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Centella asiatica: Unveiling its Transformative Cosmetic Values

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Abstract

Centella asiatica, commonly known as *Gotu kola* or Indian pennywort, has been an integral part of traditional medicine systems such as *Ayurveda* and Traditional Chinese Medicine for centuries. Recently, it has gained global recognition in the cosmetic industry, mainly in the Korean cosmetic industry, due to its remarkable skin benefits. This review delves into the extensive cosmetic potential of *C. asiatica*, highlighting its active components, such as asiaticoside, madecassoside, and various triterpenoids that promote skin health. These compounds contribute to a range of skin-conditioning properties, including enhanced wound healing, antioxidant protection, and anti-ageing effects. It improves hydration, strengthens the skin barrier, and combats oxidative stress, thereby delaying signs of ageing. Moreover, this article provides insights into marketed formulations containing *C. asiatica* and its effectiveness as an anti-inflammatory, moisturising, and skin-soothing agent. The evidence underscores *C. asiatica's* role in contemporary skincare as a multifunctional botanical extract, harmonising traditional knowledge with modern cosmetic applications. By bridging ancient wisdom and innovation, *C. asiatica* exemplifies how herbal remedies can be adapted for today's beauty needs.

Major Findings: *Centella asiatica* demonstrates significant cosmetic potential due to its triterpenoids and flavonoids, offering antioxidant, anti-ageing, wound-healing, and skin-soothing effects. It enhances skin hydration, strengthens the barrier function, and is widely incorporated into modern skincare formulations for managing sensitive and ageing skin.

Keywords: Anti-ageing, Indian Pennywort, Public Health, Skin Conditioning, Well-being

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1. Introduction

Many cultures all over the world have traditionally utilised herbal plants for their therapeutic and medical qualities. These plants, which are frequently found in nature, provide bioactive substances that offer an extensive plan for wellness and healing. The use of herbal plants has become more popular recently due to a rise in interest in sustainable living and natural cures[1]. *C. asiatica* is an important medicinal herb with a long history of traditional use. Its characteristic morphological features are shown in Figure 1.

1.1 Vernacular Names

- *Manimuni* (Assam)
- *Brahmamanduki, Thankuni, Tholkuri* (Bengali)
- *Chokiora* (Bihar)
- *Karinga, Karivana* (Bombay)
- *Vallari* (Deccan)
- *Barmi, Moti brahmi* (Gujarati)
- *Bemgsag, Brahma-manduki, Khulakhudi, Mandookaparni* (Hindi)
- *Brahmisoppu, Urage, Vandelaga-illikiwigidda, Vondelaga* (Kannada)
- *Kodagam, Kodangal, Kutakam, Kutakan, Kutannal, Muthal, Muttil, Muyalchevi* (Malayalam)
- *Brahmi, Karinga, Karivana* (Marathi)
- *Bat-maina* (Meghalaya)
- *Thalkudi* (Oriya)
- *Bhekaparni, Bheki, Brahmamanduki, Darduchhada, Mahaushadhi, Mandukaparni, Mandukaparnika, Manduki, Mutthil, Supriya, Tvashti* (Sanskrit)

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Figure 1. Whole plant of *Centella asiatica.*

- *Hingotukola* (Sinhalese)
- *Babassa, Vallarai, Vallari* (Tamil)
- *Babassa, Bekaparnamu, Bokkudu, Brahmi, Saraswataku, Mandukbrammi* (Telugu)
- *Thankuni, Thunimankuni* (Tripura)
- *Brahmi* (Urdu)

1.2 History

Centella asiatica is a significant medicinal herb utilised in the East and gaining popularity in the West as well. Often called *Mandukparni*, Indian pennywort, Tiger grass or *Jalbrahmi*, it has been utilised for thousands of years as a medicine in India's *Ayurvedic* tradition and is mentioned in the venerable Sushruta Samhita, an old Indian medical book[2]. The inhabitants of Java and other Indonesian islands also use the herb known as *Gotu kola* in China; it is one of the purported "miracle elixirs of life" that were discovered more than 2,000 years ago[3,4]. Contrary to *kola* nuts, *Gotu kola* does not contain caffeine and has not been demonstrated to have stimulant qualities. *Centella* and its extracts were added to the Indian pharmacopoeia in the nineteenth century. There, it was prescribed for the treatment of several skin ailments, including leprosy, lupus, varicose ulcers, eczema, psoriasis, diarrhoea, fever, amenorrhea, and diseases affecting the female genitourinary tract, in addition to wound healing[5].

In India, *C. asiatica* is commonly referred to as a "Brain food" due to its extensive use in treating skin ailments, mending wounds, and revitalising brain and nerve cells. Based on records from the Export and Import Bank of India, one of the important medicinal plants traded globally is *C. asiatica*. However, the natural population of this plant species has been drastically decreased because of widespread, unrestricted extraction, inadequate cultivation, and inadequate initiatives to replace it. Furthermore, the International Union for Conservation of Nature and Natural Resources currently recognises it as an endangered and threatened plant species[6,7].

1.3 Different Parts of *Centella asiatica*

Centella asiatica (L.) is a perennial creeper herb that grows up to 15 cm (6 inches) tall and is prostrate, stoloniferous, and slightly scented. Glabrous, striated, and rooted at the nodes is the stem. In areas that are shaded, marshy, damp, and moist, such as paddy fields and riverbanks, *C. asiatica* thrives profusely, creating a lush green carpet. A sandy loam with 60% sand content is shown to be more productive for *C. asiatica's* regeneration than clayey soil[8]. Each leaf has one to three long petioles that are 1.5 to 5 cm wide, 2 to 6 cm long, orbicular-reniform, with sheathing leaf bases and crenate margins. The leaves are glabrous on both sides. Blooms appear in fascicled umbels, with three to four white, purple, or pink blooms in each umbel. April through June is when flowers bloom. Throughout the growth season, roughly 2-inch-long, oblong, globular fruits with a highly thickened pericarp are produced. The pendulous embryos in seeds are squeezed laterally[9]. It grows in swampy places in most tropical and subtropical nations, including sections of Madagascar, South Africa, South America, Pakistan, India, and Eastern Europe. The majority of tropical or

moist pantropical regions, including rice fields, as well as rocky, higher altitudes, are home to about 20 species related to CA. This plant, which grows near water, has no flavour or smell. It grows small oval fruit and has small fan-shaped green leaves. Its flowers are white, light purple to pink, or both. The entire plant is utilised in medicine[10].

