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Applications and Conservation of the *Lilium polyphyllum*

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Abstract

Natural remedies for treating illnesses were sought after by ancient humans, who employed animals and plants with therapeutic powers out of instinct. Plants were utilized for prevention and therapy up until iatrochemistry was discovered in the 16th century as human understanding increased. People have sought out medicines throughout history to relieve ailments and reduce suffering. Out of eight ashtvarga plants, *Lilium polyphyllum* is a herbaceous, bulbous herbal medication used in traditional, conventional, and modern medical systems to treat a variety of physiological conditions. It is a significant source of many compound types with a variety of chemical structures and medicinal effects. Present review is compilation of immense medicinal potential of the plant with information on its habit, habitat and conservation status.

Keywords: Natural remedies, conservation, medicinal, Lilium, Kshirkakoli

INTRODUCTION

Natural remedies for treating illnesses were sought after by ancient humans, who employed animals and plants with therapeutic powers out of instinct. In the past, knowledge of medicinal plants' functions centered on experience and on empiric frameworks. Plants were utilized for prevention and therapy up until iatrochemistry was discovered in the 16th century as human understanding increased. People have sought out medicines throughout history to relieve ailments and reduce suffering. Modern processing and application methods were made possible by the discovery of medicinal plants' restorative powers over time and their transmission through the generations (Biljana Bauer Petrovska, 2012).

The World Health Organization estimates that 80% of people in underdeveloped nations rely on traditional plants for basic medical needs. At least 25% of medications in today's pharmacopeia are still made from plants, along with synthetic counterparts. Plants have been used to heal ailments since ancient times, drawing on systems like the Rig Veda Charak Samhita and Sushrut Samhita (Dhyani et al., 2010). The use of plants for novel pharmaceuticals changed significantly in the 18th century, with Astavarga plants being highly effective in rejuvenating and health-promoting chemicals, immunity, cell regeneration, and treating various ailments (Dhyani et al., 2010)

The plant has exceptional medicinal values and is also known as one of the ‘Astavarga’ plants. Ashtavarga plants are also said to act as antioxidants in the body and to rapidly restore health. Because of their potent therapeutic properties, Astavarga plants are used in several ways, including Chyavanprasha, a tonic that promotes health and prevents sickness, oil, medicated clarified butter, and Churana (powder). Several formulations are offered as pharmaceutical items in Indian marketplaces, such as Chyavanprasha and the widely used medication. Nearly all basic healthcare facilities in rural India offer Sudarshana Churna (Dhyani et al., 2010).

Following are Astavarga plants

a) *Habenaria intermedia*
b) *Habenaria edgeworthii*
c) *Lilium polyphyllum*
d) *Roscoea purpurea*
e) *Polygonatum verticillatum*
f) *Polygonatum cirrhifolium*
g) *Malaxis muscifera*
h) *Crepidium acuminatum*

The immune system is boosted by the rejuvenating and health-promoting effects of Ashtavarga plants, which also have a remarkable ability for cell regeneration. They help promote body fat, speed up the healing of fractures, and manage diabetic problems. Additionally, ashtravarga herbs act as antioxidants and instantly restore health. They are utilized in a variety of ways because of their strong medicinal value, including medicated clarified butter, powder, oil, and Chyavanprasha,

a tonic that promotes health and prevents sickness (Mathur 2003; Pandey 2005; Sharma and Balkrishna 2005).

Lilium polyphyllum is a herbaceous, bulbous herbal medication used in traditional, conventional, and modern medical systems to treat a variety of physiological conditions. It is a significant source of many compound types with a variety of chemical structures and medicinal effects, but many more pharmacological effects have not yet been investigated or confirmed. less is known about populations of *Lilium polyphyllum,* according to the plant's known present status. Around 100 species of plants belonging to the family *Liliaceae* may be found in the northern hemisphere's chilly-temperate areas. it is a well-liked blooming plant genera in the world, lilies are appreciated (used) as food and medicinal plants. More than 30 Ayurvedic formulations employ *Lilium polyphyllum* D. Don ex Royle, also called Kshirkakoli, to treat general ill health and as expectorant, used during feverish conditions, stimulating sexual desire and as an astringent (Shalini Dhyani et al., 2018). Flowers are pendulous, Fragrant, pale or green shaded outside, white within with purple streaks, and orange anthers are few of its characteristics. It can reach up to 90cm in height (Shalini Dhyani et al., 2018; Dhyani A, 2007).

