



## Therapeutic Potential of *Convolvulus prostratus* Forssk. in Traditional Medicine and Nanobiotechnology: A Comprehensive Review

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### ABSTRACT

Medicinal plants continue to play a crucial role in drug discovery and pharmaceutical research due to their therapeutic efficacy and chemical diversity. *Convolvulus prostratus* Forssk. (syn. *Convolvulus pluricaulis* Choisy), commonly known as Shankhpushpi, is an important Ayurvedic medicinal plant extensively used for the management of cognitive impairment, anxiety, stress, insomnia and neurological disorders. The present review compiles and critically analyzes available information on the traditional uses, phytochemical constituents, pharmacological activities and recent formulation approaches of *C. prostratus*. Data was collected from scientific databases including PubMed, Scopus, Web of Science, SciFinder and Google Scholar with emphasis on peer-reviewed literature. Phytochemical investigations reveal the presence of alkaloids (shankhapushpine, convolvine), flavonoids (kaempferol, quercetin, apigenin), coumarins (scopoletin, umbelliferone), phenolic compounds, sterols, vitamins and fatty acids which contribute to its broad spectrum of biological activities. Experimental studies have demonstrated its neuroprotective, nootropic, anxiolytic, antioxidant, anti-inflammatory and antistress properties. The pharmacological mechanisms involve modulation of neurotransmitters such as acetylcholine and GABA, attenuation of oxidative stress, neuroinflammation and activation of neuroprotective signaling pathways including Nrf2/ARE and PI3K/Akt. Recent advances in pharmaceutical formulations, particularly nano-based delivery systems have shown potential to enhance bioavailability and target brain delivery of its bioactive compounds. Despite substantial preclinical evidence and extensive traditional usage, clinical validation and standardization of formulations remain limited. Further investigations are required to establish dosage parameters, molecular targets and long-term safety. This review highlights the pharmaceutical significance of *C. prostratus* and its potential as a natural neurotherapeutic agent in modern drug development.

**Keywords:** *Convolvulus prostratus*, neuroprotective activity, phytochemistry, nanotechnology.

### INTRODUCTION

In recent years, medicinal plants have attracted growing interest in modern healthcare because they are widely available, cost-effective, generally well-tolerated and accepted across cultures. As a result, herbal treatments are increasingly valued around the world. This growing reliance on plant-based remedies has made it essential for both developed and developing countries to focus on maintaining their quality, effectiveness and safety<sup>1</sup>. *Convolvulus prostratus* Forssk. Syn. *Convolvulus pluricaulis* Choisy (CP) commonly known as Shankhpushpi (due to the shape of the flower is like a shankh; a marine shell), Aloe weed or Bindweed — is a perennial herb in the Convolvulaceae family. It typically thrives in arid, sandy and rocky xerophytic environments, especially in northern and central India. The plant grows with slender, branching stems close to the ground and bears small, funnel-shaped pale blue or white flowers.

#### 1. Distribution and Habitat

*Convolvulus prostratus* is native to the Indian subcontinent but is also reported in Pakistan, Sri Lanka, Nepal, Thailand, Myanmar, Malaysia and Indonesia with naturalized populations found in parts of Australia and East Africa, primarily due to its medicinal uses. The species favors well-drained sandy to loamy soils and is tolerant of high temperatures and low rainfall contributing to its prevalence in dry and open ecosystems. It is widely distributed

throughout India, particularly in Rajasthan, Madhya Pradesh, Uttar Pradesh, Punjab, Haryana, Gujarat, Maharashtra, Bihar, Tamil Nadu and Andhra Pradesh. It typically thrives in semi-arid to tropical climates commonly found in open grasslands, sandy soils, roadsides and wastelands, often flourishing in dry, sunny habitats. The plant is known to grow at altitudes up to 2000 meters, especially in the Himalayan foothills. According to recent studies, its ecological adaptability allows it to survive under minimal water conditions in open, uncultivated lands, where it grows as a prostrate, spreading perennial herb. The plant's natural occurrence and conservation needs are increasingly highlighted due to overharvesting in certain regions for its traditional use in Ayurvedic medicine<sup>2,3,4,5</sup>. Bioactive constituents, pharmacological properties, traditional uses and future prospects of *Convolvulus prostratus* Forssk. shown in Fig.1.

#### 2. Botanical Description

A perennial, prostrate herb, often found crawling along the ground with ascending or spreading slender stems reaching 10–30 cm in length<sup>6</sup>. Stems are cylindrical (terete), without wings, covered in dense, silky-haired pubescence (ferruginous hairs) with internodes of 10–12 mm. Microscopic anatomy revealed conical unicellular and stalked multicellular glandular hairs; striated cuticle; chlorenchyma, collenchyma and pericycle and phloem fibers present; older pith cells exhibit pitting, Leaves are



simple, alternate phyllotaxy; sessile or subsessile, often lacking petiole, linear to linear-oblongate, approx. 1–3 cm long by 1–6 mm wide, tapering to an acute apex, with entire margins and a decurrent base. Thin and brittle lamina covered with hairs; parallel venation. isobilateral lamina; both anisocytic and paracytic stomata; moderate stomatal index (~17 upper, 16 lower); collenchyma beneath upper epidermis; abundant calcium oxalate crystals along veins<sup>7</sup>.

linear, 3–7 mm long, sepals lanceolate-ovate, about 4–8 mm, densely silky-hairy; corolla funnel-shaped, ~1–1.3 cm, pale blue, white, or pink, with velvety mid-petal regions; buds hairy. Fruit is globose, straw-colored capsule (~3–4 mm diameter), seeds 2–4 per capsule, dark brown, shortly pubescent, ~2–2.5 mm long (Table 1). Vernacular names of *C. prostratus* Forssk. mentioned in Table 2. Botanical description of *C. prostratus* Forssk. shown in Table 3.