1.3.1 Root

Wavy outline with three to five layers of rectangular cork cells with exfoliated cells and three or four layers of parenchyma cells, oval to round starch grains measuring eight to sixteen μ in diameter, with centric hilum and micro sphenoidal crystals of calcium oxalate; thin-walled, oval to polygonal, parenchymatous cells make up the secondary cortex; secretory cells are present and scattered toward the periphery; secondary phloem and secondary xylem are made up of regular elements; vessels are lignified with reticulate and spiral thickening; pith is almost obliterated.

1.3.2 Stem

The single-layered epidermis, which has a roughly concave-convex outline and is made up of round to cubical cells covered in striated cuticle, is followed by two or three layers of collenchymatous cells, six to eight layers of thin-walled, isodiametric, parenchymatous cells, and intercellular spaces; vascular bundles are collateral, open, arranged in a ring, capped by patches of sclerenchyma, and traversed by wide medullary rays; vessels with spiral thickening are present.

1.3.3 Leaf

Petiole: Two projections next to the ventral groove give it a distinctive appearance; Single-layered epidermis with cubical cells covered in a thick cuticle; absent on projections; resin canal present on the dorsal side of each vascular bundle, except those that occur in projecting arms; seven vascular bundles, two of which are less developed and present in projections.

1.3.4 Midrib

A single layer of epidermis, two or three layers of collenchyma on both surfaces, four or five layers of parenchyma, and a largely chloroplast-free interior. The central zone is occupied by vascular bundles that have differentiated into phloem and xylem, with the latter consisting of sieve tubes, companion cells, and phloem parenchyma and the former of radial rows of vessels with xylem parenchyma in between.

1.3.5 Lamina

A striated cuticle-covered epidermis of tangentially elongated cells on both surfaces, with the upper surface being larger; mesophyll differentiated into 2 or 3 layers of palisade cells, and 5 to 7 layers of loosely arranged cells; stomata are more prevalent on the lower surface, where they are generally anisocytic, but the anomocytic type also occurs on both surfaces; palisade ratio is 3 to 5, the stomatal index on the upper surface is 9 to 12, and on the lower surface 11 to 17.

1.3.6 Fruit

The epicarp is made up of a single layer of epidermis that is externally covered in thick cuticle; the mesocarp is made up of polygonal, thin-walled parenchymatous cells that have patches of sclerenchymatous cells on both lateral sides; each ridge has a patch of sclerenchyma and a vittae; The endocarp is made up of wavy layers of columnar sclereids, while the endosperm and embryo are made up of thin-walled parenchymatous cells that are oval to polygonal in shape.

1.3.7 Powder

Green to greenish brown in colour and contains pieces of polygonal epidermal cells with stomata, palisade cells, and vasculature with spiral, reticulate, and annular thickening; it also has calcium oxalate microsphenoidal and rosette crystals and simple, oval to spherical starch grains with a diameter of 8 to 16 μ[11].

2. Geographical Distribution

The plant is native to Eastern South America, Madagascar, South Africa, Southeast Asia, Mexico, Venezuela, Colombia, and sections of China, India, Sri Lanka, and the Western South Sea Islands. It is widely distributed throughout India up to an altitude of 600 meters on moist, sandy, or clayey soils. It is sometimes seen in big clusters that form a dense green carpet or as a weed in crop fields and other waste places. The plant can be multiplied by stolons or seeds. The stem and leaves of the aerial portions, whether fresh or dried, are used medicinally[12]. Native people gather *C. asiatica*, which grows widely in

both eastern and western Nepal, for a variety of traditional medical purposes. For instance, aerial components are used to treat high blood pressure, lower uric acid levels, combat fever, and improve memory[13].

2.1 Distribution of *Centella asiatica* Across the World

The geographical distribution of *C. asiatica* across different regions of the world is presented in Table 1.

3. Collection and Cultivation

More than 100 ancient and contemporary pharmacopoeias contain the raw herb and its alcoholic extract in various formulations for treating conditions such as burn wounds, keloid hypertrophic scars, neurological processes, leprosy lesions, and stomach and duodenal ulcers. The presence of pentacyclic ursine-type triterpenoid centellosides, specifically asiatic acid, madecassic acid, asiaticoside, and madecassoside, is largely responsible for the therapeutic success of *C. asiatica*. Among these, asiaticoside promotes wound healing by stimulating fibroblast proliferation and collagen type-I synthesis, while madecassoside has a potent anti-inflammatory effect through increased collagen type-III secretion. Derivatives of asiaticoside are also being used to treat Alzheimer's because they shield cells from the neurotoxicity caused by β-amyloid[15].

Since most *Centella* herb used in the pharmaceutical sector is gathered from untamed natural stands, it has erratic quality profiles and high levels of heavy metal and microbial contamination. To meet the enormous market demand for this valuable plant, there is a growing need to begin structured commercial production of it. It is essential to screen and define *C. asiatica* germplasm for commercial cultivation in a specific environmental niche because genotype x environment interactions have a significant impact on biomass production and biosynthesis of bioactive chemicals in medicinal herbs. To determine which genotype(s) of *C. asiatica* are most adapted for growing in the agroclimatic conditions of the Indo-Gangetic plains, the current study evaluated Indian germplasm accessions of the plant[16].

Naturally, plants thrive in clayey, loose, sandy loam soil that is moist and healthy, and grow most abundantly in well-drained beds during monsoon seasons. Both seeds and rooted suckers are used to spread the plant. The plants can withstand intense shade and thrive well in it. Stem cuttings with one node can be planted. The nodes give rise to the roots. To plant one hectare of ground, 300 kg of rooted suckers are required. No preparation is needed. One ploughing and two harrowing should be used to thoroughly prepare the field before planting. When preparing the field, manure should be added at a rate of 20 t/ha and properly mixed with the soil. With irrigation, planting can be done in February or March at a 45 by 45 cm spacing. This crop is irrigated. Mango and other tree orchards are suitable places to cultivate the plant as a pure crop. Frequent hoeing and weeding are necessary to keep the beds completely free from weeds. Reducing waterlogging in the beds is crucial during the rainy season. Drainage is required during the rainy season, and irrigation is required every two weeks during the dry months. The experimental plantation did not exhibit any signs of disease, pests, or any other physiological issue. Ninety days after sowing, the crop reaches maturity. It is picked when the leaves are fully grown by hand-cutting. For easier drying, the leaves are picked while the weather is sunny. Before the gathered material is dried in the shade, unwanted material is sifted out of the crop. The production starts to decrease after the second year and requires new planting[17].