The plant is currently listed as critically endangered in IUCN's Red Data book (Anurag Dhyani et al., 2021). It is classified as follows:

- Kingdom- Plantae
- Phylum- Tracheophyta
- Division- Angiosperms
- Class- Liliopsida
- Family- Liliaceae
- Genus- Lilium
- Species- *Lilium polyphyllum* D.Don

Habitat

In humus-rich forests located from 2100-3000 meters over the seafloor, L. polyphyllum flourishes (Rana & Samant, 2010). It flourishes on northern mild slopes beneath Cedrus deodara woodland in cooler, moister, acidic soil. Only 2 to 4 hours of sunshine reach the plant each day, and it typically snows from December to March. Harsil, Dhanaulti, and Kaddukhalsites only get 1-2 months of snowfall, compared to 3-4 months for Valley of Flowers, Chirwara and the Gangotri populations. In the temperate zone, these populations coexist with various herb and shrub species. L. polyphyllum thrives in soil that is rich in humus, silt as well as sand and plant's bulbs need a lot of moisture to form roots (Dhyani et al, 2009)

Location

The Himalayan area, (especially northwestern and southwestern) is the only place where it may be found in its natural environment (Rana & Samant, 2010; Anurag Dhyani et al., 2021). It may be found in the chilly high-altitude regions of Afghanistan and Pakistan, India and Nepal (Anurag Dhyani et al., 2012). The species has a few irregular recurring populations in the Indian Himalayan Region of India in Dhauladhar, Shimla, Pulga-Kullu of Himachal Pradesh, in Jammu and Kashmir's Doda and Chatru, Chakrata, Chakisain, Gargia, Pithoragarh, Raath, and Gangotri region in Uttarakhand. *L. polyphyllum* is also found at found at Chirwasa, Gangotri, Valley of flowers, Dhanaulti, Lambidhar and Kaddukhal (Sourabh et al, 2014).

MEDICINAL PROPERTIES

Anti Inflammatory

The phytochemical investigation of *Lilium polyphyllum* and its anti-inflammatory effect revealed that the plant has a significant amount of phytochemicals that may be employed singly or in conjunction to treat inflammation. The investigation, which used three different solvent systems, revealed that water extract had the most anti-inflammation properties, followed by ethanol and that DCM extract had the weakest effects. The results of the HPLC, GC-MS, 1HNMR, and 1,3CNMR analyses revealed the presence of a number of significant phytochemicals, including 5-hydroxymethyl furfural, Palmitic acid, Methyl piperate, Methyl 2-furoate, and Methyl palmitate, which are either individually or collectively responsible for the property in question (Amin mir et al, 2014)

Antidiabetic

The study examined the spectrum and anti-diabetic activities of several *Lilium polyphyllum* extracts. The enzymes amylase and glycosidase, which convert oligosaccharides into glucose molecules, were shown to be significantly inhibited by the plant, according to the results. The results of the GC-MS analysis revealed a number of chemicals, such as methyl palmitate, 5-hydroxymethyl furfural, methyl 2-furoate, palmitic acid, piperine and methyl piperate which supported the plant's antidiabetic characteristics even further (Amin Mir et al., 2014.).

Antioxidant

The research supported the use of *L. polyphyllum* extract as an Astavarga component by demonstrating that it includes phenols and flavonoid components with antioxidant activity. The hydroxyl groups in phenolic compounds, which can prevent cancer and mutation by scavenging free radicals or by boosting antioxidant enzymes may be the cause of L. polyphyllum's scavenging ability. Because of its high antioxidant content, this species' intake in a variety of formulations may help prevent aging and enhance vitality (Anurag Dhyani, Bhagwati Prasad Nautiyal, et al. 2023). Another study conducted FRAP, ABTS and DPPH assay on methanolic extracts of bulbs of *Lilium polyphyllum*. According to the study, *L. polyphyllum* bulbs can serve as a natural supply of antioxidants (K Rosy Kumari et al, 2014).