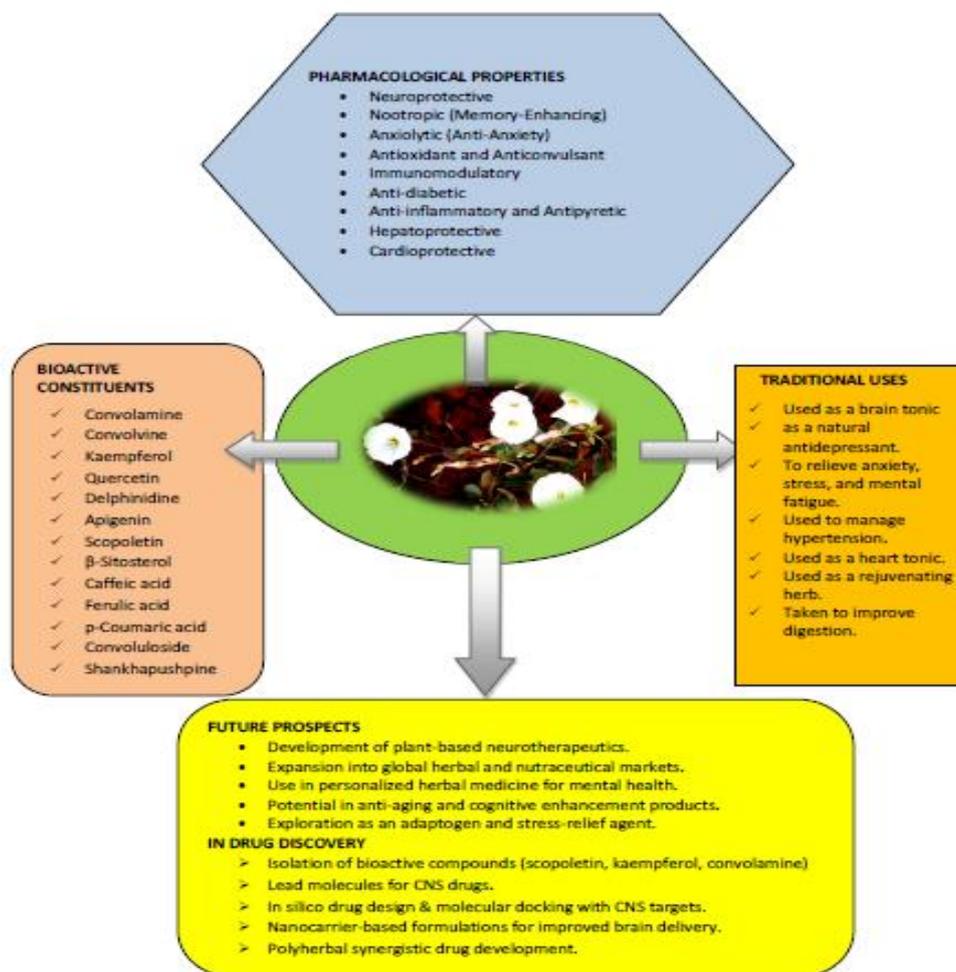
**Table 1:** Taxonomic Description of *Convolvulus prostratus* Forssk.

Taxonomic Rank	Classification
Kingdom	Plantae
Subkingdom	Tracheobionta
Division	Magnoliophyta
Class	Magnoliopsida
Order	Solanales
Family	Convolvulaceae
Genus	<i>Convolvulus</i>
Species	<i>Prostratus</i> (syn. <i>Pluricaulis</i> )

**Table 2:** Vernacular Names of *Convolvulus prostratus* Forssk.

Language / Region	Vernacular Name
English	Aloeweed, Speedwheel
Hindi	Shankhpushpi
Sanskrit	Sankhapuspi
Gujarati	Shankhaval
Malayalam	Vishnukarandi
Marathi	Shankhabela
Tamil	Vishnukranthi
Telugu	Shankhapushpi
Bengali	Shankhapushpi
Urdu	Sankhaholi

Inflorescence is often solitary or in small cymes (1–3 flowers) in leaf axils, on short pedicels (3 mm) , bracts are



**Figure 1:** Bioactive Constituents, Traditional Uses, Pharmacological Activities and Future Prospects of *Convolvulus Prostratus* Forssk.

**Table 3:** Botanical Description of *Convolvulus prostratus* Forssk.<sup>7,8,9</sup>

Botanical Feature	Description
<b>Plant Habit</b>	Perennial, prostrate or diffuse herb; low-growing with slender, spreading branches (10–30 cm long)
<b>Habitat</b>	Dry, sandy or rocky soils; distributed across India—especially Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh.
<b>Stem</b>	Terete (cylindrical), finely hairy, ferruginous (reddish-brown), solid with long internodes (~10–12 mm)
<b>Leaf Arrangement</b>	Alternate, simple; sessile or subsessile
<b>Leaf Shape &amp; Size</b>	Linear to linear-oblong or oblanceolate; 1–3 cm long and 1–6 mm wide; apex acute; margins entire with decurrent leaf base
<b>Leaf Surface</b>	Pubescent (hairy), brittle texture; parallel venation
<b>Stomata Type</b>	Both anisocytic and paracytic; stomatal index: 17.02 (upper), 16.37 (lower)
<b>Trichomes</b>	Conical unicellular and stalked multicellular glandular hairs
<b>Inflorescence</b>	Axillary cymes (1–3 flowers); pedicels short (~3 mm)
<b>Flower</b>	Funnel-shaped, 1–1.3 cm long; pale blue, white, or pink; buds hairy; 5-lobed corolla
<b>Calyx</b>	5 sepals; ovate-lanceolate; 4–8 mm long; silky hairy
<b>Fruit</b>	Globose capsule; straw-colored; 3–4 mm diameter
<b>Seeds</b>	2–4 per capsule; dark brown; shortly pubescent; ~2–2.5 mm long

### 3. Traditional uses of *Convolvulus prostratus* Forssk.

*Convolvulus prostratus* Forssk. (Shankhpushpi) holds significant importance in traditional medicine, particularly in Ayurveda, Unani and Siddha systems due to its wide range of ethnomedicinal uses. In traditional Ayurvedic texts, it is described using terms like "sara", "medhya", "vr̥ṣya" and "rasāyana"—which reflect its diverse healing properties. These terms refer to the plant's ability to act as a gentle laxative, enhance memory and intellect, boost vitality and reproductive health, and serve as a rejuvenating tonic that supports overall longevity and wellness<sup>10</sup>.

