

Centella asiatica: Unlocking its health and medicinal benefits in India



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Abstract

Centella asiatica, commonly known as Gotu Kola or Indian Pennywort, is a medicinal herb traditionally used in Ayurvedic, Chinese, and Indonesian medicine for its diverse therapeutic benefits. Rich in bioactive compounds such as triterpenoids, flavonoids, and phenolic acids, *C. asiatica* demonstrates antioxidant, anti-inflammatory, antimicrobial, and wound-healing properties. Its applications range from enhancing skin health by promoting collagen synthesis and hydration to neuroprotection, cardiac health, and digestive support. By regulating inflammation and oxidative stress, it supports cellular health across multiple systems. Notably, its minimal side effects make it a valuable component in natural medicine and cosmetic formulations.

Keywords: Antioxidant, Anti-inflammatory, UV protection, Mitoprotective agent.

1. Introduction

Centella asiatica (CA) (Linn.) Urban synonym *Hydrocotyle asiatica* Linn. commonly known as Indian Pennywort, belongs to the family Apiaceae (previously known as Umbelliferae) (1). *Centella asiatica*, commonly known as Gotu Kola, is a perennial herbaceous plant recognized for its wide range of medicinal properties. Traditionally used in Ayurvedic, Chinese, and Indonesian medicine, this plant is acclaimed for its therapeutic benefits. Its applications span across various domains, particularly in skin care, however, antioxidant, antimicrobial, anti-inflammatory, anticancer, neuroprotective, and wound healing activities due to its rich composition of bioactive compounds like triterpenoids, flavonoids, and phenolic acids are also reported (2). One of the primary uses of *Centella asiatica* is in dermatology. The plant's triterpenoids, including asiaticoside and madecassoside, contribute to its potent wound healing properties. These compounds stimulate collagen synthesis, promote cell proliferation, and enhance the tensile strength of newly formed skin. Consequently, *Centella asiatica* is widely used in the treatment of burns, surgical wounds, and hypertrophic scars. Additionally, its anti-inflammatory and antioxidant properties help in managing skin conditions like eczema, psoriasis, and acne, making it a popular ingredient in many cosmetic and pharmaceutical formulations (3). Beyond skin health, *Centella asiatica* is known for its neuroprotective effects. It is used to enhance cognitive function and memory, reduce anxiety, and alleviate stress. The plant's ability to modulate neurotransmitter levels, along with its antioxidant activity, supports brain health and protects against neurodegenerative diseases. Studies have shown that *Centella asiatica* can improve mental clarity, concentration, and overall cognitive performance, making it a valuable herb in managing mental fatigue and age-related cognitive decline (4). Furthermore, it is used in the treatment of leprosy, wound, cancer, fever, allergies, abscesses, asthma, catarrh, convulsions, dysentery, eczema, gonorrhoea, hypertension, headache, bronchitis, jaundice, pleuritis, rheumatism, ulcers, spasms,

tuberculosis, urethritis, etc. (5). *Centella asiatica*, applied in the recommended doses, is not toxic and the possible side effects are rare (3). Its diverse therapeutic properties and minimal side effects make it an invaluable component of natural medicine.



Figure 1. *Centella asiatica*

2. *Centella asiatica* provides a variety of skin healing benefits

2.1. Moisturization and hydration of skin

The skin's stratum corneum layer plays a key role in hydration, housing natural moisturizing factors and a lipid matrix of ceramides, cholesterol, and fatty acids that prevent water loss. Aging skin often experiences diminished hydration and elasticity, leading to common issues like dryness (6,7).

Centella asiatica extract has shown promising results in enhancing skin hydration and barrier function. This botanical ingredient, rich in triterpene saponins, strengthens the epidermal barrier, reducing trans-epidermal water loss and improving skin moisture retention. In clinical trials, creams containing *Centella asiatica* significantly increased hydration and reduced water loss over a four-week period. Additionally, *Centella asiatica* supports collagen synthesis by activating fibroblasts, which is crucial for skin repair and elasticity. Improved blood circulation from its use also enhances nutrient delivery to the skin, supporting its overall health (8,9).

2.2. Anti-acne

Acne develops in areas with sebaceous (oil) glands, particularly on the face and trunk. These glands produce sebum, which can clog hair follicles, leading to Comedones (blackheads or whiteheads). When clogged follicles become a breeding ground for *Propionibacterium acnes*, an inflammatory response occurs, causing redness, swelling, and pustules (10).