Antimicrobial

Linalool and Terpineol, Sitosterol-3-glyceryl-2-linoleiyl-3- linoleiate, and Linalool are all present in dried pseudobulb. 12-dienoyl-3-tetra cosanote, Glyceryl-1- octadec-9-enoyl-2-octadec-9 and Glyceryl-1-n-octadec-9-enoyl-2-ndecomoyl-3-n-decanoadte. Moreover, it contains alkaloids like Peimitidine, Propeimine, Peimisine, peimine, Peimiphine and imperialine (Kumar Sagar, 2014). Linalool and -terpineol may be found in the bulbs of Lilium polyphyllum, and three steroidal glycerides can be found in the methanolic extract, hence it can also be used for its antimicrobial properties.

General medicinal properties and antiaging

Other than above mentioned medicinal properties, this plant also contains secondary metabolites that help in treating Rheumatalgia, Agalactia, cough, bronchitis, conditions pitta vitiated, seminal weakness, strangulation, burning feeling, hyperdipsia, periodic fevers, haematemesis, and general weakness are among the problems it is used to treat (A. Balkrishna et al., 2017; Pragya Thakur et al, 2014). Because of its high antioxidant content, this species' intake in a variety of formulations may help prevent aging and enhance vitality (Dhyani et al., 2023).

MORPHOLOGY OF *LILIUM POLYPHYLLUM (*KSHIRKAKOLI)

Lilium polyphyllum, often known as Kshirkakoli or Himalayan Lily, is a magnificent morphological perennial herbaceous plant. This plant is native to the Himalayas and has distinguishing traits in its roots, leaves, stems, and flowers. The morphology of *Lilium polyphyllum* sheds light on its adaptability to alpine conditions, reproductive tactics, and involvement in ecological systems (Chang Shook Lee et al., 2011).

Figure 1. *Diagram of L. polyphyllum*

Roots

The fibrous root system of *Lilium polyphyllum* is extensively developed. The roots perform critical services such as attaching the plant to the earth, absorbing water and nutrients, and storing carbohydrates. The fleshy texture of the roots, which is designed for water storage, is the most noticeable trait. This modification permits the plant to withstand the harsh conditions of the Himalayan region, which frequently include shortages of water and significant temperature swings. Lilium polyphyllum's fleshy roots are normally white or creamy in color and can reach several centimeters into the soil (Chakraborty & Purabi Saikia, 2023).

Stems

Lilium polyphyllum has tall stems that can reach heights of one metre. They are often unbranched, giving the plant a beautiful, straight appearance. The stem is cylindrical or somewhat angular in form. At the top, it has numerous whorls of spectacular trumpet-shaped flowers. The colour of the stem can range from green to reddish-purple, depending on genetic differences and environmental conditions (Gao et al., 2015).

Leaves

Lilium polyphyllum has lance-shaped, alternating leaves with pronounced veining. These leaves are spirally placed around the stem, providing a distinct and visually appealing pattern. They are typically dark green with smooth surfaces. The leaf margins may have a small undulation, which adds to their visual appeal. The leaves are important in photosynthesis because they are the major

places for converting solar energy into carbohydrates, which feed the growth of plants and developmental processes (Hartmann & Trumbore, 2016).

Flower

The gorgeous blossoms of *Lilium polyphyllum* are its most remarkable and attractive feature. The flowers are big, trumpet-shaped, and usually have six separate tepals. Tepals are petal-like structures that are frequently joined at the base to form a single, flamboyant structure. These beautiful blossoms are a magnet for pollinators and have high decorative value. The tepals' predominant color is white or cream, however, some varieties have pinkish or purplish tinges. The inner surface of the tepals frequently exhibits elaborate patterns of colored dots or streaks, which add to the overall beauty of the flowers (Dahlgren et al., 1985).

Lilium polyphyllum, also known as Kshirkakoli, is a plant endemic to the Himalayas that is both beautiful and adaptable. Its morphology reflects its unusual adaptations to its alpine environment, with thick roots, long unbranched stems, lance-shaped leaves, and beautiful trumpet-shaped flowers. Understanding the delicate features of Lilium polyphyllum's morphology reveals information about its aesthetic and ecological importance (Chang Shook Lee et al., 2011). Lilium polyphyllum's big, fragrant flowers serve as the focal point of its morphology, attracting pollinators and commencing the fertilization process. The reproductive adaptations of the plant, such as the involvement of insects and ants in pollination and seed dissemination, highlight its intricate interaction with its ecosystem (Dhiman et al., 2021).

Anatomy

To better grow and enjoy the beauty of *Lilium polyphyllum*, horticulturists, botanists, and researchers must first understand its anatomy (Dhiman et al., 2018).