Table 1. Distribution of *Centella asiatica*

Sr. No.	Region	Countries
1	Africa	Angola, Madagascar, Zambia, Zimbabwe, Senegal, Sudan, Mali, Tanzania, Somalia, Nigeria, Mozambique, Mauritius, Congo, Kenya, Botswana, Malawi, Cameroon, South Africa, Central Africa
2	North America	United States, Mexico
3	Asia	Vietnam, Taiwan, Pakistan, Nepal, Malaysia, China, Japan, Korea, Thailand, Bhutan, Indonesia, Yemen, Bangladesh, India, Myanmar, Saudi Arabia, Sri Lanka
4	South America	Venezuela, Brazil, Colombia, Eastern South America
5	Europe	France[14]

Table 2. hytoconstituents present in *Centella asiatica*

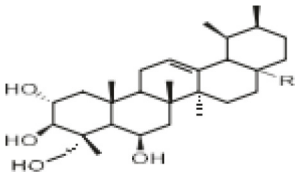
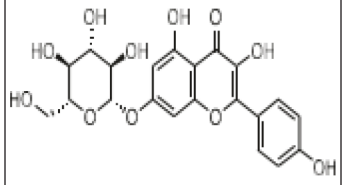
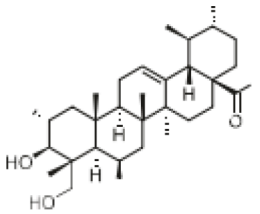
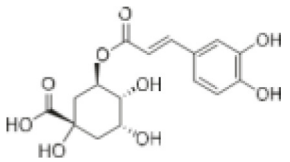
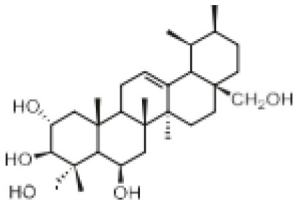
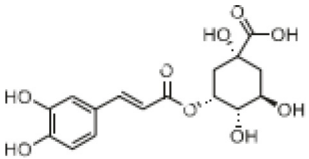
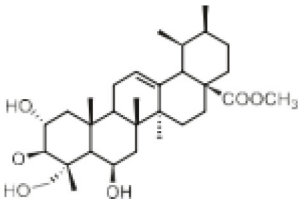
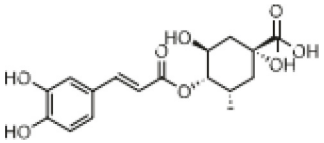
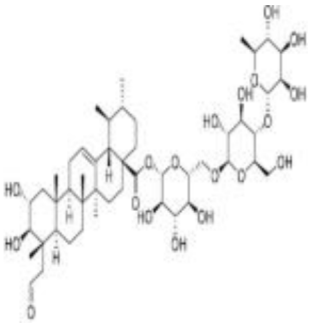
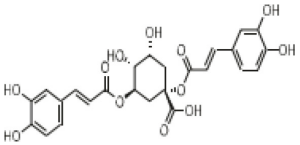
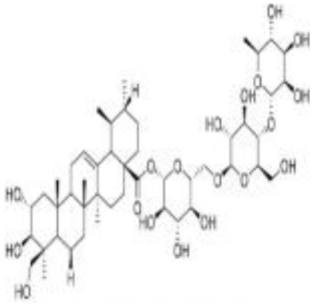
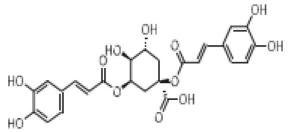
Name of the Constituents/ Reference	Structure	Name of the Constituents / Reference	Structure	Name of the Constituents / Reference	Structure
Madecassoside [Brahminoside][21]	 R=COO-glc(1-4)rha	7-glucosylkaemferol[23]		Madecassic acid [Brahmic acid] [21]	
Chlorogenic acid (3-O-caffeoylquinic acid) [23]		Brahmol[22]		Neochlorogenic acid (5-O-dicaffeoylquinic Acid)[23]	
Methyl brahmate [22]		Cryptochlorogenic acid (4-O-caffeoylquinic acid)[23]		Scheffuroside B[2α,3ß,23-trihydroxy-urs-20-en-28-oic acid O-α-L-rhamnopyranosyl-(1-4)-O-β-D-glucopyranosyl-(1-6)-O-ß-Dglucopyranosyl ester][22]	
1,3-dicaffeoylquinic acid[23]		Scheffuroside F[23]		1,5-dicaffeoylquinic acid[23]	

Table 2. Continued...

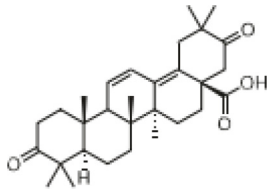
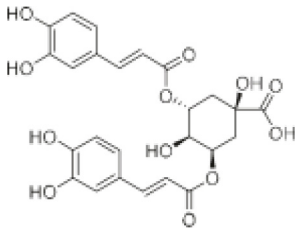
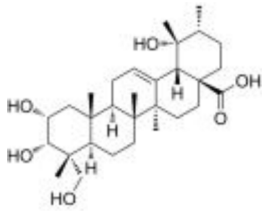
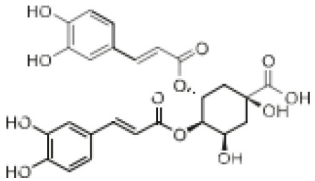
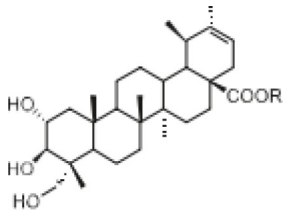
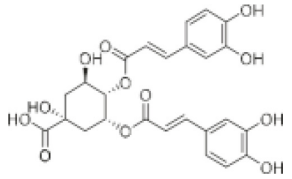
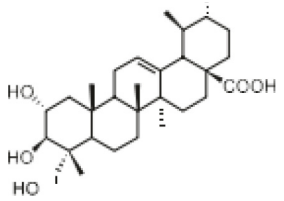
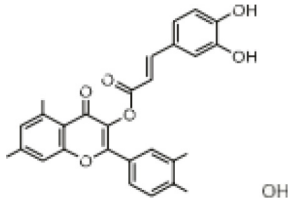
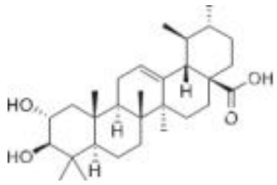
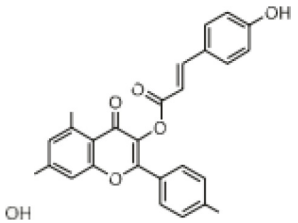
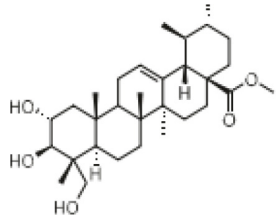
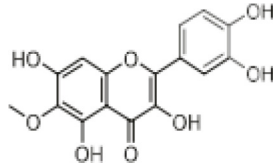
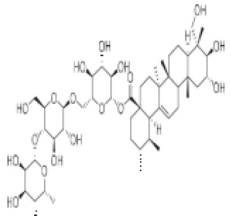
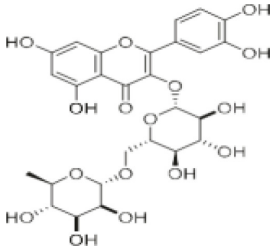
Name of the Constituents/ Reference	Structure	Name of the Constituents / Reference	Structure	Name of the Constituents / Reference	Structure
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3,4-dicaffeoylquinic acid (isochlorogenic acid B)[23]		2α,3ß,23-trihydroxy-urs-20-en-28-oic acid[22]	 R=H	4,5-dicaffeoylquinic acid (isochlorogenic acid C)[23]	
Asiatic acid (2 ,3ß,23-trihydroxy-urs-12-en-28-oic acid)[22]		Castillicetin[23]		Madasiatic acid[22]	
Castilliferol[23]		Methyl asiatate[22]		Patuletin[23]	
Asiaticoside [2α,3ß,23-trihydroxy-urs-12- en-28-oic acid O-α- L-rhamnopyranosyl-(1-4)-O-ß-D glucopyranosyl-(1- 6)-O-ß-D-glucopyranosyl ester][21]		Rutin[23]		Camphene [23]	

