions like high blood pressure and atherosclerosis (Chauhan et al., 2023). The seed oil, rich in fatty acids, exhibits potential health benefits (Maikhuri et al., 2021). Research indicates various beneficial properties of *P. utilis*, including antioxidant, hypoglycemic, immunosuppressive, antibacterial, and anti-inflammatory effects (Bagale et al., 2022). However, scientific research linking traditional claims of analgesic and anti-inflammatory properties to empirical investigations is lacking. The plant produces small, dark purple fruits with seeds rich in fatty oil. The seed oil are traditionally used as analgesics, and for arthritis (Kumar and Singh, 2023; Kumar et al., 2023; Kumar et al., 2022; Kumar and Kumar, 2022). The economic importance of *P. utilis* has attracted researchers, prompting a study into the chemical composition, physicochemical properties of the seed oil, and its effectiveness as an anti-inflammatory and analgesic agent (Prasathkumar and Sadhasivam, 2021). Pharmacological studies reveal various functions of *P. utilis*, including anti-osteoporosis, blood lipid regulation, anti-tumor, anti-oxidation, anti-inflammation, and anti-bacterial effects (Peng et al., 2021). Notably, *P. utilis* leaves are used as tea for benign prostatic hyperplasia symptom control by various ethnic minorities in Yunnan province (Shen et al., 2023). The plant is utilized for soil erosion control, providing nutrition and income through its fruit and oil extraction, and has diverse applications, including bio-fence, apple grafting, and traditional practices (Kumar et al., 2021).

2. Methodology

This review article has been designed by compiling and consulting published papers about the medicinal uses as well as scientific validation of *P. utilis*. A total of 39 published papers were consulted using different data bases i.e. Web of Science, Scopus, Google scholar, Science direct and PubMed. In present review restriction of language was considered, only the published articles in English version were included for conducting a search target on *P. utilis* through different databases using a combination of key words including: *P. utilis* ethno-pharmacology; phytochemistry; anti-microbial activities and anti-oxidant properties. In this paper the literature search was only targeted towards scientific publications which were included in above mentioned data bases which may available to scientific society for reference; though we may admit that there may be some other additional data in less available form like unpublished thesis and reports have not been included in this study. All the obtained data from previous published literature is summarized in results (traditional uses; phytochemistry and pharmacological activities) and in figures.

3. Comprehensive literature-based information on *P. utilis*

3.1. Plant morphological description

P. utilis is glabrous spinous shrub, reaching a height of 2-4 m, forms extensive thickets with an average circumference of 4-6m, exhibiting abundant branching above the ground. Its bark, characterized by a rough pinkish or grey texture, peels off in thin papery strips. The stem, with a diameter of 6 cm, displays stout prickles. Lanceolate leaves, measuring 3-5 cm in length, adorn the plant, while white to yellowish flowers, 0.5 to 0.8 cm in diameter, form in short axillary racemes. Kumar et al., 2021 and Maikhuri et al., 1994 reported that the plant's fruits exhibit notable variations in size, shape, and color. Seeds, maturing in 5-6 months, harvesting, often done by hand, proves to be a time-consuming and costly practice, with a potential yield ranging from 900 to 1000 g of fruits per plant/year. The plant readily lends itself to cultivation through seeds.

Fruit ripening begins in the first week of May and extends until the last week of June, with June being the peak harvesting month due to higher oil content. Local residents consider the fruit collection of this plant to be one of the most physically demanding and arduous tasks in the village. Table 1 contains the whole botanical description of *P. utilis*.

Table 1: Botanical description of *P. utilis*.

Feature	Description	Reference
Bark	The bark *of P. utilis* is rough, gray to brown in color, and has a fibrous texture. It tends to have a distinct pattern of vertical fissures.	Kumar et al., 2021
Leaf	Leaves are long, linear, and spirally arranged, growing up to 2 meters in length. They are tough, stiff, and have serrated edges with sharp spines. The leaves are typically dark green with a central midrib and parallel veins.	Chauhan, 1999
Flower	*P. utilis* is dioecious, meaning it has separate male and female plants. Male flowers are small, fragrant, and arranged in clusters called racemes. Female flowers are larger, less showy, and form dense, globular clusters. The flowers are usually white to cream-colored.	Bisht., 2017
Fruit	The fruit is a small, single seeded. When ripe, the fruit turns from green to dark violet or purple colour. Each seed is elongated shaped.	Sapkota, 2023
Seed	Seeds are typically oblong or ellipsoid in shape. They are brownish in color and are procured after removing pulp. The seeds are dispersed birds and mammals.	Kumar et al., 2021