Stem Anatomy

The stem of *Lilium polyphyllum* is an essential organ that supports the plant as well as transports water, nutrients, and photosynthates. The stem has different properties that play an important role in the growth and development of the plant. The stem is erect and unbranched, reaching a maximum height of around 90 centimeters, and has a smooth, glossy look with a greenish color. It has a core vascular bundle that is made up of xylem and phloem tissues. The xylem transports water and minerals, whereas the phloem supports the passage of organic substances. *Lilium polyphyllum* leaves are spirally organized along the stem, attached in a whorled manner, giving optimal solar exposure for photosynthesis (Jensen et al., 2016).

Leaf Anatomy

Lilium polyphyllum's leaf morphology is ideal for efficient photosynthesis. The leaves are lance-shaped and elongated, with pointy points, and measure 7-15 cm in length and 1-2 cm in breadth. They are spirally placed along the stem. The upper and lower epidermal layers of the leaf epidermis are covered by a waxy cuticle to prevent water loss through transpiration. Stomata, which are important for gas exchange, are found in the lower epidermis. The mesophyll, the leaf's primary tissue, includes chloroplasts that are responsible for photosynthesis and is separated into two

layers: the palisade mesophyll, which is rich in chloroplasts and placed immediately beneath the upper epidermis, and the spongy mesophyll, which is positioned beneath it (Boyer et al., 1997).

Root Anatomy

Lilium polyphyllum roots are essential for anchoring the plant and absorbing water and nutrients from the soil. Understanding root anatomy is critical for the survival and growth of the plant. Kshirkakoli has a fibrous root structure composed of several thin, branching roots that spread horizontally in the upper layers of soil, facilitating effective water and nutrient absorption. These roots are normally white in color and are protected by a covering known as the root epidermis. The stele is the middle section of the root that contains vascular tissues, including the xylem for water and mineral transport and the phloem for organic compound movement (Thakur et al., 2014).

Reproductive Structures

Lilium polyphyllum's reproductive structures are critical to the plant's life cycle and species propagation. The complicated and exquisite features of these structures distinguish them. Kshirkakoli flowers are hermaphroditic, meaning they have both male (stamens) and female (carpels) reproductive organs. They are often enormous and showy, with six petal-like parts known as tepals that range in color from white to pale pink and have dark patterns at the base. These blooms are produced on a raceme, which is a spike-like structure with many flowers grouped along a central stalk. Insects, particularly bees and butterflies, are drawn to the nectar in the blooms and pollinate Lilium polyphyllum. This ensures pollen transport for fertilization (J.M. van Tuyl et al., 2011).

The anatomy of *Lilium polyphyllum* (Kshirkakoli) allows for a better knowledge of this lovely and botanically significant plant. Horticulturists and botanists interested in its cultivation and protection will benefit greatly from understanding its stem, leaves, roots, and reproductive structures (He et al., 2017).

Why is it Endangered?

Lilium polyphyllum, a medicinal plant species in India, is facing a serious threat of extinction. The survey reveals that only a few populations of *L. polyphyllum* are left due to destructive harvesting and high demand for multiple purposes (Dhyani et al., 2014). Unfortunately, many medicinal plant species in India are also endangered and have been included in the Red Data Book of vulnerable species due to various anthropogenic activities and unsustainable wild harvesting practices (Biswas et al., 2017). To gain a better understanding of this issue, an ethnomedicinal survey was conducted in four states in India: Uttar Pradesh, Uttarakhand, Punjab, and Himachal Pradesh. This survey involved interviews with 24 local medical practitioners, 18 shopkeepers, and 4 traditional healers. Based on the survey conducted by Kaur et al. in 2021, it was found that the use of formulations containing Kshirakakoli was most prevalent in Himachal Pradesh and Uttarakhand. The primary reasons for the threat to this species are biotic and abiotic stress, unregulated collection, changes in weather, habitat degradation, soil infertility, agricultural invasion, as well as the use of flowers in temples and decorations. The local people harvest the bulbs of this species, which provide a heating effect that relieves them from the cold environment. It has also been reported that they sell these bulbs in the market to earn money (Dhyani, 2007). The flower of this

species is very attractive and has a pleasant fragrance that catches people's attention, leading to the plucking of the flowers. Unfortunately, this activity has led to the depletion of *L. polyphyllum*. For medicinal purposes, the bulbs or roots of the entire plant are uprooted and disrupted, causing further degradation. Due to its medicinal properties, there is a high demand for this species in trade, leading to overexploitation. Therefore, it is essential to take action to preserve and maintain the natural habitats of these valuable medicinal plants for the nation (Biswas et al., 2017).