Traditionally, it is used as a brain tonic, recommended for enhancing memory, learning, and cognitive function. Various parts of the plant are utilized to manage anxiety,

stress, insomnia, epilepsy and mental fatigue, attributed to its nootropic and neuroprotective properties. Besides its cognitive benefits, *C. pluricaulis* is employed for treating hypertension, ulcers, fever, skin diseases, and urinary disorders.<sup>11</sup> *C. pluricaulis* along with honey is used to control bleeding<sup>12</sup>. The plant's bioactive compounds, including alkaloids (like shankhpushpine), flavonoids and coumarins are believed to exert antioxidant, anxiolytic, anticonvulsant and anti-inflammatory effects. In rural Indian communities, the plant is often prepared as a decoction or paste for oral consumption or topical application. Overall, its longstanding use in traditional healing practices is now corroborated by pharmacological studies, highlighting its therapeutic potential as a natural remedy for cognitive and neurological disorders.

**Table 4:** Key Ingredients and Primary Indications of formulations prepared from *Convolvulus prostratus* Forssk.<sup>11, 20, 21</sup>

Formulation Name	Form	Key Ingredients	Primary Indications
<b>Shankhpushpi Syrup</b>	Liquid (Asava/Syrup)	Shankhpushpi, Brahmi, Vacha, Nootropics	Memory enhancement, anxiety, stress, insomnia
<b>Shankhpushpi Churna</b>	Powder	Pure Shankhpushpi dried powder	Mental fatigue, cognitive enhancement
<b>Shankhpushpi Ghrita</b>	Medicated Ghee	Shankhpushpi, Brahmi, Vacha, Yashtimadhu	Memory loss, epilepsy, psychosis, ADHD in children
<b>Medhya Rasayana</b>	Herbal tonic	Shankhpushpi, Guduchi, Yashtimadhu, Mandukaparni	Rejuvenation of brain and nervous system
<b>Manas Mitra Vatakam</b>	Tablet	Shankhpushpi, Brahmi, Swarna bhasma, Jatamansi, Vacha	Psychiatric disorders, insomnia, anxiety, epilepsy
<b>Saraswatarishta</b>	Fermented liquid	Shankhpushpi, Brahmi, Vacha, Ashwagandha, Shatavari	Mental clarity, depression, memory, speech disorders
<b>Brahmi Vati (Smriti Sagar Ras)</b>	Tablet	Shankhpushpi, Brahmi, Jatamansi, Swarna makshik bhasma	Memory enhancement, stress, hysteria
<b>Smriti Sagar Ras</b>	Tablet	Shankhpushpi, Ras sindoor, Brahmi, Jatamansi	Loss of memory, epilepsy, mental retardation
<b>Unmad Gaj Kesari Ras</b>	Tablet	Shankhpushpi, Brahmi, Swarna bhasma, Rajata bhasma	Schizophrenia, anxiety neurosis, psychosis
<b>Swarna Prashan (medhya dravya)</b>	Oral drops	Shankhpushpi, gold bhasma, honey, ghee	Cognitive development in children