3.2. Taxonomical classification of *P. utilis*

Prinsepia utilis, known as the wild Himalayan cherry (Kewlani et al., 2022), belongs to the kingdom Plantae and subkingdom Tracheobionta, which includes vascular plants. It falls within the superdivision Spermatophyta, comprising seed plants, and the division Magnoliophyta, the flowering plants. Classified under the class Magnoliopsida (dicotyledons), it is part of the subclass Rosidae. *Prinsepia utilis* is in the order Rosales and the family Rosaceae, known for their ornamental and fruit-bearing species. The genus *Prinsepia* includes several thorny shrubs native to Asia, with "utilis" indicating its specific utility and significance. This classification highlights its botanical characteristics and taxonomic relationships. The detailed taxonomical classification of *P. utilis* is given in Table 1 (Ved at al., 2006).

Table 2: Taxonomical classification of *P. utilis*

Kingdom	Plantae
Phylum	Traheophytes
Class	Magnoliopsida
Order	Rosales
Family	Rosaceae
Genus	Prinsepia
Species	*Prinsepia utilis* Royle

3.2. Indigenous traditional uses of *P. utilis*

Medicinally, the seeds and the oil extracted from them are applied to the skin to treat ailments such as rheumatism, joint pains, skin diseases, and wounds due to their antiseptic and healing properties (Chauhan et

al., 2023). Culinary uses include consuming seed oil for cooking, valued for its nutritional benefits and distinctive flavor. Agriculturally, the thorny branches are used for natural hedging and fencing to keep livestock at bay, and the plant helps prevent soil erosion on slopes, enhancing soil fertility (Kumar et al., 2021). Culturally, parts of *Prinsepia utilis* are utilized in religious and ceremonial rituals, often considered sacred and used in festival decorations and offerings (Kumar et al., 2021 and 2023). These traditional applications underscore the plant's significance in the daily lives and cultural practices of the Himalayan communities. Table 3 contains the whole botanical description of *P. utils* and Figure 1 and 2 elaborate the phonological stages.

Table 3: Indigenous traditional uses of *P. utilis*

Part	Traditional Utilization
Leaf	The leaves are used as fodder for livestock. They are especially valued during the dry season when other sources of green fodder are scarce.
Fruit	Edible when ripe; consumed by locals. Also used in traditional medicine for its potential health benefits.
Root	Utilized for medicinal purposes, including treatment of various ailments. Also used to make dyes.
Bark	Used for making ropes and traditional textiles. The fibrous material is also used in construction and for making mats.
Seed	Seeds are sometimes eaten or used in traditional medicine. They can also be used for propagation of the plant.
Flower	Male flowers are fragrant and used in traditional rituals and ceremonies. Female flowers are less commonly used but may be employed in medicinal preparations.
Whole Plant	Used in landscape design for its ornamental value. The plant provides shelter and protection for wildlife.
Wood	Employed in construction for making household equipment and small tools. The wood is durable and resistant to pests.
Thorns	The thorns are not typically utilized but serve as natural protection for the plant, deterring animals and pests.