Centella asiatica extract contains asiaticoside, a compound that inhibits *P. acnes* growth and has anti-inflammatory properties, reducing acne lesions. Clinical trials have shown that a 5% Centella extract can significantly inhibit acne-causing bacteria (17.3 mm inhibition zone). It also helps heal inflamed acne by promoting tissue repair, balancing sebum production, and reducing redness, making it ideal for acne-prone skin (11,12).

2.3. Sun protection

Centella asiatica plays a crucial role in sun protection as a key ingredient in sunscreen formulations. Ultraviolet exposure is a major contributor to skin damage, leading to conditions like premature aging and increased skin cancer risk. The photoprotective properties of a titrated *Centella asiatica* extract have been shown to mitigate Ultraviolet B-induced damage in human dermal fibroblasts, with studies indicating that this extract restores cell viability and alters microRNA expression in response to ultraviolet exposure (13,14).

The sun protection factor of *Centella asiatica* extract has been measured, revealing increased effectiveness at higher concentrations (15). The therapeutic compound asiaticoside enhances these benefits, improving cell viability and morphology in ultraviolet-exposed cells while inhibiting pathways that contribute to photoaging (16). Asiaticoside, along with another compound, madecassoside,

neutralizes free radicals generated by ultraviolet exposure, reducing oxidative stress and preventing premature aging. They also promote collagen synthesis and improve skin hydration, essential for maintaining skin integrity under sun exposure. Together, these compounds establish *Centella asiatica* as a valuable component in developing effective and multifunctional sunscreens (17,18).

2.4. Anti-aging

Centella asiatica plays a significant role as an anti-aging agent, addressing both chronological aging and photoaging caused by ultraviolet radiation. Photoaging results from oxidative stress, which damages cellular components and accelerates the breakdown of collagen and elastin, essential for skin elasticity and firmness (19). This plant is rich in triterpenoids that enhance skin repair and protect skin cells from ultraviolet-induced damage by improving cell viability and significantly inhibiting lactate dehydrogenase release in HaCaT cells exposed to ultraviolet B irradiation (20).

Centella asiatica also contains castilliferol and castillicetin, which inhibit matrix metalloproteinases (MMPs) enzymes responsible for breaking down collagen and elastin in response to oxidative stress (21,22). By binding to MMPs at active sites, these compounds help reduce collagen degradation. Furthermore, *Centella asiatica* enhances collagen synthesis, maturation, and crosslinking, improving skin structure and reducing wrinkles. Its properties boost microcirculation, aiding in oxygen and nutrient delivery to the skin (23,20). The plant also exhibits antioxidant effects that combat oxidative stress, protecting against premature aging (24).

2.5. Striae

Centella asiatica shows promising effects in managing and preventing striae, commonly known as stretch marks, which result from rapid skin stretching that disrupts the extracellular matrix and damages collagen and elastin fibres. Striae, which frequently appear during pregnancy, puberty, and weight fluctuations, affect a large proportion of women and result in fibrotic skin changes and impaired connective tissue (25-27). *Centella asiatica* aids in striae treatment by promoting fibroblast migration and matrix synthesis, enhancing elastin production, and improving collagen fibre organization and maturation without necessarily increasing collagen quantity (28). This plant's efficacy in reducing striae severity and improving skin health is attributed to its fibroblast-stimulating and elasticity-enhancing properties, making it valuable for striae prevention and management (29,30).

3. Cognitive health and neuroprotection

Mitochondria are essential organelles responsible for producing adenosine triphosphate (ATP) through oxidative phosphorylation, which is crucial for energy metabolism in neurons. CA helps maintain the integrity of the mitochondrial membrane, which is crucial for ATP production. By enhancing mitochondrial function and ATP production, *Centella asiatica* can help meet the high energy demands of neurons, particularly in the context of neurodegeneration where energy deficits are common. *Centella asiatica* also prevents mitochondrial dysfunction and apoptosis which can help preserve neuronal populations that are often lost in neurodegenerative diseases, potentially slowing disease progression and improving cognitive function (31).

It acts as an antioxidant by reducing brain oxidative stress, evidenced by lower malondialdehyde (MDA) levels. It also boosts cholinergic function by lowering acetylcholinesterase (AChE) activity, which enhances the availability of acetylcholine, a key neurotransmitter for memory and learning (32).

Centella asiatica has been found to significantly enhance cognitive abilities in menopausal women. *Centella asiatica* is associated with increased levels of BDNF, a protein crucial for brain health. Higher BDNF levels support neuron survival and promote the growth of new neurons, which is vital for maintaining cognitive function (33).