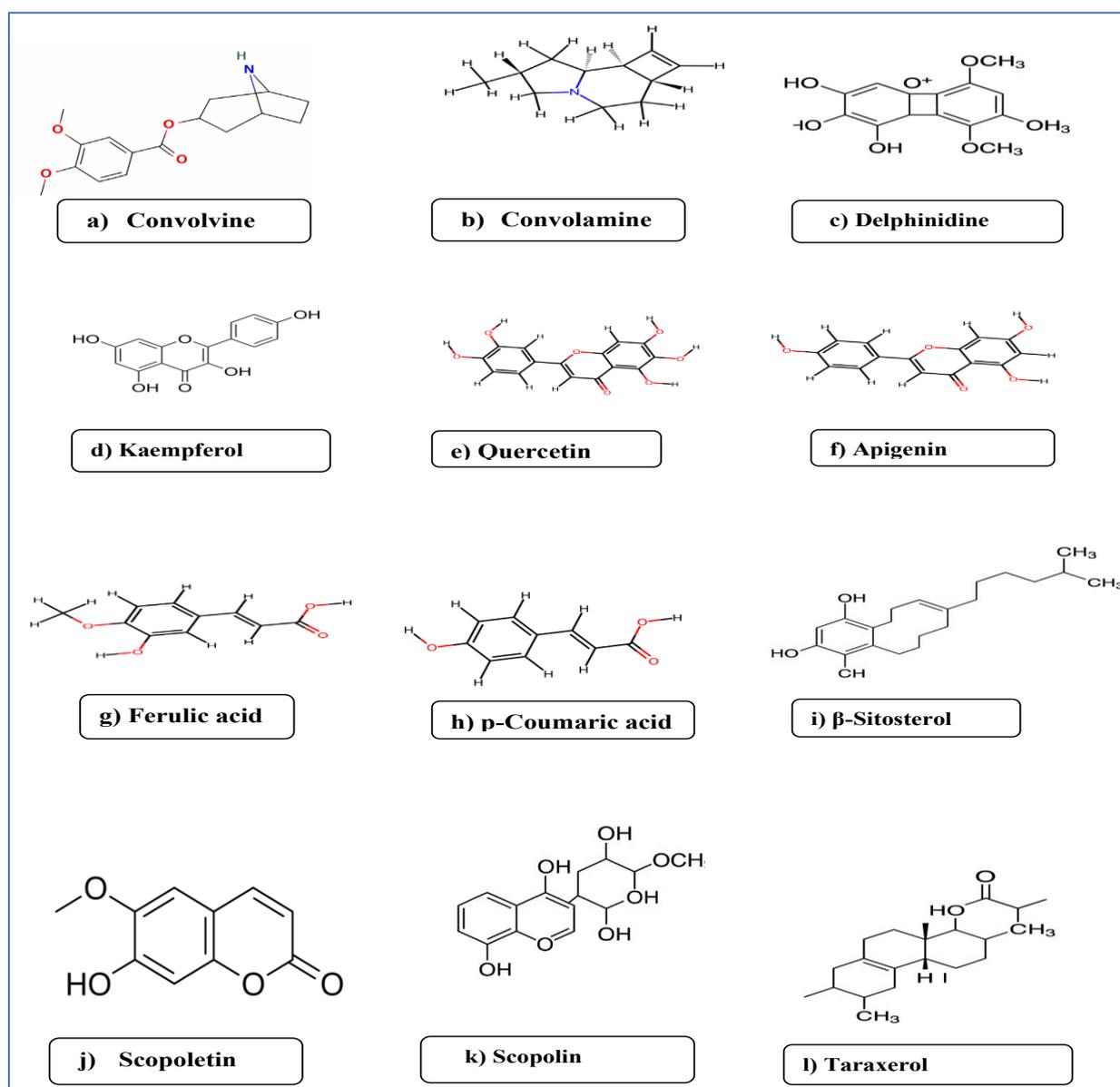


Shankpushpi has long been used in traditional Indian medicine for its diverse therapeutic benefits. The leaves are traditionally used to manage chronic bronchitis, cough, asthma, depression, and mental disturbances, while the roots help treat childhood fever. The herb in its entirety, often combined with cumin and milk, is used for conditions like nervous weakness, memory loss, syphilis, and scrofula. Shankpushpi oil is known to promote hair growth. It is also valued for treating neurological disorders such as epilepsy and insomnia, as well as heart diseases and bleeding disorders.<sup>13-20</sup>. Key Ingredients and Primary Indications of

formulations prepared from *Convolvulus prostratus* Forssk. shown in Table 4.

#### 4. Bioactive Constituents of *Convolvulus prostratus* Forssk

*Convolvulus prostratus* Forssk. (Shankpushpi) contains a diverse array of bioactive constituents responsible for its pharmacological properties, particularly its nootropic and neuroprotective effects. Different chemical constituents such as proteins, carbohydrates, volatile oils, fixed oils, phenolic compounds, steroids, flavonoids were extracted from the plant.



**Figure 2:** Chemical Structure of Some Bioactive Constituents of *Convolvulus prostratus* Forssk

Key phytochemicals identified in recent studies include alkaloids notably *shankhapushpine*, Convolvine (8-azabicyclo[3.2.1]octan-3-yl 3,4-dimethoxybenzoate), Convolamine (3 $\alpha$ -ethyl-1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\beta$ -tetrahydro-1H-pyrrolizine-1-methanol) phyllabine (3 $\alpha$ -ethyl-1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\beta$ -tetrahydro-1H-pyrrolizine-1-carbaldehyde), confoline (Methyl 1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\beta$ -tetrahydro-3-ethyl-1H-pyrrolizine-1-carboxylate), convosine (3 $\alpha$ -ethyl-1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\beta$ -tetrahydro-

1H-pyrrolizine-1-ethanol), convo lidine (1 $\alpha$ ,2 $\alpha$ ,3 $\beta$ ,4 $\beta$ -Tetrahydro-3-ethyl-1H-pyrrolizine-1-carboxylic acid), coumarins such as Ayapanin (6-methoxy-7-hydroxycoumarin), *scopoletin* (7-Hydroxy-6-methoxy-2H-1-benzopyran-2-one) and *umbelliferone* (7-Hydroxycoumarin), coumarin glycoside Scopolin (7-( $\beta$ -D-glucopyranosyloxy)-6-methoxycoumarin), flavonoids such as Kaempferol (3,5,7-Trihydroxy-2-(4-hydroxyphenyl)-4H-1-

benzopyran-4-one), quercetin (2-(3,4-Dihydroxyphenyl)-3,5,7-trihydroxy-4H-chromen-4-one), Apigenin (5,7-dihydroxy-2-(4-hydroxyphenyl)-4H-chromen-4-one), phenolic compounds such as caftaric acid ((2E)-3-(3,4-dihydroxyphenyl)-2-propenoic acid 2-(3,4-dihydroxyphenyl)ethyl ester), caffeic acid (3-(3,4-Dihydroxyphenyl)prop-2-enoic acid), ferulic acid ((E)-3-(4-Hydroxy-3-methoxyphenyl)prop-2-enoic acid), p-Coumaric acid ((E)-3-(4-Hydroxyphenyl)prop-2-enoic acid), sterols notably  $\beta$ -Sitosterol ( $3\beta$ )-Stigmast-5-en-3-ol), Campesterol (( $3\beta$ )-24-Methylcholest-5-en-3-ol), Stigmasterol (( $3\beta$ ,22E)-Stigmasta-5,22-dien-3-ol), glycosides i.e., Convolvulose ((2S,3R,4S,5S,6R)-2-(hydroxymethyl)-6-[(4-hydroxyphenyl)formamido]oxane-3,4,5-triol), triperpenoids (Taraxerol ( $3\beta$ )-Damas-20(29)-en-3-ol), tannins, anthocyanin (Delphidine 3,3',4',5,5',7'-Hexahydroxyflavylium), vitamins including Vitamin C (ascorbic acid), Vitamin E ( $\alpha$ -tocopherol), fatty acids such as Palmitic acid, Linoleic acid, Oleic acid and ceryl alcohol. The chemical Structure of some Bioactive Constituents of *Convolvulus prostratus* Forssk. shown in fig.2. These compounds contribute to its antioxidant, anxiolytic, memory-enhancing and anti-inflammatory activities.<sup>3,4,10, 22,23,24,25</sup>

### 5. Pharmacological Properties of *Convolvulus*

a wide spectrum

### 6. Pharmacological Properties of *Convolvulus prostratus* Forssk.

*Convolvulus prostratus* Forssk. (Shankhpushpi) exhibits a wide spectrum of pharmacological properties primarily attributed to its rich phytochemical profile including alkaloids, flavonoids, coumarins and glycosides. Traditionally recognized for its nootropic and neuroprotective effects, modern studies have validated its roles in enhancing memory, reducing anxiety, mitigating oxidative stress and protecting against neurodegenerative disorders like Alzheimer's disease (Table 5).<sup>10,26,27</sup>

A study utilizing network pharmacology and computational approaches effectively elucidates the multi-targeted neuroprotective mechanisms of *Convolvulus pluricaulis* against dementia. The analysis highlights that its key phytoconstituents—such as kaempferol, quercetin, scopoletin and convolvine interact with critical neurodegenerative disease-associated targets, including AChE (Acetylcholinesterase), MAPK1 (Mitogen-Activated Protein Kinase 1), AKT1 (v-Akt murine thymoma viral oncogene homolog 1), TNF (Tumor Necrosis Factor) and CASP3 (Caspase-3). These interactions potentially modulate multiple signaling pathways like Nrf2/ARE (Nuclear factor erythroid 2-related factor 2/Antioxidant Response Element), PI3K/Akt (Phosphoinositide 3-Kinase/ Protein Kinase B), MAPK (Mitogen-Activated Protein Kinase) and neurotrophin pathways contributing to anti-inflammatory, antioxidant, antiapoptotic and cholinergic regulatory effects. The molecular docking results further validate the strong binding affinities of its active compounds toward key neuroprotective targets. Collectively, this study supports

the therapeutic potential of *C. pluricaulis* as a multi-component, multi-target nootropic agent and underscores its promise in the development of plant-based interventions for dementia management<sup>28</sup>.