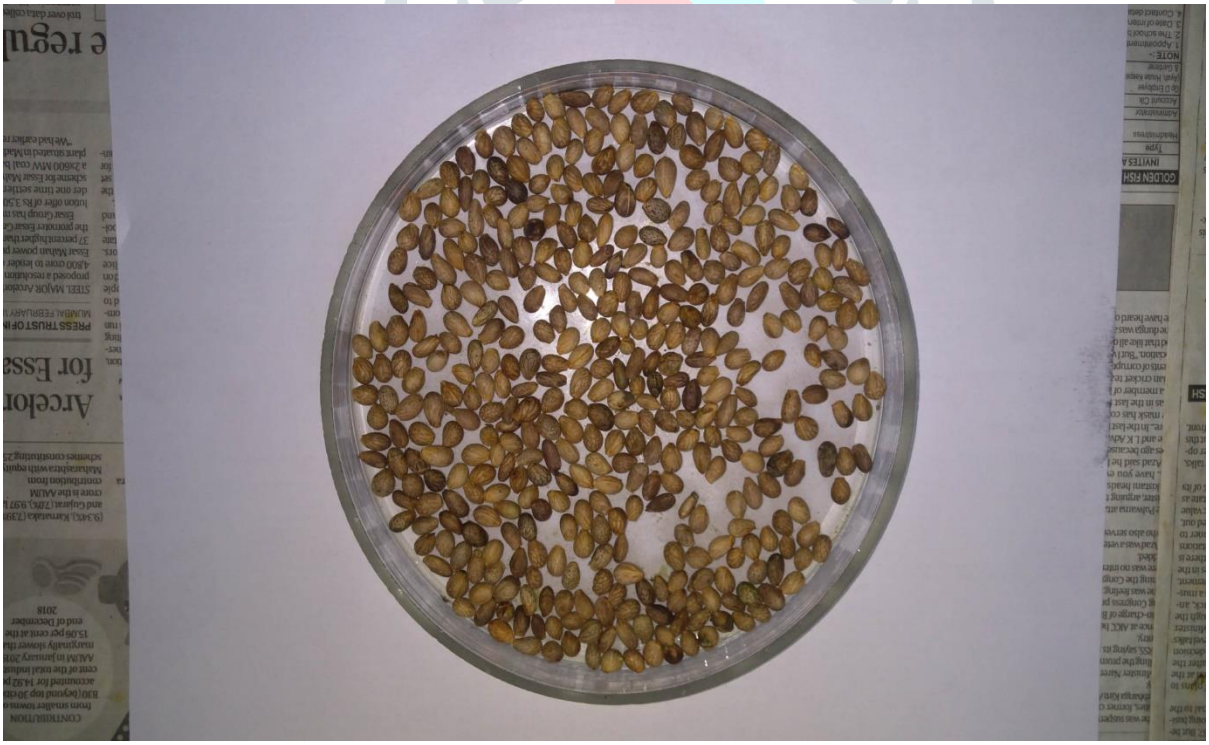
A- Plant of *Prinsepia utilis* Royle

B- Buds of *Prinsepia utilis* Royle

C- Flowers of *Prinsepia utilis* Royle

Figure 1: Different phonological stages of *P. utilis* Royle

A- Fruits *Prinsepia utilis* Royle



A- Seeds of *Prinsepia utilis* Royle

Figure 2: Fruit and seed of *P. utilis* Royle

Pharmacological studies

Pharmacological studies on *Prinsepia utilis* have provided valuable insights into its therapeutic potential. Traditionally, it has been used in folk medicine for its purported health benefits. The plant exhibits diverse pharmacological activities, including anti-inflammatory, antioxidant, antimicrobial, wound healing, and gastro protective effects (Chauhan et al., 2023). Further research is warranted to elucidate the mechanisms of

action of its bioactive compounds and explore its potential applications in clinical settings. *P. utilis* holds promise as a source of novel therapeutic agents for various diseases and health conditions. This plant has recently been found to have a variety of therapeutic benefits shown in Figure 1.

Wound Healing Activity

P. utilis has been investigated for its potential wound healing properties (Chauhan et al., 2023). The leaves, rich in tannins and other phytochemicals, have traditionally been used to treat wounds (Ma et al., 2022). Studies suggest that extracts from the leaves and roots enhance the healing process by promoting cell proliferation and collagen synthesis (Singh et al., 2021). The presence of antimicrobial compounds also aids in preventing infections at the wound site, making it a promising candidate for natural wound healing treatments.

Antipyretic Potential

The antipyretic activity of *Prinsepia utilis* is supported by both traditional usage and scientific evidence. The plant's effectiveness in reducing fever is likely due to its ability to modulate inflammatory responses and mitigate oxidative stress (Thakur et al., 2018). However, while animal studies provide promising results, further research is needed to fully understand the mechanisms involved and to evaluate the safety and efficacy of P. utilis in human populations.

