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Baghnakh (*Martynia annua*): Prehistory to contemporary medicinal value

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Abstract
India, a developing country, sees around 80% of its population relying on traditional medicine for primary healthcare, as noted by the World Health Organization. *Martynia annua* has a rich history in traditional Indian medicine for treating conditions such as inflammation, epilepsy, and snake bites. The Santal tribal community uses this plant for hair loss, and further research highlights its effectiveness against dysentery, cardiac issues, worm infestations, constipation, hemorrhages, bacterial infections, and ulcers. Its leaves serve as an antiseptic, while the juice is utilized as a gargle for sore throats, and the fruit mixed with coconut oil is applied topically for burns. Various secondary metabolites isolated from *Martynia annua* have contributed to its diverse pharmacological properties, including anthelmintic, analgesic, antipyretic, antibacterial, anticonvulsant, antifertility, antioxidant, CNS depressant, and wound-healing activities. Continued clinical and pharmacological research is essential to fully explore its potential therapeutic benefits.

Keywords: Ayurveda, dravyaguna, *Martynia annua*, phytoconstituent, traditional medicine

Introduction
Medicinal plants are gift of nature for human society to make disease free healthy life. Mother Nature has gifted India with an abundance of medicinal plants, making it the world's largest medicinal garden. With its rich botanical heritage and diverse therapeutic plants, India is a global hub for natural healing, rooted in centuries-old traditions of herbal medicine. Indian Vedas have documented the therapeutic use of plants for treating various ailments. In the 21st century, traditional medicine systems are widely recognized and practiced globally. India has a unique identity in the world with several established conventional medical practices, such as homeopathy, yoga, naturopathy, Siddha, Unani, and Ayurveda [1]. Since the inception of human civilization, medicinal plants have been integral to medical practices and persist as vital components in contemporary pharmacological production [2]. Various plant species serve as a source of medicine with *Martynia annua* being one of them. The family Martyniaceae encompasses the plant *Martynia annua*, commonly referred to as Baghnakh, which is considered to be divinely bestowed. It is a long history of medicinal usage in this cultural context and has been used for its therapeutic qualities in traditional Indian medicine [3]. Santal (largest tribe in the Jharkhand and West Bengal) tribal community in India has employed *Martynia annua* for the treatment of fever and hair loss. Extract of leaf is utilized as a mouthwash for alleviating sore throats and serves as an antiseptic agent [4]. *Martynia annua* fruits powder and coconut oil are combined and used on burns as well as inflammatory conditions. Leaf paste is applied directly to domestic animal wounds and leaf juice is gargled for sore throats [5]. It is also utilized in the treatment of dysentery, cardiac issues, worm infestations, constipation, hemorrhage, bacterial infections, ulcers, and various other illnesses [6].

Taxonomic Identity
The taxonomic positions of *Martynia annua* are as follows: [7]
Kingdom - Plantae
Phylum - Mangnoliophyta
Order - Lamialesa
Family - Martyniaceae
Genus - *Martynia*
Species - *M. annua*

Vernacular Names of *M. annua*

Martynia annua is identified by various vernacular names across different regions of India. In Hindi, it is known as Baghnakh and Bichu; in Sanskrit, as Kakanasika; in Gujarati, as Vichechida; in Tamil, as Thelkodukkukkay; in Bengali, as Bagbnoki; in English, as Tiger's Claw; in Telugu, as Garudamukku; in Marathi, as Vinchu; in Malayalam, as Pulinakhnam; and in Kannada, as Huli Nakha [8, 9].

Geographical Distribution

Martynia annua exhibits a widespread geographical distribution. Native to Central America, Mexico, and the Caribbean. It is frequently found in overgrazed grassland, waste fields, degraded moist and dry deciduous forests, and thick clumps along roadsides [10]. Naturalized across India, it is predominantly found in states such as Andhra Pradesh, Karnataka, Kerala, Maharashtra, Odisha, Uttar Pradesh, Punjab, and Rajasthan [49].

Vital Environmental Conditions for Plant Growing

Martynia annua thrives in open areas that receive full sunlight but can also tolerate partial shade. It is adaptable to a range of soil types with a pH between 6.1 and 7.8, encompassing slightly acidic to slightly alkaline conditions. This flexibility allows it to grow in various environmental settings. Optimal growth occurs in locations where it can benefit from abundant light and suitable soil pH [11].