**6.1 Neuroprotective activity (Acetylcholinesterase Inhibition & Memory Protection):** Medicinal plants offer promising neuroprotective potential due to their rich content of bioactive constituents<sup>29</sup>. *Convolvulus pluricaulis* exhibits significant neuroprotective effects against scopolamine-induced cognitive impairments in Wistar rats. Administration of the plant extract improved learning and memory performance likely due to its antioxidant and neuroprotective properties<sup>30</sup>.

Aqueous extracts showed neuroprotection in rats against scopolamine or aluminum chloride-induced cognitive deficits, likely through anti-AChE, antioxidant mechanisms and mitigation of tau and amyloid precursor protein upregulation<sup>6</sup>. The plant extract inhibits acetylcholinesterase activity leading to increased acetylcholine levels in the brain which improves synaptic transmission and cognitive function. This is particularly beneficial in conditions like Alzheimer's disease where cholinergic deficits are prominent<sup>30</sup>.

In a zebrafish model of scopolamine-induced cognitive impairment, *C. pluricaulis* extract significantly inhibited AChE activity—comparable to, and in some measures superior to, synthetic inhibitor isoxazole—primarily via competitive and non-competitive interaction sites involving compounds like scopoletin and kaempferol<sup>31</sup>. The tested polyherbal formulation exhibited significant learning and memory-enhancing effects in streptozotocin-induced memory-impaired rats. The improvement in cognitive function was attributed to the formulation's ability to reduce mitochondrial-targeted cytochrome activity, thereby mitigating oxidative stress and neurodegeneration. Nath *et al.* investigated that combination of *C. pluricaulis* with  $\omega$ -fatty acid showed greater effect on learning and memory as compared to alone which was comparable with the standard drug<sup>32</sup>. The presence of bioactive compounds like flavonoids and alkaloids in *C. pluricaulis* promotes neurogenesis and enhances synaptic plasticity contributing to improved learning and memory. These findings suggest that the polyherbal formulation can serve as a potential neuroprotective agent for managing memory impairment and related cognitive disorders<sup>33</sup>.

The exact mechanism involves multiple signaling pathways such as inhibition of acetylcholinesterase inhibition, in turn, increased acetylcholine in the synaptic cleft resulting in improved cholinergic neurotransmission which is crucial for learning, memory and neuroprotection. The elevated acetylcholine interact with Muscarinic receptors and nicotinic receptors that increases intracellular calcium, improve calcium influx and promote neurotransmitter release. The downstream effects include enhances CAMP/PKA pathway due to muscarinic receptor activation; improving mitochondrial function and reducing Reactive Oxygen Species (ROS). The bioactive constituents of CP also



activates Nrf2 which increases antioxidant enzymes (SOD, CAT, GPx and GSH), inhibiting Keap1, which normally degrades Nrf2. It also activates MAPK (Mitogen-Activated Protein Kinase) pathway which includes ERK1/2, JNK and p38 MAPK; by activating ERK promoting cell survival and by inhibiting JNK/p38 it reduces stress-induced apoptosis. PI3K/AKT pathway activation by constituents of CP promotes cell survival, anti-apoptotic signaling and GSH biosynthesis; inhibition of NF- $\kappa$ B (Nuclear Factor kappa-light-chain-enhancer of activated B cells) reducing expression of pro-inflammatory cytokines (IL-1 $\beta$ , TNF- $\alpha$ ) and enhanced anti-inflammatory response.

**6.2 Anxiolytic & CNS Depressant Activity:** Recent pharmacological studies have confirmed the traditional use of *Convolvulus pluricaulis* as an anxiolytic and central nervous system (CNS) depressant agent, attributing these effects to its rich phytoconstituents like alkaloids, flavonoids, and coumarins<sup>34</sup>. A study by Khan *et al.* demonstrated that hydroalcoholic leaf extract of *C. pluricaulis* (100–300 mg/kg) produced significant anxiolytic and CNS depressant effects in Swiss albino mice. Behavioral assays such as the elevated plus maze and open field test confirmed reduced anxiety-like behavior and overall CNS depression. Importantly, no toxicity was observed up to a dose of 2000 mg/kg, indicating a wide safety margin<sup>35</sup>.

The petals of *Convolvulus pluricaulis* demonstrated significant anxiolytic (anxiety-reducing) effects in mice, as observed using the elevated plus maze model<sup>36</sup>. Similarly, Yuvraj Babu, *et al.* reported that aqueous extracts of *C. pluricaulis* significantly ameliorated behavioral changes in stress-induced rats. Treated animals showed improvements in anxiety-related parameters and restoration of antioxidant enzyme levels, suggesting that the plant exerts both anxiolytic and adaptogenic effects through reducing oxidative stress. These findings support the plant's potential role in managing anxiety disorders and related CNS disturbances, though clinical trials are still lacking<sup>37</sup>. Anti-anxiety and CNS depressant properties of Shankhpushpi was also reviewed by Chandra *et al.*<sup>24</sup>.

The mechanism involves enhancement of GABAergic signaling due to binding of plant alkaloids with GABA-A receptors causing GABA mediated chloride influx and hyperpolarization resulting in calming or sedative effect. The phytoconstituents inhibits Monoamine Oxidase (MAO-A and MAO-B) results in decreased degradation of serotonin, dopamine and non-epinephrine causing elevated synaptic level and antidepressant effect.