Conservation strategy

Kshirkakoli is one of India's most significant medicinal herbs, and it is currently considered a threatened species included in the Red Data Book. To preserve *L. polyphyllum*, two conservation strategies are commonly used: ex-situ conservation and in-situ conservation, which involve the use of biotechnology (Gabba et al., 2023 and Das et al., 2023). Additionally, local and national laws prohibit the collection of threatened species, and it is often necessary to obtain specific authorization from the authorities before harvesting any part of the plant (Gupta et al., 2023).

In-situ conservation: In order to protect and manage a species, it must be preserved in its natural environment. This can be achieved through various measures, such as creating protected areas, limiting overexploitation, and rehabilitating degraded habitats (Dhyani et al., 2014). It is crucial that the public, especially those living in close proximity to these areas, feel a sense of responsibility and are educated on scientific conservation methods and their benefits. The implementation of in situ conservation can be made more effective through this participatory approach (Zehra et al., 2023). A systematic approach for the preservation of threatened plant species with significant medicinal value is in situ conservation. In-site conservation methods for medicinal and endangered plants include Sacred Groves, National Parks, Biosphere Reserves, and other similar techniques (Chandra et al., 2016). The National Medicinal Plants Board (NMPB) in India is actively working to conserve medicinal plants through the establishment of Medicinal Plants Conservation and Development Areas (MPCDAs). The State Forest Departments play a crucial role in preserving Red Listed Medicinal Plant species and their associated flora. To enhance the biodiversity of medicinal plants in the country, collaboration with research institutions is also being considered (Biswas et al., 2017).