Botanical Description of Plant

In Ayurveda, *M. annua* is also known as Kakanasa and Baghnakh, which is a member of martyniaceae family. It is herb can reach a height ranging from 30 to 100 cm, making it a moderately tall plant. Its growth habit is upright, allowing it to stand erect and support its structure effectively. The variation in height, from shorter specimens at 30 cm to taller ones reaching up to 100 cm, indicates its adaptability to different growing conditions and environments [50].

As visualise in Figure-1 the stems of *Martynia annua* are cylindrical and approximately 2 cm in diameter, typically becoming woody at the base and covered with glandular hairs. The petioles, which attach the leaves to the stem, range from 6 to 18 cm in length, supporting the plant's foliage and optimizing sunlight capture [12].

The leaves of *Martynia annua* are large, with blades that are broadly ovate to triangular-ovate in shape, measuring 9 to 22 cm in length and 9 to 20 cm in width. They have a cordate (heart-shaped) base, margins that are sinuolate-dentate (wavy with tooth-like projections), and an acute apex, giving them a pointed tip [51].

The bell-shaped flowers are bluish white with subtle purple streaks, and the inflorescence resembles a raceme. The pedicels are 1- 2 cm long, getting thicker, and curving naturally. Calyx measures between 15 and 20 mm. Corolla is typically between 55 and 65 mm long, and the tube is 35 to 45 mm length. The corolla is a pipe-shaped campanulate with dots that are either yellow, pink, or purple on the inner surface and two stamens are present. The fruit is tough, divided into two parts, and has a woody texture with two sharp, backward-facing hooks [12, 13].

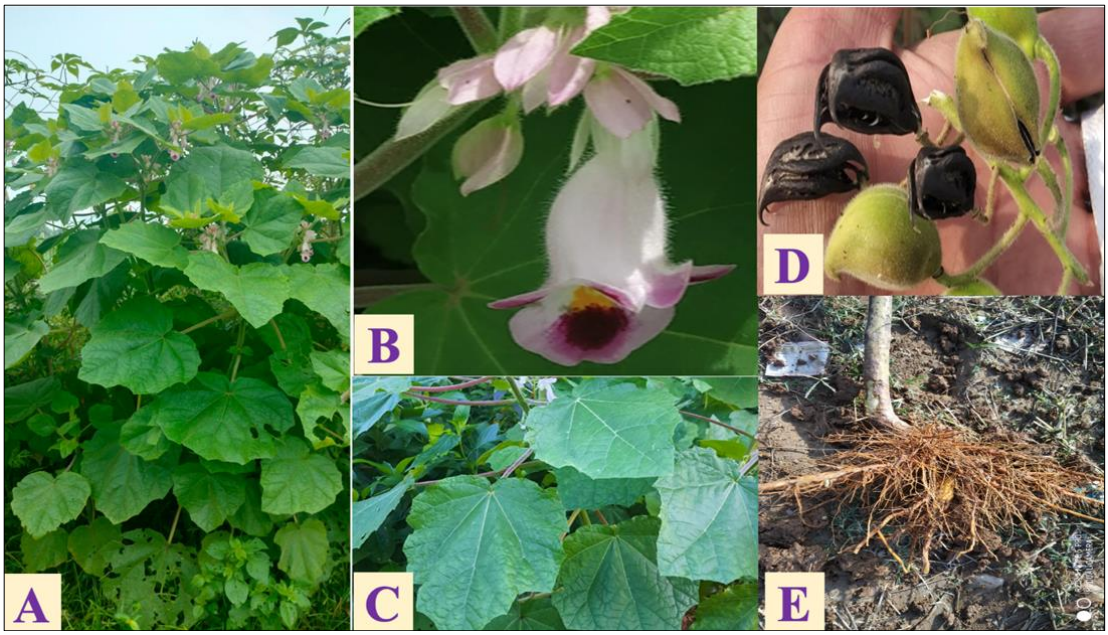


Fig 1: Morphological features of *Martynia annua*: (A) Whole plant with glandular-hairy leaves, (B) trumpet-shaped flower, (C) cordate, lobed leaves (D) spiny, curved fruit (devil's claw), (E) taproot with secondary branches

Microscopy of *Martynia annua*

The transverse section (TS) of a foliage is characterized by multicellular covering trichomes on both the lower and upper epidermis, along with palisade parenchyma, spongy parenchyma, vascular bundles, and collenchyma positioned beneath the epidermal layers. The crossover portion of the stem is distinguished by the presence of vascular packs, endodermis, multicellular covering trichomes, parenchymatous cortex, and centralise pith. Epidermis, parenchymatous cortex, endodermis, and vascular packs are present in the cross-over region of the root [14, 15].