Table 2. Continued...

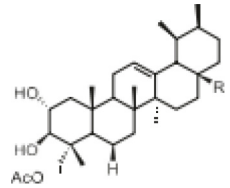
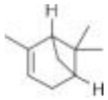
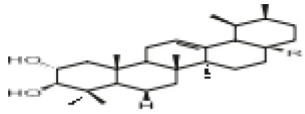
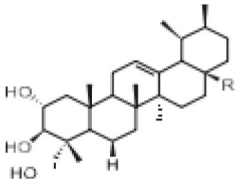
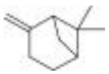
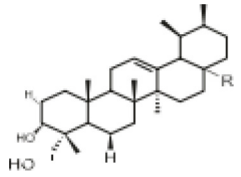
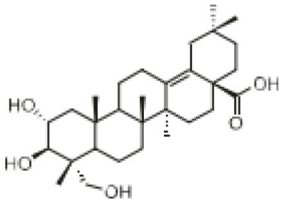
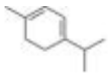
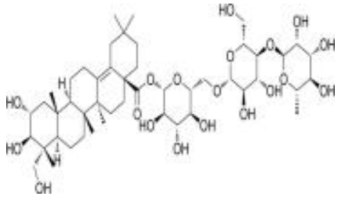
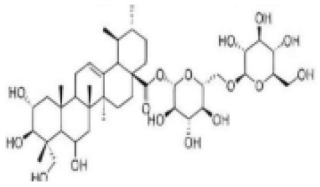
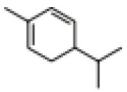
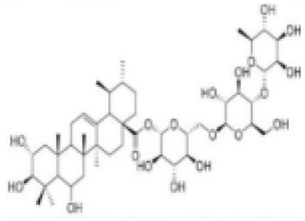
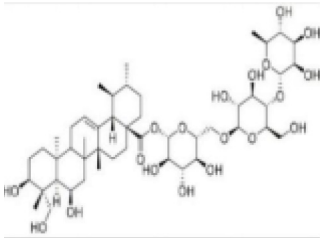
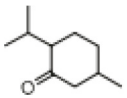
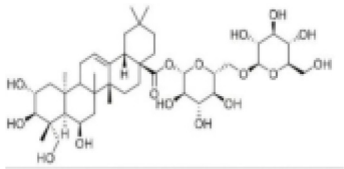
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Asiaticoside E [22]	 R=COO-glc(1-6)glc(1-4)rha	β-Pinene [23]		Asiaticoside F [22]	 R=COO-glc(1-6)glc(1-4)rha
Centellasapogenol A[2α,3ß,23-trihydroxy-olean-13-en-28-oic acid][22]		α-Terpinene[23]		Centellasaponin A [22]	
CentellasaponinB [22]		α-Phellandrene [23]		CentellasaponinC [22]	
Centellasaponin D [22]		Menthone [23]		Centelloside D [23]	

Table 2. Continued...

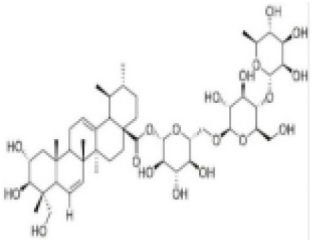
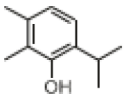
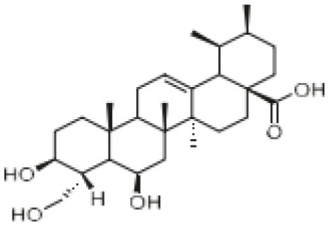
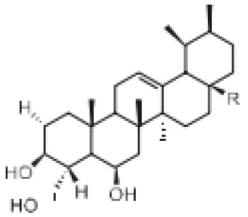
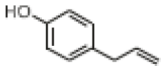
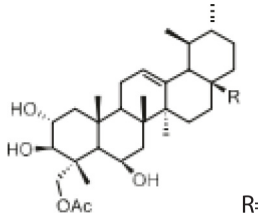
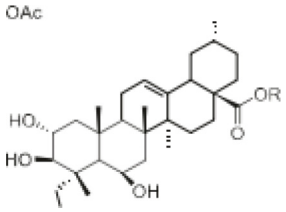
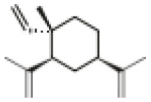
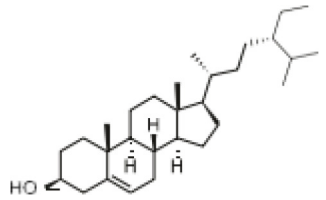
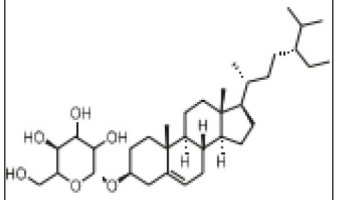
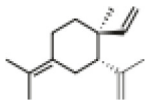
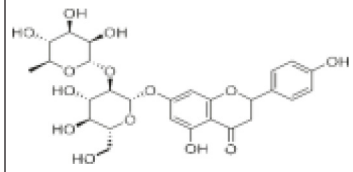
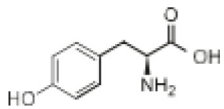
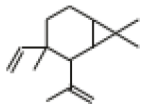
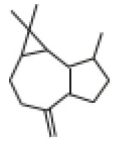
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Isothankuniside [22]	 R=COO-glc(1-6)glc(1-4)rha	Chavicol[23]		23-O-acetyl madecassoside [24]	 R=COO-glc(1-6)glc(1-4)rha
23-O-acetylasiaticoside B [24]	 R=COO-glc(1-6)glc(1-4)rha	β-Elemene[23]		Sitosterol[23]	
Sitosterol 3-O- - glucoside [24]		γ-Elemene[23]		Naringin[23]	
Tyrosine [23]		Bicycloelemene[23]		Aromadendrenec[23]	