4. Cardiac and circulatory health

Centella asiatica improves cardiac health through several mechanisms and bioactive compounds, particularly its triterpenes such as asiatic acid, asiaticoside, and madecassoside. Here are the key ways in which it contributes to cardiac health:

- 4.1. Antioxidant activity:** *C. asiatica* is rich in antioxidants that help combat oxidative stress in cardiac tissues. By neutralizing free radicals, it protects heart cells from oxidative damage, which is crucial for maintaining overall cardiac function.
- 4.2. Anti-inflammatory effects:** The plant exhibits significant anti-inflammatory properties, which help reduce inflammation in the cardiovascular system. Chronic inflammation is a key factor in the development of various heart diseases.
- 4.3. Improvement of lipid profiles:** *C. asiatica* has been shown to lower cholesterol levels and improve lipid metabolism. By reducing levels of LDL (bad cholesterol) and increasing HDL (good cholesterol), it helps prevent atherosclerosis and other cardiovascular conditions.
- 4.4. Enhancement of endothelial function:** The extracts of *C. asiatica* improve endothelial function, which is essential for regulating blood flow and maintaining vascular health. Healthy endothelial function helps prevent hypertension and reduces the risk of cardiovascular events.
- 4.5. Regulation of blood sugar levels:** The antidiabetic properties of *C. asiatica* help manage blood glucose levels, which is important for preventing diabetes-related cardiovascular complications. By controlling hyperglycemia, it supports overall cardiac health (31-33).

5. Digestive health

Centella asiatica augments digestive health through antioxidant, anti-inflammatory, and prebiotic properties, promoting beneficial gut bacteria and suppressing pathogens (34,35). This is particularly valuable for conditions like Small Intestinal Bacterial Overgrowth and Inflammatory Bowel Disease. Polyphenols in *Centella* balance gut microbiota, and decoction-based preparations boost polysaccharides, enhancing prebiotic effects (34). As a Rasayana, it rejuvenates digestive function, while nervine tonic effects alleviate stress-related digestive issues (35). Key compounds like Asiatic and madecassic acids provide anti-inflammatory and healing benefits, supporting conditions such as gastritis, ulcers, and liver-related digestive disorders (36,37).

6. Wound healing, anti-inflammatory and antioxidant property

Centella asiatica has been used for wound healing due to compounds like asiatic acid and madecassic acid, which promote fibroblast proliferation, collagen synthesis, and angiogenesis, improving blood flow and tissue regeneration. Asiaticoside enhances wound contraction and re-epithelialization, accelerating healing and reducing oxidative stress (38,39). Its anti-inflammatory properties reduce cytokines and inhibit COX-2, helping soothe sensitive skin and chronic inflammation. Antioxidant and antimicrobial qualities make it valuable in cosmetics for calming acne, eczema, and promoting youthful skin (40,41). *Centella asiatica*, a herb known for its medicinal properties, is renowned for its antioxidant activity due to its rich content of phenolic compounds, flavonoids, and triterpenoids. Phenolic compounds like chlorogenic acid, catechin, and quercetin are abundant in *Centella asiatica* and are known for scavenging free radicals and reducing lipid peroxidation, thus protecting cellular components from damage (42). The extracts, containing gluconic acid, ferulic acid, kaempferol, chlorogenic acid, and asiatic acid, provide excellent antioxidant and anti-hyperlipidemic properties, potentially useful for treating diseases like hyperlipidemia (43). Asiaticoside, a triterpene, enhances key antioxidant enzymes such as superoxide dismutase (SOD), reduced glutathione (GSH), and vitamin E, bolstering the skin's natural defenses (44). The antioxidant mechanisms include preventing chain initiation, binding metal ions, decomposing peroxides, and scavenging radicals (45). Several studies support the antioxidant efficacy of *Centella asiatica*. For example, an in vitro study showed strong DPPH radical scavenging activity (46). In vivo studies demonstrated that treatment with *Centella asiatica* reduced renal and brain levels of pro-inflammatory cytokines (MDA, TNF- α , IFN- γ) and increased anti-inflammatory cytokines (IL-4, IL-10), along with significantly boosting antioxidant status (47).

7. Conclusion

Centella asiatica offers a versatile natural remedy, positively impacting skin repair, neuroprotection, cardiovascular function, and digestion through its antioxidant and anti-inflammatory actions. Clinical and traditional applications substantiate its effectiveness in promoting skin elasticity, cognitive function, cardiac health, and wound healing. Its minimal toxicity and rich composition support its role in therapeutic and cosmetic formulations, making *Centella asiatica* a promising herb in modern healthcare and wellness products in India.

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