Biological Profile

Genetics

M. annua shows chromosomal variation, with diploid counts ranging from 32 to 36 (2n = 32–36). This genetic diversity enhances the plant's adaptability to different environments and strengthens its evolutionary potential, allowing it to thrive in varied conditions and possibly paving the way for speciation [16].

Reproductive Biology

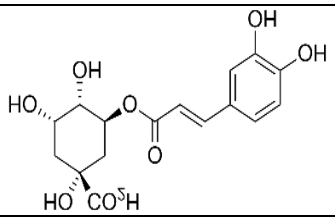
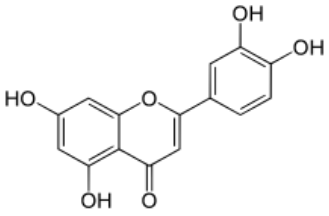
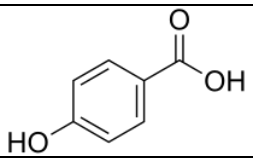
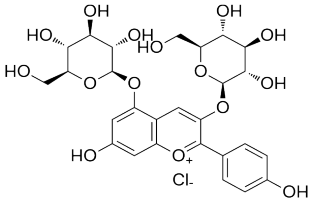
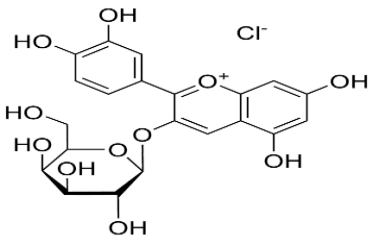
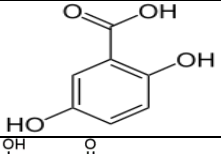
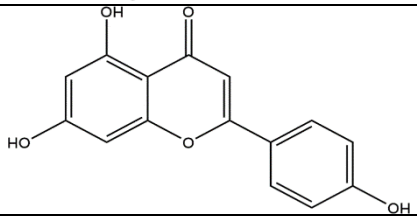
M. annua flowers are tubular, pendant, and have their corolla

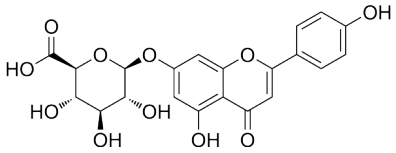
openings oriented sideways, producing nectar. Carpenter bees (*Xylocopa latipes* and *Xylocopa pubescens*), digger bees (*Amegilla* species), and hawkmoths (*Macroglossum gyrans*) regularly pollinate these flowers in India during the day. The flower structure supports self-pollination through contact between the stigma's curved lobe and the mature anthers [17].

Phytochemistry of *Martynia annua*

The phytochemical composition of *Martynia annua* reveals a diverse array of bioactive compounds that contribute to its therapeutic potential. Qualitative analysis indicates the presence of carbohydrates, glycosides, phenols, tannins, anthocyanins, and flavonoids in whole-plant extracts [18]. The methanolic leaves extract (MEMA) exhibited elevated concentrations of alkaloids, glycosides, terpenoids, tannins, steroids, and saponins, while cardiac glycosides, anthraquinones, and phenols were present at moderate levels [19]. Key constituents identified in the leaves include chlorogenic & sinapic acid, and p-hydroxybenzoic acid with cyanidin-3-galactoside prevalent in the flowers, and 'pelargonidin-3, 5-diglucoside' and 'gentisic acid' found in the fruit [20]. The chemical structures of some phytochemical constituents identified in *M. annua* are presented in Table 1.

Table 1: Major phytochemicals of *Martynia annua*.