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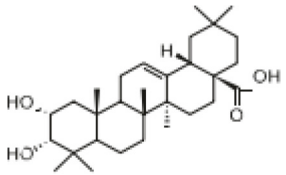
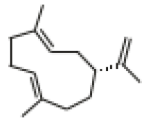
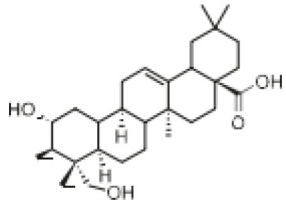
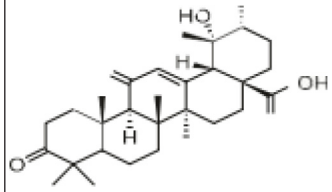
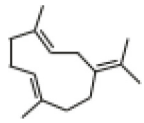
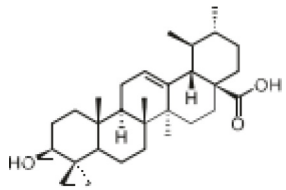
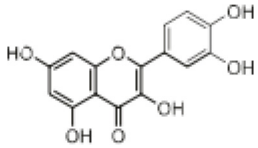
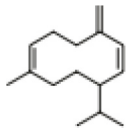
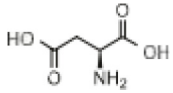
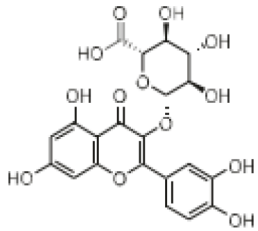
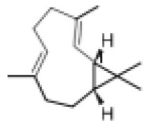
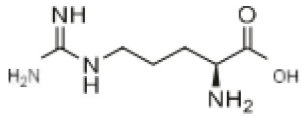
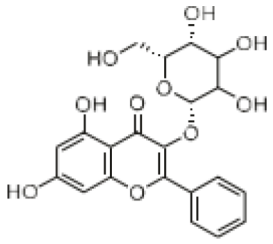
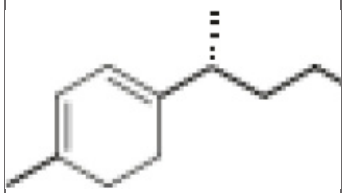
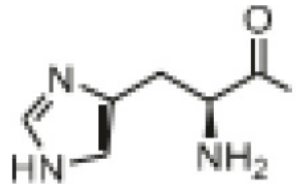
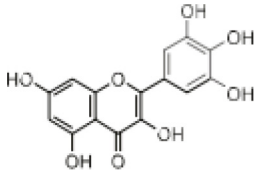
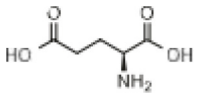
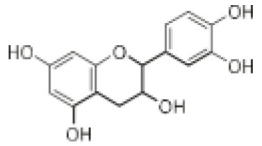
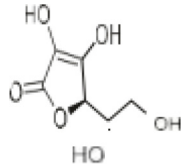
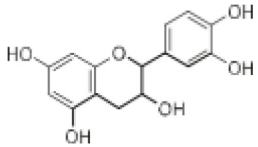
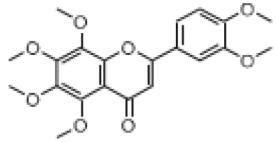
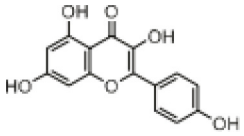
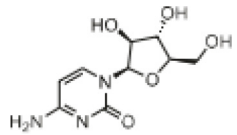
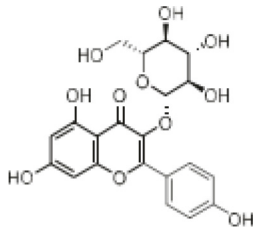
Name of the Constituents/ Reference	Structure	Name of the Constituents / Reference	Structure	Name of the Constituents / Reference	Structure
3-epimaslinic acid [23]		Germacrene A[23]		Arjunolic acid[23]	
Pomolic acid [23]		Germacrene B[23]		Ursolic acid[23]	
Quercetin [23]		Germacrene D[23]		Aspartic acid [23]	
Querectin-3-O- -D-glucuronide [23]		Bicyclogermacrene [23]		Arginine [23]	
3-glucosylquercetin [23]		Curcumene [23]		Histidine [23]	

Table 2. Continued...

Name of the Constituents/ Reference	Structure	Name of the Constituents / Reference	Structure	Name of the Constituents / Reference	Structure
Myricetin[23]		Glutamic acid[23]		Catechin [23]	
Ascorbic acid[23]		Epicatechin[23]		Nobiletin [21]	
Kaempferol[23]		Arabinoside[22]		3-glucosyl kaempferol [23]	

4. Phytoconstituents

Scientific research has supported the Indian medical system's claims, and *C. asiatica* has been shown to have a few biochemical components, such as secondary metabolites, which make it a significant medicinal component of the modern medical system[18]. Major constituents responsible for pharmacological value are terpenoids and flavonoids. The major phytoconstituents of *C. asiatica* and their chemical structures are mentioned in Table 2. Other major constituents are Asiatic acid, Asiaticoside, and Madecassoside. Secondary metabolites produced by the plant mainly comprise pentacyclic triterpenoid saponins[19].

Chemical components of *C. asiatica* are: Triterpenoids; Volatile and fatty acids; Alkaloids; Glycosides; Flavanoids; Tannins; Amino acids and sugar[20].

4.1 Triterpenoids

Triterpenoids include Asiaticoside, Madecossoside, thankuniside, centelloside, isothankunic acid, centellose, Asiatic acid, centellic acid, madecassic acid, brahmoside and brahminoside[1]. Prevalent constituents isolated from *C. asiatica* include triterpenoid saponins known as centelloids. Saponins may account for 1% to 8% of all *C. asiatica* constituents. The variable quantity of saponins depends mainly on the origin of the plant. The other components of *C. asiatica*, known as centellosides, are mostly pentacyclic triterpenoid saponins of the ursane- and oleanane-type. Additional centellosides found in *C. asiatica* include their glycosides, brahminoside, madasiaticoside and centelloside, as well as triterpenic acids, such as brahmic acid, madasiatic acid, terminolic acid, and centellic acid. Volatile oils are also present in *C. asiatica* (0.1%)[20].