**6.3 Antioxidant & Anticonvulsant Activity:** Medicinal plants serve as an important source of antioxidants. Antioxidants have gained increasing attention because of their ability to protect both food and pharmaceutical products from damage caused by oxidation<sup>38</sup>. Methanolic whole-plant extract of *C. pluricaulis* demonstrated strong free radical scavenging (DPPH IC<sub>50</sub>  $\approx$  41  $\mu$ g/ml) and decreased seizure severity in electroshock-induced convulsions at 500–1000 mg/kg, indicating both antioxidant and anticonvulsant properties<sup>39</sup>. In vitro assays with SH-SY5Y neuroblastoma

cells exposed to H<sub>2</sub>O<sub>2</sub> showed that *C. pluricaulis* pre-treatment regulated major antioxidant enzymes (Superoxide Dismutase (SOD), Catalase (CAT)) and apoptosis markers (p53, caspase-3)<sup>40</sup>.

The aqueous extract of *Convolvulus pluricaulis* effectively ameliorated behavioral alterations and oxidative stress in stress-induced rats. Treatment with the extract led to improvements in anxiety-like behaviors and restored antioxidant enzyme levels, indicating its potential in reducing stress-induced oxidative damage. These results support the traditional use of *C. pluricaulis* as a neuroprotective and adaptogenic herb, highlighting its role in managing stress-related disorders<sup>37</sup>. *C. pluricaulis* enhances endogenous antioxidant enzymes like superoxide dismutase (SOD), catalase (CAT), and glutathione (GSH), reducing oxidative stress in neural tissues. This scavenging of reactive oxygen species (ROS) helps prevent neuronal damage and supports mitochondrial function, which is critical in neurodegeneration.

**6.4 Hypolipidemic & Antihyperglycemic Activity:** *C. pluricaulis* exerts a protective effect against lipid abnormalities in rats subjected to a high-fat diet combined with low-dose streptozotocin-induced diabetes. Administration of *C. pluricaulis* methanolic extract significantly improved lipid profiles by reducing total cholesterol, triglycerides, and low-density lipoprotein (LDL) levels, while enhancing high-density lipoprotein (HDL) levels. These findings suggest that *C. pluricaulis* possesses hypolipidemic and metabolic regulatory properties, supporting its potential as a natural therapeutic agent for managing dyslipidemia and associated metabolic disorders<sup>41</sup>.

**6.5 Cytotoxic/Anticancer Potential:** In vitro assays on HepG2 hepatocellular carcinoma cells revealed significant cytotoxicity (IC<sub>50</sub>  $\approx$  35.9  $\mu$ g/ml). The extract induced apoptotic morphological changes, DNA fragmentation and caspase activation, with minimal cytotoxicity toward normal fibroblast cells indicating selective toxicity against cancerous cells<sup>42</sup>. Additionally, metabolomic analyses have identified compounds such as  $\beta$ -sitosterol and scopoletin in *C. pluricaulis*, which are known for their anti-proliferative and apoptosis-inducing effects in various cancer models<sup>4</sup>. These phytochemicals potentially modulate oxidative stress, mitochondrial pathways and key signaling molecules such as p53 and caspase-3 as observed in neuroblastoma (SH-SY5Y) cells under oxidative stress conditions<sup>40</sup>.

**6.6 Antiulcer and Antigastric Activity:** A study by Sahoo *et al.* demonstrated that *C. pluricaulis* extracts significantly reduced gastric ulcer formation in animal models. The extract's protective effect was evident through a reduction in ulcer index and prevention of mucosal damage. In conclusion, *Convolvulus pluricaulis* demonstrates significant antiulcer and antigastric potential, working through antioxidant defense, anti-inflammatory effects and mucosal protection<sup>43</sup>.



**Table 5:** Pharmacological Profile of *Convolvulus prostratus* Forssk.

Plant Part	Bioactive Constituents	In Vitro / In Vivo Study	Extract Used	Pharmacological Activity	Mechanism / Key Details
Whole Part	Alkaloids (convolvine, convolvamine), flavonoids (kaempferol, quercetin, apigenin), Phenolic compounds, glycosides, sterols	In vivo rat model	Aqueous extract	Neuroprotective activity	Oral administration of <i>C. pluricaulis</i> extract preserved mRNA levels of muscarinic receptor 1 (M1 receptor), Choline acetyl transferase (ChAT) and Nerve Growth Factor-Tyrosine Kinase A receptor (NGF-TrkA), upregulation and protein expression of Cyclin dependent kinase 5(Cdk5) indicating its neuroprotective effect <sup>30</sup> .
Aerial Part	Coumarin, flavonoids, alkaloids	In vivo rat model	Ethyl Acetate extract	Anxiolytic and Antioxidant activity	Modulation of GABAergic pathway, activation of antioxidant defense mechanism, muscle relaxant effect at higher doses i.e., 200mg/kg <sup>48</sup> .
Whole plant	Scopoletin	In vivo rat hippocampal model	Methanolic extract	Enhanced synaptic plasticity & cognition	Increased hippocampal LTP, decreased LTD; improved memory retention (CFC/NORT); scopoletin replicated effects ex vivo <sup>49</sup> .
Whole plant	Alkaloids, flavonoids	In vivo rat model	Aqueous extract	Neuroprotective, Memory enhancement; increased antioxidant enzyme activity	Reduced cold-stress-induced cognitive deficits; elevated Superoxide dismutase (SOD), Glutathione peroxidase (GPx), Glutathione (GSH levels); improved Morris Water Maze performance <sup>37</sup> .
Whole plant	<i>Convolamine, convolvine, Kaempferol, quercetin, myricetin, luteoli, Scopoletin, <math>\beta</math>-sitosterol</i>	In vivo <i>Drosophila melanogaster</i> (fruit fly)	Aqueous extract	Neuroprotective, Lifespan-extending, Antioxidant, Cholinergic restoration, Anti-tau aggregation, Improved locomotor function	hMAPT protein accumulation reduces tau toxicity in neurons; SOD and CAT enzymes reduce oxidative stress; Lipid peroxidation helps protect neuronal membrane integrity; ROS prevents oxidative damage to neurons and AChE levels improve neurotransmission and memory <sup>50</sup> .
Whole plant extract	Scopoletin	In vivo (behavioral and electro physiological in Adult male Wistar rats) and ex vivo (electrophysiology with isolated compound)	Aqueous extract	Memory enhancement - Synaptic plasticity modulation - Cognitive boosting	500 mg/kg dose significantly enhanced memory and synaptic strength - Scopoletin mimicked the plant extract's synaptic plasticity effects <sup>51</sup> .
Whole Plant	Flavonoids, phenolic compounds	In vivo Wistar rats	Methanol extract	Hypolipidemic Effect	By modulating key enzymes involved in lipid synthesis and degradation, the extract helps regulate serum cholesterol, triglycerides, and LDL levels while increasing HDL levels <sup>52</sup> .
Whole Plant	Alkaloids, phenolics	In vitro	Ethanol extract of <i>C. pluricaulis</i> and <i>Evolvulus alsinoides</i>	Anti-inflammatory effect	Both extracts were effective in inhibition of hemolysis with significant anti-inflammatory activity in a dose dependent manner. <i>C. pluricaulis</i> extract showed better result than <i>E. alsinoides</i> <sup>53</sup> .
Whole Plant	Scopoletin, 4-hydroxycinnamic acid, Kaempferol, quercetin, ayapanin	<i>In-Silico</i> (Computational analysis)	-	Nootropic and Cognitive development	The bioactive compounds target the signaling pathways like PI3K/AKT signaling and insulin signaling pathway <sup>28</sup> .
Whole Plant	Alkaloids, flavonoids	In vivo albino rats	Aqueous	Neuroprotective and Memory-	Cognitive function improvement due to the formulation's ability to reduce mitochondrial-targeted cytochrome