S. No.	Phytochemical	Structure	Parts	Ref.
1	Chlorogenic acid		Leaf	19
2	Luteolin		Leaf	12
3	*p*-hydroxybenzoic acid		Leaf	19&20
4	Pelargonidin-3, 5-diglucoside,		Flower	20
5	Cyanidin-3-galactoside		Flower	20
6	Gentisic acid		Fruit	20
7	Apigenin		Whole Plant & Seeds	20

8	Apigenin 7-O-glucuronide		Seeds	51

Traditional and Economic Importance of *Martynia annua*

Tribal women in India and across the world have long-standing traditions of utilizing natural resources for crafting adornments. One such practice involves the use of *Martynia annua*, a plant with distinctive, hooked seed capsules. These capsules are transformed into intricate and culturally significant necklaces, often combining them with other natural materials. The process of crafting these necklaces is a testament to the ingenuity and resourcefulness of tribal communities, preserving traditional skills and knowledge while creating unique and beautiful pieces of art [21]. Bracelets are also commercially available in the market made up with the fruit of *M. annua* as shown in Figure -2.

Fig 2: Commercially available necklace and bracelet crafted from *Martynia annua* fruits.

In ancient Indian medicine and mythology, the plant species was frequently utilized to treat various ailments, including epilepsy, inflammation, and tuberculosis, with different parts utilized for different diseases. The fruits of this species are utilized locally as a sedative and as a treatment for scorpion stings and venomous bites. The fruit is believed to counteract poisons and is helpful in treating inflammations, while its ash, combined with coconut oil, is topically administered to burns [22]. The leaves of the plant are consumed when food is scarce and have medicinal properties. They are used to help treat epilepsy and infections, applied directly to swollen glands in the neck affected by tuberculosis. Additionally, the juice from the leaves can be used as a gargle for sore throats, while a paste made from the leaves is used to heal wounds in domestic animals [23-24]. The entire plant is also utilized by the Santal tribe for treating fever, scabies, sores, hair loss, and carbuncles on the back [25]. In the tribal regions of the Satpura Plateau in the state of Madhya Pradesh (India), a paste made up of the roots of *M. annua* is utilized in conventional Indigenous remedies to treat cancer and rheumatism [26].

Medicinal Value during Prehistory of Baghnakh

Charaka Samhita: In the Madhur Skandha, Acharya Charaka recognizes Kakanasa and lists it as a component of Chyavanprashavaleha, a formulation employed for its Rasayana karma effect [27], as an ingredient in Tryushnadi Ghrita, which is utilized in the treatment of Kasa Rog (cough disorders), and is also included in Dhupan Dravya for the management of Apasmara Rog (Epileptic seizures) [28].

Sushruta Samhita

Acharya Sushruta classifies Kakanasa within the Madhur Varga, known for its therapeutic benefits and also included in Anuvasan Vasti Dravya, used in medicated oil enemas for various treatments [29].

Dhanwantari Nighantu

The Dravyaguna (Ayurvedic Pharmacology) manuscript, which was composed between the 7th and 10th centuries A.D., is one of the most authentic. The author of this work has classified this plant as a Karveeradi Varga, and Dhankshnasa, Kaktundphala, Surangi, Taskarsnayu, and Dhwankshtundaphala are some of its synonyms. It is believed to have Ushna Virya and Tikta (bitter) Rasa and is used to treat constipation, clean wounds for external use, and make oil from its fruits [30].

Kaidev Nighantu

Kaidev Nighantu, written in the 14th century, is considered a highly authentic source on Dravyaguna (the study of medicinal substances). The author classifies the plant under Aushadhi Varga and lists several synonyms for Kakanasa, including Jeevaniya, Chorsnayu, Kakangi, Shirobala, Kakasya, and Surangika. The plant is characterized by its astringent (Kashaya), bitter (Tikta), and pungent (Katu) tastes, with a katu vipaka (post-digestive effect) and Ushna Virya (warming potency). It is used to treat conditions such as swelling (Shotha), blood disorders (Rakta Vikar), skin diseases (Switra and Kushtha), and Kapha imbalances, and is also employed for emetic purposes [31].

Bhavprakash Nighantu

This Dravyaguna text, which was composed in the 16th century A.D., is one of the most authentic. According to Acharya Chunekar's Fruit Paste of *Martynia Annua* and Guduchiyadi Varga, the author of this literature has classified this plant. Linn is applied locally for scorpion bites, fruit-infused oil is used for a variety of skin conditions, and leaf paste is applied locally for Apachi. In *Bhavprakash Nighantu*, it is referred to as in verse number 248 [32].