5. Cosmetic Uses

5.1 Skin-conditioning Agents

5.1.1 *Centella asiatica* Extract

Centella asiatica extract is used as a skin-conditioning agent. It is also known as *gotu kola* extract. It is the extract of the whole plant.

5.1.2 *Centella asiatica* Callus Extract

Centella asiatica callus culture is also used as a skin-conditioning agent. It is a suspension of the cultured callus cells of *C. asiatica*.

5.1.3 *Centella asiatica* Leaf Extract

Leaf extract obtained from *C. asiatica* is also used as a skin-conditioning agent.

5.1.4 *Centella asiatica* Flower Extract

Flower extract obtained from *C. asiatica* is also used as a skin-conditioning agent.

5.1.5 *Centella asiatica* Root and Stem Extract

Root and stem extract obtained from *C. asiatica* is also used as a skin-conditioning agent.

5.1.6 *Centella asiatica* Leaf Water

An aqueous solution of the steam distillate, which is obtained from the leaves of *C. asiatica*, is called *Centella asiatica* leaf water. It is used as skin-conditioning agent and used as face toner.

5.1.7 *Centella asiatica* Meristem Cell Culture Extract

Centella asiatica meristem cell culture extract is an extract of *C. asiatica*. It is used as a skin-conditioning agent.

5.2 Skin Protectant

5.2.1 *Centella asiatica* Leaf Cell Culture Extract

Centella asiatica leaf cell culture extract is the extract of a culture of the leaf cells of *C. asiatica*. It isused as a skin protectant.

5.2.2 *Centella asiatica* Meristem Cell Culture

Centella asiatica meristem cell culture is a suspension of the cultured meristem cells of *C. asiatica*, which is used as a skin protectant[25].

5.3 Antioxidant Activity

An imbalance in the production of antioxidants and oxidants can lead to oxidative stress, which releases reactive oxygen species (ROS) and damages cells. Examples of ROS include peroxide, hydroxyl ions, superoxide radicals, and nitric oxide radicals. These entities have been linked to pathophysiological states like ageing, cancer, inflammatory disorders, and cardiovascular diseases. Antioxidants are substances that scavenge free radicals and protect the human body from the damaging effects of reactive oxygen

species (ROS). *C. asiatica* contains a large quantity of polyphenolic compounds and flavonoids, which provide better antioxidant activity; especially the leaves contain a high number of phenolic compounds.

A prior study that was published revealed a strong correlation between total phenolic content and antioxidative activity. The findings showed that phenolic compounds had a beneficial effect on *C. asiatica*'s antioxidant property. It is safe and efficient to take *C. asiatica* extract to strengthen the body's defence against free radicals and maintain oxidative stress in a balanced state. Asiaticoside is the most significant triterpene component, which is used in the initial stages of wound healing. It was shown that the leaves of *C. asiatica* exhibited optimal antioxidative activity in three different pathways: linoleic acid peroxidation (98.2%), superoxide free radical activity (86.4%), free radical scavenging activity, and DPPH (92.7%)[26].

5.4 Moisturising Property

Centella asiatica extract contains components like triterpenoid saponins, flavonoids and phenolic acids that can increase stratum corneum hydration. Formulations containing *C. asiatica* extract help improve skin moisture by increasing the surface hydration and decreasing the transepidermal water loss (TEWL). The decrease in TEWL was mainly related to the presence of components in *C. asiatica* extract such as triterpenoid saponins and polyphenols. These components bind to the water present on the stratum corneum surface and form an occlusive hydrophilic film. The results obtained concluded that cosmetic formulations containing *C. asiatica* extract have moisturising and anti-inflammatory properties. Therefore, formulations containing *C. asiatica* can be used in the treatment of dry and sensitive skin[27].

5.5 Anti-ageing Property

Cosmetics containing *C. asiatica* extract may increase the hydration of the stratum corneum and improve the epidermal barrier function. Consequently, it can be used as a moisturising agent in skin-protective and anti-ageing cosmetics. Components like Madecassoside, Madecassic acid, Asiaticoside and Asiatic acid help to improve skin hydration and provide anti-ageing benefits[9].

6. Toxic Effects

Centella asiatica has been used for a variety of purposes for centuries. It is advantageous to apply this information, as it is not only socially appealing but also carries minimal risk and is sustainable. *C. asiatica* is not toxic when given in the recommended doses, and possible side effects are usually rare. *C. asiatica* may cause local allergic reactions, especially when used externally and subcutaneously in large amounts.

6.1 Liver Toxicity

Rare cases of acute liver injury have been reported, particularly in individuals using *C. asiatica* for weight loss or skin conditions. Instances of jaundice and granulomatous hepatitis have been reported in a study, suggesting that while hepatotoxicity is uncommon, it can occur, especially with prolonged use or high doses. Hepatotoxic effects also occur due to diterpenic or triterpenic active principles, which cause apoptosis, change the cell membrane and cause liver damage.

6.2 Gastrointestinal Issues

Users may experience mild gastrointestinal disturbances such as bloating, diarrhoea, and nausea[28].

6.3 Allergic Reactions

Cosmetic formulations containing *C. asiatica* can cause skin irritation or allergic reactions,particularly in sensitive individuals. Symptoms may include burning sensations or rashes[12].

7. Marketed Formulations

Centella asiatica, also known as *Cica*, is a highly popular ingredient in the skincare market, known for its exceptional skin-soothing, healing, and anti-inflammatory properties. A comparative overview of selected commercial formulations, including brand name, manufacturer, formulation type, key ingredients, benefits and price, is presented in Table 3. Several brands have developed a range of formulations that incorporate *C. asiatica* to address various skin concerns, including redness, irritation, acne, and signs of ageing. These marketed formulations come with unique ingredient combinations and targeted benefits in diverse types such as: Sheet masks; Creams; Gels; Serums; Toners; Patches; Cleansers and Sunscreen.