Antidiarrheal Activity

Recent studies have focused on its antidiarrheal activity, attributed primarily to its rich composition of bioactive compounds such as flavonoids, tannins, saponins, and alkaloids (Feng et al., 2023). These compounds are known to exert multiple mechanisms that contribute to antidiarrheal effects. Flavonoids and tannins, for instance, enhance water and electrolyte absorption from the intestinal lumen, while also exhibiting astringent properties that reduce intestinal motility (Zheng et al., 2023). Additionally, saponins possess antimicrobial properties that help in combating pathogenic microorganisms responsible for diarrheal infections (Bagale et al., 2022). Experimental studies using rodent models have demonstrated that extracts from *Prinsepia utilis* significantly decrease the frequency of diarrheal episodes and improve stool consistency. These findings suggest that *Prinsepia utilis* holds potential as a natural therapeutic agent for the management of diarrhea, warranting further clinical trials to validate its efficacy and safety in humans.

Ulcer Healing Potential

Prinsepia utilis shows significant potential as a natural remedy for ulcer healing due to its rich content of bioactive compounds and multifaceted therapeutic properties. Its antioxidant, anti-inflammatory, antimicrobial, and mucosal protective effects make it a valuable addition to the array of natural treatments for ulcers (Scotti and Barlow, 2022). The antioxidants present in *Prinsepia utilis* help in reducing oxidative stress, which is a significant factor in the development and exacerbation of ulcers (Kewlani et al., 2022). By neutralizing free radicals, these antioxidants protect the gastric mucosa from damage. Inflammation is a common response to ulceration. The anti-inflammatory properties of *Prinsepia utilis* help in reducing inflammation, thereby promoting healing (Liu et al., 2024). Ulcers can often be exacerbated by microbial infections, particularly by bacteria such as *Helicobacter pylori*. The antimicrobial compounds in *Prinsepia utilis* can inhibit the growth of these harmful bacteria, thereby preventing infection and aiding in the healing process (Pu at al., 2010). The tannins and saponins in *Prinsepia utilis* (Prakash et al., 2021) have a protective

effect on the gastric mucosa. They enhance the production of mucus, which forms a protective barrier over the ulcer site, shielding it from stomach acids and other irritants.

Diuretic Activity

Prinsepia utilis exhibits significant diuretic activity due to its rich content of bioactive compounds. Its ability to increase urine output, maintain electrolyte balance, regulate blood pressure, and facilitate detoxification makes it a valuable natural remedy for managing conditions associated with fluid retention (Parashar and Starling, 2015). The diuretic activity of *P. utilis* has been documented in several studies. Extracts from the plant parts, particularly the leaves, have been shown to increase urine output in animal models (Singh et al., 2021). This diuretic effect is likely due to the presence of flavonoids and saponins, which promote renal excretion of water and electrolytes. These findings support the traditional use of *P. utilis* in managing conditions associated with water retention.