काकनासा तु काकाङ्गी काकतुण्डफ़ला च सा ।।248।।

Raj Nighantu

Authored in the 17th century, this text is widely recognized as an authoritative reference in the field of Dravyaguna. In this text, the plant *Martynia annua* Linn. is classified within the Guduchiyadi Varga. It is characterized by its sweet (Madhur) taste and its cooling (Sheet) potency. The plant is utilized in the management of Pittaj disorders and the greying of hair, and is also employed as a Rasayana (rejuvenative). The fruit, root and whole plant of *Martynia annua* are identified as the

useful parts. In Raj *Nighantu*, it is referred to as in verse number 106 [33].

काकनासा ध्वान्क्षनासा काकतुण्डफ़ला च वायसी।
सुरङ्गी तस्करस्नायुध्वााष तुण्डफ़ला सुनाशसिका ॥106 ॥

Adarsha Nighantu

The Dravyaguna's content has been extensively examined in this Ayurvedic text. The author of this text refers to this plant as Arkadi Varga. The fruit of Kakanasa resemble a crow's beak, hence *Pentatropis microphylla* and *Martynia annua* should be regarded as the original Kakanasa and *M. annua*, respectively, according to Acharya 'Vapalal Vaidya' kakanasa is a controversial drug [34].

Contemporary Medicinal Value of Baghnakh

Antibacterial activity

M. annua leaf extracts in chloroform, ethyl acetate, and methanol were found to be antibacterial when tested against gram negative and gram positive microbes. Every single solvent extract exhibit antibacterial movements that are particular to various bacteria. Higher antibacterial potential against *Bacillus subtilis, Proteus vulgaris* and *B. thuringiensis* is indicated by chloroform extract. While methanol extract showed greater antibacterial ability toward *P. vulgaris, S. paratyphi B, B. subtilis,* and *Pseudomonas aeruginosa*, and effectiveness of ethyl acetate extract against *Klebsiella pneumonia, Proteus mirabilis, P. vulgaris, Salmonella paratyphi A,* and *Salmonella paratyphi B,* was undeniable. The disc diffusion method, which required 100% awareness alone of all solvent extract, was applied to achieve the antibacterial target [35].

Anthelmintic Activity

Compared to the reference medicine albendazole, the petroleum ether root extract of *M. annua* exhibited strong anthelmintic efficacy against earthworms *Pheritima posthuma* [36]. *Pheritima posthuma*, commonly known as the Indian earthworm, was chosen for study due to its significant anatomical and physiological similarities to the intestinal roundworm parasites commonly found in human beings [48].

Antipyruvatic and analgesic activity

The analgesic properties of aqueous, ethanol, petroleum ether, and chloroform extracts from *M. annua* fruits were assess in Swiss albino mice through hot plate and tail flick assays, while their antipyretic effects were tested in Wistar rats with brewer's yeast-induced hyperpyrexia. The extracts exhibited notable analgesic and antipyretic activities at a dose rate of 20 mg/kg body weight. Additionally, the petroleum ether extract and chloroform extracts showed significantly superior antipyretic and analgesic effects compared to the aqueous and ethanol extracts of the fruit [37].

Anti-Convulsant activity

Methanolic leaves extract of *M. annua* (MEMA), administered at doses 200 and 400 mg/kg body weight, notably reduced the duration of tonic hind limb extension and provided protection against seizures in the animals. The MEMA 200 and 400 mg/kg body weight have demonstrated 16.31% and 82.73% protection against maximum electroshock (MES) caused by seizures, respectively, when evaluated with the conventional old medicine 'phenytoin' (100%), whereas on evaluation with the same old drug 'diazepam' (100%), the MEMA 200 mg/kg body weight and 400 mg/kg body weight have shown 70.33% and 82.88% defence of convulsion and 83.33% & 100% offered protection against mortality in a dose-dependent manner in relation to 'pentylenetetrazol' (PTZ)-prompted epilepsy. But the anticonvulsant pastime of MEMA turned into something else because of the potentiation of neurotransmitters in the brain [38].

Anti- Fertility activity

The antifertility activity of a 50% ethanol extract from *Martynia annua* L. roots was investigated in male rats at doses of 50, 100, & 200 mg/kg body mass. The findings revealed a significant reduction in the weights of the testes, epididymis, seminal vesicles, and ventral prostate. Additionally, the antifertility effects were dose-dependent and did not alter general body metabolism [39].