				enhancement Effect	activity, thereby mitigating oxidative stress and neurodegeneration <sup>33</sup> .
Whole plant	Scopoletin, kaempferol	In vivo zebrafish model	Aqueous extract	AChE inhibition; anti-amnesic	Competitive & non-competitive binding at catalytic (His447) & peripheral sites; improved cognition <sup>31</sup> .
Leaves	Alkaloids, flavonoids	In vivo mouse model	Hydroalcoholic leaf extract	CNS depression; anxiolytic; muscle relaxant	Reduced locomotor activity (actophotometer), increased open-field and elevated plus-maze anxiety endpoints; safe up to 2000 mg/kg <sup>35</sup> .
Whole plant	Tropane alkaloid convolamine	In vivo zebrafish/mouse models	Crude/natural extract	Sigma-1 receptor modulation; restored motor & learning deficits in disease models	Convolamine modulated S1R (not classic agonist), rescued Wolfram syndrome zebrafish motor deficits and learning in mouse models <sup>54</sup> .
Whole Plant	ascorbic acid, flavonoids and phenolic compounds	In vivo <i>Drosophila</i> model	dietary plant extract	Antioxidant, Antidepressant	Gene expression analysis revealed upregulation of GLUT1 (glucose transporter 1), CG6293 (ascorbate transporter), rdl (resistant to dieldrin), GABA-B-R1 (GABA-B receptor subtype 1) and SOD1 (superoxide dismutase 1), all of which play crucial roles in neuroprotection and oxidative stress resistance <sup>55</sup> .

**Table 6:** Green synthesis of Nanoparticles using *Convolvulus prostratus* Forssk. extract and their potential Applications

Nanoformulation	Method / Capping Agent	Size & Type	Key Applications & Mechanism
Silver Nanoparticles (AgNPs)	Aqueous leaf extract (flavonoids/alkaloids as capping agents)	12–20 nm, spherical, crystalline	Catalytic degradation of dyes/phenols via redox electron transfer; electrocatalytic applications for sensor platforms <sup>59</sup> .
Solid Lipid Nanoparticles (SLNs)	Methanol <i>C. pluricaulis</i> extract	150–250 nm, Spherical, Smooth surface Morphology	Improved dissolution rate of Convoline leading to enhanced bioavailability <sup>60</sup> .
Iron oxide NPs (Fe <sub>3</sub> O <sub>4</sub> -NPs)	Aqueous <i>C. pluricaulis</i> extract	~33 nm; porous agglomerates	Non-toxic in 14-day oral toxicity; biocompatible, potential for biomedical delivery <sup>61</sup> .
Lipid-Hybrid Nanoparticles	Plant lipids with Rivastigmine, stabilized by <i>C. pluricaulis</i> lipids	~100–200 nm solid-lipid nanoparticles	Enhanced blood–brain-barrier delivery; synergistic neuroprotection and cholinesterase inhibition for Alzheimer's therapy <sup>52</sup> .

**6.7 Anthelmintic Activity:** Giradkar worked on developing and evaluating taste-masked pellets of Shankpushpi (*C. pluricaulis*) with anthelmintic potential. In conclusion, the study successfully formulated Shankpushpi pellets using appropriate techniques to effectively mask its natural bitter taste without compromising therapeutic efficacy. The optimized formulation showed good physicochemical properties, satisfactory drug release, and confirmed anthelmintic activity in vitro<sup>44</sup>.

**6.8 Anti-inflammatory and Antipyretic Activity:** *C. pluricaulis* exhibits significant anti-inflammatory and analgesic activities, supporting its traditional use in managing pain and inflammation. The experimental findings demonstrated that extracts of *C. pluricaulis* effectively reduced inflammation and pain responses in animal models, indicating the presence of bioactive constituents with therapeutic potential. These results suggest that *C. pluricaulis* could serve as a promising natural alternative for developing plant-based anti-inflammatory and analgesic agents, though further detailed pharmacological and clinical

investigations are recommended to validate its efficacy and safety for human application<sup>45</sup>. *C. pluricaulis* modulates pro-inflammatory cytokines and downregulates neuroinflammatory mediators, protecting neurons from inflammation-induced apoptosis<sup>33</sup>.

**6.9 Hepatoprotective Activity:** The alcoholic, chloroform, and aqueous extracts of *C. pluricaulis* possess notable hepatoprotective activity. Among the tested extracts, the alcoholic extract showed the most significant protective effect against liver damage induced in experimental models, as evidenced by improvements in biochemical markers and histopathological observations. These findings suggest that *C. pluricaulis* contains bioactive constituents capable of supporting liver health and mitigating hepatic injury<sup>46</sup>.