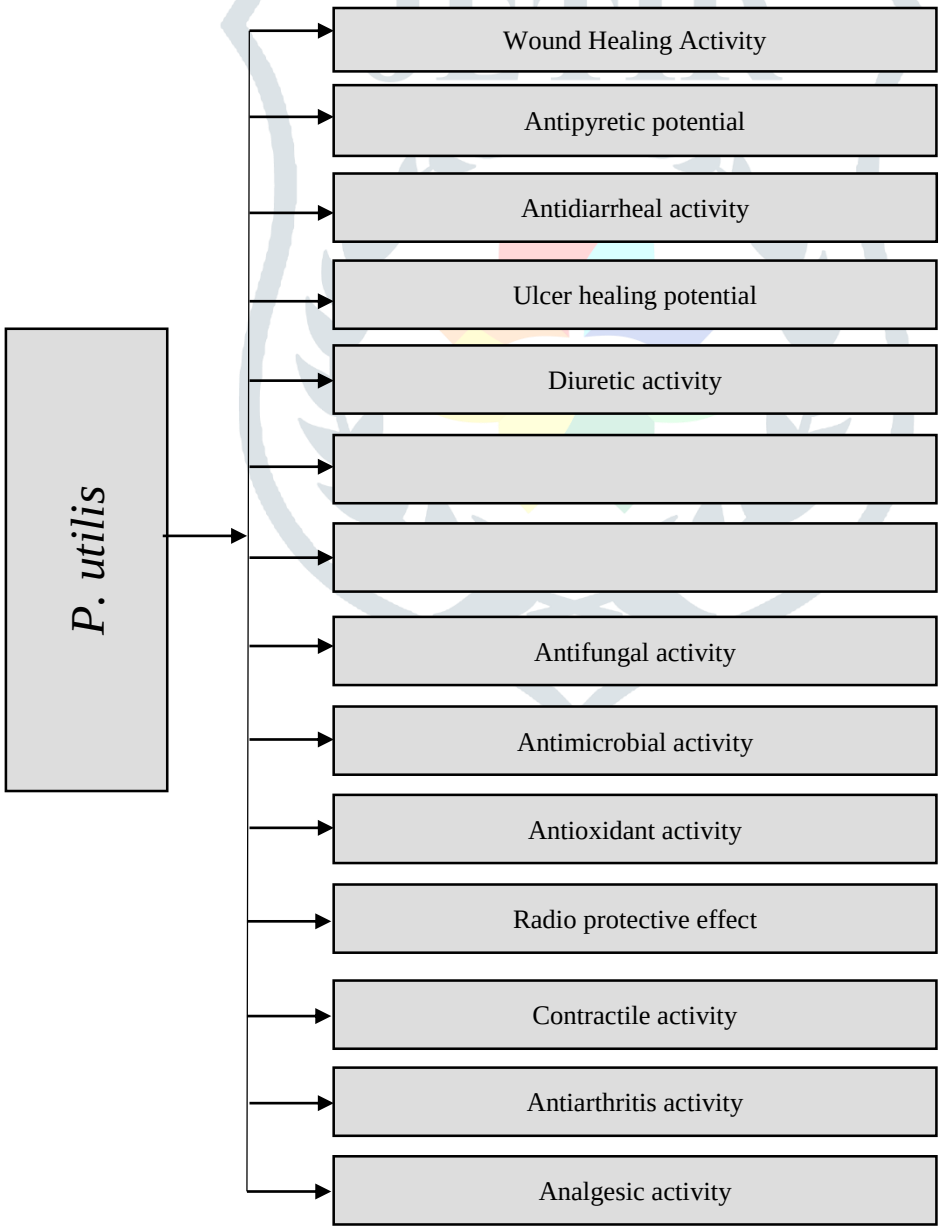


Figure 3: Pharmacological studies on *Prinsepia utilis*

Antifungal Activity

The antifungal activity of *P. utilis* has been substantiated through various studies (Bagale et al., 2022). Extracts from the leaves, roots, and fruits have demonstrated inhibitory effects against several fungal pathogens, including Candida species. The antifungal activity is primarily attributed to the presence of essential oils and other phytochemicals that disrupt fungal cell membranes.

Antimicrobial Activity

P. utilis exhibits broad-spectrum antimicrobial activity (Bhandari et al., 2023). Studies have shown that extracts from the plant are effective against a range of bacterial pathogens, including Gram-positive and Gram-negative bacteria (Bagale et al., 2022). The antimicrobial properties are due to the presence of compounds such as alkaloids, tannins, and flavonoids, which interfere with bacterial growth and replication.

Antioxidant Activity

The antioxidant potential of *P. utilis* is well-documented. Extracts from the leaves, roots, and fruits have shown significant free radical scavenging activity in various assays (Wani et al., 2022). The high content of phenolic compounds and flavonoids is responsible for the strong antioxidant effects, which help in reducing oxidative stress and preventing cellular damage.

Analgesic Activity

P. utilis has demonstrated analgesic properties in preclinical studies (Chauhan et al., 2024). Extracts from the plant have been shown to reduce pain perception in animal models, which is attributed to the modulation of pain pathways and the inhibition of inflammatory mediators. This supports the traditional use of *P. utilis* in pain management.