Table 3. Marketed cosmetic formulations of *Centella asiatica*

Sr. No.	Brand Name	Company/ Brand	Formulation Type	Key Ingredients	Benefits	Price
1	Cica daily soothe 	VT Cosmetics	Sheet mask	*Centella* extract+3 types of hyaluronic acid + propolis extract + 4x centella complex	HydratingSoothing	₹3000/ 30 sheets
2	VT Redle Shot 100 	VT Cosmetics	Reedle shot cream	Cica Hyalon + Cica Reedle	Daily natural careImproved absorptionDaily cycle care	₹3800/50 ml
3	VT Reedle Shot 300 	VT Cosmetics	Reedle shot cream	Cica Hyalon + Cica Reedle	Intensive care every 3 daysImproved absorptionSkin texture care	₹5400/50 ml
4	VT Reedle Shot 700 	VT Cosmetics	Reedle shot cream	Cica Hyalon + Cica Reedle	Special care per weekEnhanced skin turnoverSkin regeneration	₹7500/30 ml
5	CICA Cream - CICALIO 	VT Cosmetics	Cream	*C. asiatica* complex + green propolis extract	Soothe, hydrate, and moisturiseProtect skin by creating a Cica-infused moisture barrier	₹1590/50 ml
6	Pro CICA Clear Spot Patch 	VT Cosmetics	Patch	*C. asiatica* extract + hyaluronic acid	Reduces redness and irritation.Minimises the appearance of enlarged pores	₹3488/ 30 sheets
7	CICA Mild Foam Cleanser 	VT Cosmetics	Cleanser	*C. asiatica*Extract	Cleansing, moisturising, and soothing effectOffers deep hydration and nutrients to your dry and sensitive skin	₹6964/ 300 ml

Table 3. Continued...

Sr. No.	Brand Name	Company/ Brand	Formulation Type	Key Ingredients	Benefits	Price
8	Cica and Ceramide Overnight Repair Face Serum 	Dr. Sheth's	Face serum	1% Ceramide Complex, *C. asiatica* extract (Cica), 2% Squalane, Marula Oil, Hemp Oil	Strengthens skinRepairs and rejuvenatesHydrates skin	₹599/30 ml
9	Cica and Ceramide Gentle Cleanser 	Dr. Sheth's	Cleanser	Cica Extract+Ceramide Complex+5% Glycerin+*Aloe vera* extract	Gently cleanses and unclogs pores, deeply hydrates and nourishes skinCalms and soothes irritationNon-irritating formula for dry and sensitive skin	₹349/125 ml
10	Centella and 10% Niacinamide Face Serum 	Dr. Sheth's	Serum	*Centella* extract+10% Niacinamide+1% Zinc PCA+Liquorice Extract.	Removes pigmentationReduces acne and acne scarringHydrates and soothes skinReduces inflammation	₹599/30 ml
11	Centella and Niacinamide Sunscreen SPF 50 Pa+++ 	Dr. Sheth's	Sunscreen	*C. asiatica* extract, niacinamide, hybrid sun filters	*C. asiatica* Extract (Cica Extract) significantly calms and soothes persistent irritation and redness while building the skin's barrierPowerful hybrid filters prevent sun damage	₹699/50 g
12	Centella and Vitamin E Cleanser 	Dr. Sheth's	Cleanser	*C. asiatica* extract+ 2%Vitamin E beads + almond oil + *Ashwagandha* extract	Gently cleanses dirt and excess oilFights dullness and inflammationLeaves skin fresh and hydrated	₹299/100 ml
13	10% Cica Glow Face Serum 	The Derma Co	Serum	Cica extract+Tranexamic Acid + Kojic Acid	Gives Glow, Hydration and NourishmentAntioxidant, Anti-inflammatory, Dark Spot Correction and Even Toning	₹599/30 ml

Table 3. Continued...

Sr. No.	Brand Name	Company/ Brand	Formulation Type	Key Ingredients	Benefits	Price
14	5% Cica-Glow Daily Face Moisturiser 	The Derma Co	Moisturiser	Cica extract+Tranexamic Acid + Alpha Arbutin	Makes skin glowHydration and Nourishing	₹349/50 g
15	2% Cica-Glow Daily Face Wash 	The Derma Co	Face wash	Cica extract+ Tranexamic Acid + Liquorice Extract	Glows and evens skin toneDeeply exfoliates and hydratesNourishing	₹349/100 ml
16	CICA Calming Skin Renewing Night Gel 	Dot and Key	Gel	Cica extract + Niacinamide + Green Tea + Hyaluronic acid	Heals Acne and Soothes InflammationFades Scars and BlemishesBalanced and Hydrated SkinRestorative Night Treatment	₹495/60 ml
17	Cica + Niacinamide Oil-Free Face Moisturiser 	Dot and Key	Moisturiser	Cica extract + Niacinamide + Ceramides + Oatmeal	Fades Acne Scars and Dark SpotsSoothes Redness and Irritation	₹495/60 ml
18	Cica and 1% Salicylic Daily Exfoliating Shower Gel 	Dot and Key	Shower Gel	Cica extract + 1% salicyclic acid + Niacinamide + Green Tea	Reduces Body Acne and Soothes IrritationClean, Acne-Free Skin	₹399/250 ml
19	CICA Face Wash 	Dot and Key	Face wash	Cica+ Green Tea+ *Aloe vera* + 2% Salicylic Acid	Acne PreventionTackles blackheads and blemishesSoothing and calming	₹249/100 ml

Table 3. Continued...

Sr. No.	Brand Name	Company/ Brand	Formulation Type	Key Ingredients	Benefits	Price
20	CICA Calming Mattifying Sunscreen SPF 50 PA++++ 	Dot and Key	Sunscreen SPF 50	*C. asiatica* extract, niacinamide, UV filters	Blendable, quick-absorbing sunscreen made with Cica and Niacinamide that leaves behind no white castFades sunspotsPrevents uneven skin tone and pigmentationReverses photodamage to prevent ageing from sun exposure	₹445/50 g
21	10% Niacinamide + Cica Serum 	Dot and Key	Serum	Cica + 10% Niacinamide + Alpha arbutin	Fades acne scars and dark spots for spotless skinControls acne breakouts for blemish-free skinSoothes inflammation and redness for calm skinReduces excess oil and minimises pores	₹450/20 ml
22	Cica Calming Skin Clarifying Toner 	Dot and Key	Toner	Cica + Niacinamide + Green tea	Anti-acne and dark spot removalExfoliation, pore treatment, and even toning	₹395/150 ml
23	Cica Clear Spot Correction Gel 	Dot and Key	Gel	Cica + 2% Salicylic acid	For active acne, soothingLight weight and non-dryingReduces active acne and rednessFades acne scars and dark spotsFor oily, acne-prone skin	₹350/20 ml
24	Cica + 2% salicylic skin-clearing face serum 	Dot and Key	Serum	2% Salicylic acid + Cica + Zinc	Anti-acneBlackheads treatmentOil controlSmootheningAnti-inflammatoryExfoliatingDark spot correction	₹550/30 ml

Table 3. Continued...