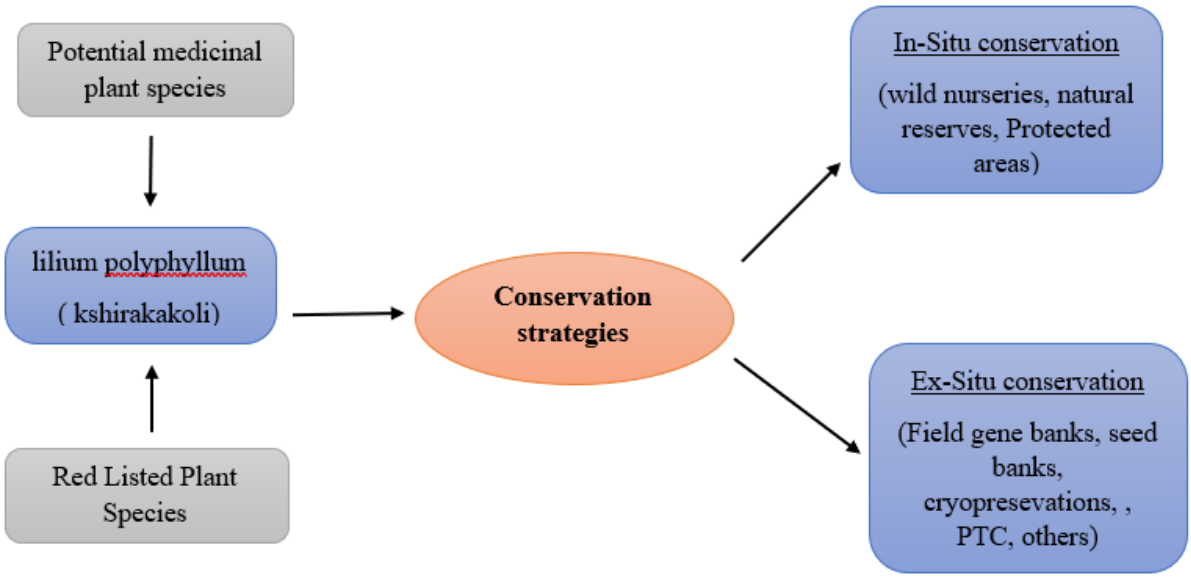

Figure 2. Flow chart of conservation strategies of kshirakakoli

Ex-situ conservation: In order to conserve endangered plant species, it is necessary to collect and preserve samples of the species outside of their natural habitat. This can be achieved through ex-situ conservation methods, such as storing the seeds of many threatened plant species in a repository. Botanical gardens, seed banks, and tissue culture facilities provide the means to accomplish ex-situ conservation (Dhyani et al., 2014). There are various government-sponsored organizations, such as the Central Institute of Medicinal and Aromatic Plants (CIMAP) in Uttar Pradesh, the National Bureau of Plants Genetic Resources (NBPGR) in New Delhi, and the Tropical Botanical Garden Research Institute (TBGRI) in Thiruvananthapuram, among others, which are dedicated to the conservation of medicinal plants (Chandra et al., 2016). As per the findings of Dhyani et al. (2023), the Dhanaulti population had the highest seed moisture content, resulting in the highest seed weight. On the other hand, the Gangotri population produced the maximum number of seeds, which could be a strategy for preserving a seed bank in harsh climates and reducing the risk of rare species going extinct. Seed preservation in the form of a gene bank is particularly useful for preserving agricultural crop germplasm. To keep the seeds viable for up to 100 years, they are stored at 20°C, as suggested by Choudhary et al. To preserve seeds for long-term storage, they can be categorized as orthodox or recalcitrant based on their ability to tolerate desiccation (Zehra et al., 2023). Cryopreservation is another method for preserving germplasm.

Conserving endangered medicinal plant species like Kshirakakoli through tissue culture preservation is of utmost importance. To aid in these efforts, the government should provide financial assistance and training programs. In addition, botanical gardens should be established to protect these species. Ex situ conservation techniques, such as assessment, quarantine, and characterization, should also be implemented. A strong support system, strategic design, and specific plans are necessary for success. It is crucial to inform stakeholders, establish nationwide monitoring systems, and promote the creation of parks and gardens (Kaundal and Devi, 2016; Hawkes et al., 2012).

According to Dhyani et al., (2014), A method of mass propagation of *Lilium polyphyllum* using in vitro seed germination and callus culture. This method can be used for both in-situ and ex-situ conservation of large numbers of plants.

To ensure sustainable societal development, ecological balance and growth must be maintained by preventing the exploitation of natural resources. The use of forest land for non-forest activities should be carefully considered by the government. The growth of the mining industry should coexist peacefully with the preservation of forests and trees. The protection of endangered plant species is also indirectly covered by several related laws. To safeguard plants like kshirakakoli, a specific policy or legal framework is needed. The protection of this plant might be aided by strong regulatory restrictions and a ban on overusing it. Such plant species don't require human intervention to survive in their natural habitat. However, the government's stance on medicinal plants is to blame for unsustainable resource consumption, which deepens the wealth divide. Because sustainable forest management procedures are not being followed, forest dwellers over-collect forest resources and over-farm them for their therapeutic properties (Zehra et al., 2023 and Chandran et al., 2021).

The Supreme Court of India is crucial in preserving the environment and biological diversity, directing the safeguarding of forests and ecological balance. The National Forest Policy of 1988 also emphasizes the importance of conservation due to industrialization and unplanned development. However, despite numerous environmental laws aimed at preventing pollution, the conservation of endangered plant species is often overlooked. This lack of concern for endangered species and the absence of effective mechanisms for their protection threatens the abundant resources of India, which are essential for sustainable development. Strong commitment and community support are needed to protect these species (Zehra et al.,2023).

The Supreme Court emphasizes the need for environmental legislation to balance industrialization and the environment. Existing laws and regulations are inadequate, and specific legislative policy mechanisms are needed. Public awareness and participation in plant species conservation are crucial. The court emphasizes the importance of better law implementation, public awareness, and conservation of endangered species like Kshirkakoli. Prioritizing these aspects is crucial for environmental justice (Zehra et al.,2023).

CONCLUSION

The study of Lilium polyphyllum reveals promising applications and underscores the importance of its conservation. With its potential medicinal properties and ecological significance, this species holds great value in various fields, including pharmaceuticals, horticulture, and biodiversity conservation. The documented therapeutic properties highlight avenues for further research into its pharmacological potential, offering possibilities for the development of new drugs or herbal remedies. Moreover, efforts towards conserving Lilium polyphyllum are imperative to safeguard its genetic diversity and ecological role, especially in the face of habitat loss and environmental degradation. By recognizing its multifaceted importance and implementing conservation

strategies, we can ensure the continued availability and utilization of this valuable species for generations to come.

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