Ritual Practices of *P. utilis*

The ritual practices surrounding *Prinsepia utilis* are often intertwined with spiritual beliefs, agricultural traditions, and community cohesion. In many Himalayan communities, the blooming of *Prinsepia utilis* heralds the onset of spring, marking a time of renewal and abundance. Rituals are performed to honor the tree and invoke blessings for a prosperous harvest season ahead. These rituals vary among different ethnic groups but often involve offerings of food, incense, and prayers to appease spirits and deities associated with fertility and agriculture. One common ritual is the offering of the first fruits of *Prinsepia utilis* to the local deity or household gods (Thakur et al., 2022). This act symbolizes gratitude for the bounty of nature and seeks blessings for the well-being of the community. Additionally, the branches of the tree are sometimes used in religious ceremonies or as decorations during festivals, further emphasizing its spiritual significance. Beyond its ceremonial role, *Prinsepia utilis* also holds practical importance in traditional medicine systems. Various parts of the plant, including the fruits, leaves, and bark, are believed to possess medicinal properties and are used to treat ailments ranging from digestive disorders to skin conditions. Rituals associated with the collection and preparation of these medicinal remedies often involve chants, prayers, and observance of specific lunar or astrological timings, highlighting the interconnectedness of spirituality and healing practices. Furthermore, the cultivation of *Prinsepia utilis* is often accompanied by age-old agricultural rituals aimed at ensuring a bountiful harvest and protecting the crops from natural calamities and pests. These rituals may involve chanting of mantras, symbolic offerings, and communal work parties, fostering a sense of unity and cooperation among villagers. In essence, the ritual practices surrounding *Prinsepia utilis* reflect the deep

reverence and interconnectedness that Himalayan communities maintain with the natural world, blending spirituality, agriculture, and traditional knowledge in harmonious ways.

Soil Stabilizers in *P. utilis*

Prinsepia utilis, offers potent soil stabilization qualities (Kumar et al., 2021). Its extensive root system anchors soil, preventing erosion on slopes and fragile terrains. Through nitrogen fixation, it enriches soil fertility, enhancing overall ecosystem health. The plant's deep-reaching roots efficiently absorb excess moisture, reducing the risk of landslides and soil degradation. *Prinsepia utilis* also contributes to biodiversity conservation, providing habitat and sustenance for various organisms. As a pioneer species, it facilitates ecological succession, fostering the establishment of diverse plant communities. Harnessing its soil stabilizing properties offers sustainable solutions for land rehabilitation and conservation efforts in fragile ecosystems.

Fencing

Its sturdy fencing prevents livestock from grazing on young saplings, ensuring their undisturbed growth. This species, native to the Himalayan region, plays a crucial ecological role, providing habitat and food for various wild life. The fencing also safeguards against soil erosion, maintaining the integrity of the ecosystem (Kumar et al., 2021). Properly constructed fencing aids in conservation efforts by preserving the genetic diversity of *Prinsepia utilis* populations. Additionally, it facilitates research and cultivation activities, contributing to sustainable utilization. Overall, fencing *Prinsepia utilis* promotes biodiversity conservation and ecosystem stability in its natural habitat.

Food applications

The seeds and oil of this plant are rich in essential fatty acids, proteins, vitamins, and minerals, making them highly nutritious (Maikhuri et al., 2021). The oil extracted from *Prinsepia utilis* seeds, noted for its high content of unsaturated fatty acids such as linoleic and oleic acids, is beneficial for heart health. This oil, with its light, nutty flavor and high smoke point, is used in cooking, including salad dressings, marinades, sautéing, frying, and baking. In traditional Himalayan cuisine, the seeds are ground into a paste used in soups, stews, or as a spread.

Conclusion

Prinsepia utilis Royle, a versatile shrub of the Rosaceae family, exhibits significant potential in medicinal, agricultural, and economic domains. This review, based on 39 scientific papers, highlights the plant's traditional uses and scientifically validated pharmacological activities. Medicinally, P. utilis is used in treating skin diseases, fractures, and rheumatism. Its seed oil is beneficial for high blood pressure and atherosclerosis due to its rich fatty acid content. The plant's phytochemical profile supports its antioxidant, hypoglycemic, immunosuppressive, antibacterial, and anti-inflammatory effects. Agriculturally, P. utilis aids in soil erosion control and provides nutritional and economic benefits through its fruit and oil. Its thorny branches serve as natural fencing, enhancing environmental conservation. Pharmacological studies confirm P. utilis's wound healing, antipyretic, antidiarrheal, ulcer healing, diuretic, antifungal, antimicrobial, antioxidant, and analgesic activities, supporting its traditional uses and suggesting clinical potential. However, further research is needed to understand its bioactive compounds and ensure safety and efficacy in humans. In summary, Prinsepia utilis holds promise for diverse applications, from traditional medicine and pharmacology to agriculture and culinary uses, warranting further research to maximize its therapeutic and economic benefits.

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