**6.10 Cardioprotective Activity:** Doxorubicin is an effective chemotherapy drug but its use is often limited due to the risk of heart damage, which occurs in a dose-dependent manner. This cardiotoxicity is mainly driven by oxidative stress, mitochondrial dysfunction and the activation of cell death pathways. As a result, there is growing interest in



natural substances that might protect the heart. *Convolvulus prostratus*, a medicinal plant traditionally used for its brain-boosting and antioxidant effects has recently gained attention for its potential role in preventing heart damage caused by doxorubicin. Preclinical studies, particularly in rats, have shown that these extracts can reduce signs of heart injury both at the biochemical and tissue levels. While these early findings are promising, more detailed studies and clinical trials are needed to confirm its protective effects and ensure it is safe for human use. This positions *Convolvulus prostratus* as a potential natural supplement to reduce heart-related side effects of chemotherapy.<sup>47</sup>

### 7. Current Omics Studies on *Convolvulus prostratus* Forssk.

Targeted and untargeted metabolomic profiling using HPLC, LC-MS, and GC-MS has identified key phytochemicals like shankhapushpine, scopoletin, flavonoids, coumarins and alkaloids. Furthermore, in a study, HPTLC is used to establish a chemical fingerprint for commercial *Shankhpushpi* with scopoletin as the marker compound. A 2024 study used HPTLC to establish a chemical fingerprint for commercial *Shankhpushpi*, with scopoletin as the marker compound<sup>56</sup>. Recent studies used LC-MS-based metabolomics to quantify phenolic compounds and neuroprotective flavonoids. Metabolomic analysis by Gupta et al. confirmed the presence of kaempferol, quercetin,  $\beta$ -sitosterol and convolvine highlighting their roles in modulating oxidative stress and neuroinflammation<sup>4</sup>. Additionally, Dwivedi and Mehta reported the isolation of scoparone, saponins and phytosterols, emphasizing their involvement in cognitive enhancement and neuroprotection. The alkaloids convolvine and convolamine, in particular, have been linked to the plant's central nervous system (CNS) activity<sup>3</sup>.

A metabolomic and neurotoxicity study using GC-MS and FT-IR characterized 22 compounds in *C. pluricaulis*, including cinnamic acid, vitamin E, ascorbic acid, squalene and various fatty acids. The extract protected SH-SY5Y nerve cells from H<sub>2</sub>O<sub>2</sub>-induced oxidative damage preserving mitochondrial membrane integrity and modulating enzymes/markers like SOD, CAT, p53 and caspase-3<sup>57</sup>.

Another recent metabolomic study on the whole plant (chloroform extracts) identified alkaloids (shankhapushpin), sterols (campesterol, lupeol), phytol derivatives, vitamin E precursors. In vitro, these extracts modulated PPAR $\gamma$  (Peroxisome Proliferator-Activated Receptor Gamma) and GLUT4 (Glucose Transporter Type 4) in adipocytes—demonstrating effects on lipid differentiation, glucose uptake and inflammatory cytokines<sup>58</sup>.

Proteomic profiling remains largely unexplored in *C. pluricaulis*. In Future 2D-PAGE and LC-MS/MS-based proteomics may help decode enzyme pathways involved in antioxidant defense and stress response contributing to its pharmacological actions.

### 8. Nanoparticle Studies with *Convolvulus prostratus* Forssk. and its potential applications

Nanoparticle-based studies involving *Convolvulus prostratus* (Shankhpushpi) have gained significant attention due to the plant's neuroprotective, antioxidant and anti-inflammatory phytoconstituents. Biosynthesis of nanoparticles using *C. pluricaulis* extracts, including silver, gold and iron oxide nanoparticles has demonstrated eco-friendly, cost-effective approaches yielding stable and bioactive nanostructures. These nanoparticles exhibit enhanced biological activities such as improved antioxidant potential, antimicrobial effects and neuroprotective properties compared to crude extracts. Their small size and increased surface area facilitate better cellular uptake, potentially enabling targeted drug delivery in neurological disorders, memory enhancement therapies and oxidative stress management.

Shadakshari et al. developed an eco-friendly method to synthesize silver nanoparticles using aqueous leaf extract of *C. pluricaulis*. Leaf extract mixed with AgNO<sub>3</sub> at room temperature; formation of AgNPs confirmed by UV-Vis (peak at 420 nm), X-ray diffraction (XRD) studies, Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), transmission electron microscopy (TEM), thermo gravimetric analysis (TGA) and differential thermo gravimetric (DTG) analysis. The synthesized nanoparticles were spherical AgNPs, well-dispersed, crystalline and stable. Phytochemicals such as (flavonoids, phenolics, alkaloids) in the extract act as reducing and stabilizing agents<sup>59</sup>. The biosynthesized AgNPs efficiently degrade dyes and phenolic pollutants; they also demonstrated high electrocatalytic activity in sensor platforms. It is Effective in phenol detoxification and dye degradation, highlighting potential for wastewater treatment. Green synthesis of Nanoparticles using *Convolvulus prostratus* Forssk. extract and their potential Applications shown in Table.6.

### CONCLUSION AND FUTURE PROSPECTS

*Convolvulus prostratus* Forssk., traditionally valued for its cognitive-enhancing and adaptogenic properties is now increasingly substantiated by modern pharmacological, phytochemical and omics-based studies. Its diverse bioactive profile—including alkaloids, flavonoids, coumarins, sterols and essential vitamins—underlies its neuroprotective, antioxidant, anxiolytic, anti-inflammatory, hepatoprotective, hypolipidemic and antiulcer effects. Mechanistic studies reveal modulation of neurotransmitter systems, acetylcholinesterase inhibition, antioxidant enzyme activation and neuroinflammatory suppression, indicating *C. pluricaulis* as a promising therapeutic agent for neurodegenerative and metabolic disorders. Advances in formulation science, notably nano-based delivery systems, further enhance its bioavailability and therapeutic potential. However, despite extensive traditional use and encouraging preclinical evidence robust clinical validation remains scarce.

Future research should prioritize standardized clinical trials to determine optimal dosing, safety profiles and long-term



efficacy in humans. Detailed proteomic and transcriptomic investigations are essential to elucidate molecular mechanisms comprehensively. Moreover, green nanotechnology applications of *C. pluricaulis* open promising avenues not only in biomedicine but also in environmental remediation. The integration of *C. pluricaulis* into modern healthcare as a plant-based nootropic and neurotherapeutic agent will require interdisciplinary efforts encompassing pharmacology, omics sciences, nanotechnology and clinical medicine.

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