Antioxidant activity

Aqueous and methanolic extracts of *M. annua* leaf were evaluated for antioxidant activity using various *in-vitro* methods, including the reducing power assay, DPPH radical-scavenging activity, H_2O_2 radical-scavenging activity, hydroxyl radical-scavenging activity, superoxide radical-scavenging assay, and total antioxidant capacity. The results indicated that the methanol extract shown greater antioxidant activity compared to the aqueous extract [40].

Antinociceptive and CNS Depressant activity

The CNS depressant and antinociceptive activities of ethyl acetate, petroleum ether, and methanol extracts from *M. annua* L. roots were evaluated. Among these, the extract of petroleum ether significantly increased hot plate test reaction time and demonstrated a stronger inhibitory effect compared to standard drugs pentazocine and paracetamol in acetic acid-induced writhing. At a dose of 50 mg/kg body weight, this extract notably reduced locomotor activity relative to the standard drug diazepam. Additionally, at 30 mg/kg body weight, it enhanced Pentobarbital induced sleep duration by up to 215.34% [41].

Anti- diabetic activity

A study investigated the antidiabetic effects of methanol extracts from *M. annua* (MEMA) flowers in diabetic rats induced with streptozotocin-nicotinamide (STZ-NIC) and streptozotocin (STZ). The administrated of MEMA led to notably reductions in blood glucose, lipid levels, and glycosylated hemoglobin, along with a rise in HDL levels after treatment for 21 days. The findings indicated that MEMA shows considerable antidiabetic effectiveness in both STZ and STZ-NIC-induced diabetic models [42].

Anti- fungal activity

Fungicide activity against *Aspergillus niger* and *Alternaria alternata* was also demonstrated by the root extract [20]. The antifungal properties of 13 coastal sand dune plants (CSDPs) from nine distinct families, including *M. annua* were investigated on the beaches of Arnala and Kalamb. The findings showed that all species, including *M. annua, P. punctatum, I. pes-caprae* & *S. orientale*, (Arnala beach), *C. rotundus, L. procumbens* (Kalamb beach), and '*E. zeylanica var. zeylanica'* were colonized [43].

Anticancer activity

The ethanolic and aqueous root extracts of *M. annua* demonstrated significant anticancer activity, with growth inhibition 'GI50' values of 11.3 and 20.4 µg/ml, respectively, against the human leukemia cell line K-562, indicating strong inhibitory effects on leukemia cell growth. However, the

activity was less pronounced when tested on women breast cancer cells (MCF-7) and lung cancer cell lines [44].

Cytotoxic activity

Alcoholic and propanone extracts of *Martynia annua* were tested for cytotoxic effects using a bioassay for brine shrimp mortality. The half-mortality rates of brine shrimp nauplii for the alcoholic and propanone extracts of *M. annua* were discovered to be 239.48 and 328.21 ppm, respectively. The study's findings showed that *M. annua* had cytotoxic potential [45].

Gastroprotective activity

The gastroprotective activity of *Martynia annua* leaves was studied in rats using doses of 200 & 300 milligram/kg body weight in an ethanol-caused gastric ulcer model. The findings showed significant inhibition of the ulcer lesion index, with the 300 mg/kg body weight dose demonstrating a marked effect (p<0.05) by reducing gastric volume, decreasing the ulcer index, and increasing gastric pH, indicating the gastroprotective potential of the ethanol extract at higher doses [46].

Wound Healing activity

The ethanolic extract of plant *M. annua* leaves exhibits a notable wound healing activity by promoting wound contraction and accelerating epithelialization. Additionally, Phytoconstituent analysis revealed that this fraction predominantly contains the flavonoid luteolin, which plays a key role in enhancing the process wound healing through its free radical scavenging properties [47].

Conclusion

Martynia annua Linn., commonly referred to as Baghnakh, is a plant of significant medicinal and cultural importance in India. Traditionally utilized for the treatment of ailments such as fever, alopecia, pharyngitis, burns, and inflammatory disorders, it also holds ethnobotanical value, with its distinctive hooked seed capsules used in traditional crafts by tribal communities. Pharmacological studies have demonstrated its diverse bioactive properties, including antibacterial, anthelmintic, analgesic, antioxidant, antifungal, and cytotoxic activities. Additionally, its therapeutic potential in managing complex conditions such as epilepsy, diabetes, and cancer highlights its relevance in both traditional medicine and modern pharmacological research. These findings reaffirm the significance of *M. annua* as a promising resource for the development of novel therapeutic applications in healthcare.

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