Sr. No.	Brand Name	Company/ Brand	Formulation Type	Key Ingredients	Benefits	Price
25	Cica Gel 	Earth Rhythm	Gel	*C. asiatica* + *Calendula* + Ginseng+ Licorice	Calms rednessFades red spotsImparts glow	₹499/100 gm
26	*Centella asiatica*(CICA) Niacinamide glow essence with hyaluronic acid 	Eco Berry	Serum	Cica + hyaluronic acid + niacinamide + vitamin b3 + vitamin c	Minimises redness and poresFades pigmentationPlumps skinDewy skinDeep hydration	₹549/100 ml
27	Cica Sleeping Mask (60 ml) 	LANEIGE	Night Cream	Cica + Forest yeast extract + Squalane	Soothing and calming night cream for dry, sensitive skinHydrating overnight treatmentStrengthens skin barrier	₹2070/60 ml
28	Mama Cica dark spot correcting Ampoule 	Quench	Serum	Cica + Korean ginseng + lotus root	Tackles blemishes and fades dark spotsPrevents acneExfoliates and clears skin	₹699/30 ml
29	Cica and 2% Niacinamide Face Mist Toner 	Quench	Toner	Cica + Niacinamide+Tea tree oil	Oil and acne controlHydrates, calms and refreshes skinMinimizes pores	₹399/100 ml
30	Mama Cica oil control overnight mask 	Quench	Cream	Cica + Lotus root + Korean ginseng	Deep cleanses skinPrevents acne, oiliness, blemishesRestores skin moistureBrightens complexation	₹699/50 ml
31	Mama Cica Zit Away acne pimple patches 	Quench	Patch	Cica + Lotus root + Korean ginseng + salicylic acid + glycolic acid	Conceals and heals pimplesFlattens pimples without leaving scarsAbsorbs pus and fluids	₹299/24 patches

Table 3. Continued...

Sr. No.	Brand Name	Company/ Brand	Formulation Type	Key Ingredients	Benefits	Price
32	Mud Sheet Mask with Cica Herb Repair 	Quench	Sheet mask	Cica + Lotus root + Korean ginseng + kaolin clay	Detoxifies and clears skinBrightens and reduces fine lines	₹150/23 ml
33	Mama Cica Pore Clearing Exfoliating Face Wash 	Quench	Face wash	Cica + Kaolin clay + Adlay seed powder	Prevents acne and controls excess oilEvens skin tone	₹399/100 ml
34	Cica Collagen Essence 	VT Cosmetics	Cream (Essence)	Cica + Low molecular fish collagen	Infused with 300 Da low molecular fish collagen that can be absorbed more easily than other animal collagens	₹2400/30 ml
35	Centella water alcohol free water 	COSRX	Toner	10% *Centella* leaf water + 85% Jeju Island mineral water	Purify and clear skinReduce redness	₹1090/150 ml
36	Cica 100 Essence Vegan Soothing and Hydrating Essence Water 	DEWYTREE	Watery essence	100% *C. asiatica* extract	Calms irritated and blemished skinSkin nourishmentBounce boost	₹2499/160 ml
37	Phyto Gel 	Earth Rhythm	Gel	*C. asiatica* + Horsetail extract	Fade scarsFight acne breakoutHeals and hydrates skin	₹429/50 g

Table 3. Continued...

Sr. No.	Brand Name	Company/ Brand	Formulation Type	Key Ingredients	Benefits	Price
38	Pure Fit CICA Toner 	COSRX	Toner	CICA-7-Complex + *Pinus pinaster* bark extract	Soothes irritated skin Reduces redness Recovers skin barrier	₹1650/150 ml
39	Cica Facial Sheet Masks 	Torriden Balanceful	Sheet mask	5D Cica Complex + Hyaluronic acid + 50% Tencel and 50% bamboo	Soothing, calming, balancing, and nourishing with *C. asiatica*, hyaluronic acid, and panthenol	₹2300/10 Sheets
40	Centella Acne Serum 	beplain	Serum	*Centella* + allantoin +chamomile+ hyaluronic acid+ panthenol	Moisturising spot corrector Relief and repair	₹1600/30 ml
41	Stretch Mark Cream 	Phade®	Cream	*Centella* + Shea Butter + Almondoil + Avocado oil + Rosehip oil	CICA technology fights against stretch marks Soothes and moisturises skin	₹860/200 ml
42	Cicapair Tiger Grass Colour Correcting Treatment Cream SPF 30 	DR. JART	Cream	Cica extract	Adapts to skin's natural colour Neutralise redness	₹9000/50 ml
43	Cicaplast Balm B5 Cream 	La Roche-Posay	Cream	*Centella* + Shea butter +Vit B5	Soothes irritated skin Reduces redness Recovers skin barrier	₹2999/40 ml
44	Retinol Cica Repair Ampoule 	Innisfree	Serum	*Centella* + Hyaluronic acid + Ceramide + Retinol	Reduces skin blemishes and improves skin elasticity Treats acne Boosts skin regeneration	₹2850/30 ml

Table 3. Continued...

Sr. No.	Brand Name	Company/ Brand	Formulation Type	Key Ingredients	Benefits	Price
45	Cica 2 in 1 Toner-Serum 	mCaffeine	2 in 1 Toner-Serum	Cica extracts + Green tea + Caffeine	Soothes redness and irritated skin Moisturises and tightens pores Tones and calms skin	₹449/150 ml
46	Ceramides and CICA Face Serum 	The Beauty Sailor	Serum	Centella+ Ceramides +hyaluronic acid	Glowing skin For promoting barrier repair and hydration Boosting glow	₹949/30 ml

8. Drug Interactions

8.1 Interaction with Antidiabetic Drugs

Blood sugar levels may be lowered by *C. asiatica* when combined with medicines to manage blood sugar; as a result, patients with diabetes may experience dangerously low blood sugar levels[29].

8.2 Interactions with Diuretics

Centella asiatica has diuretic properties. It can cause excessive fluid loss. This potential diuretic effect may lead to an electrolyte imbalance[30].

8.3 Interaction with Sedatives

Centella asiatica may have sedative qualities that enhance the effects of other sedatives; when taken with CNS depressants, such as barbiturates, benzodiazepines, or alcohol, it can lead to excessive drowsiness or sedation[31].

8.4 Interactions with Enzymes

In vitro experiments revealed that the ethanolic extract of *C. asiatica* noncompetitively inhibited CYP3A4 and competitively inhibited CYP 1A2 and CYP2C9. Flavonoids from the plant may be the cause of the inhibition of CYP1A2 and CYP3A4. *Centella* methanolic extract inhibits CYP2D6 in a noncompetitive manner[32].

8.5 Interactions with Anti-epileptic

Ethyl acetate extract of *Centella* had increased anti-epileptic effect in combination with valproate or phenytoin[33].

9. Conclusion

Centella asiatica has firmly established itself as a transformative ingredient in modern skincare, bridging the gap between ancient herbal wisdom and contemporary cosmetic science. Its diverse range of bioactive compounds, particularly triterpenoids and flavonoids, offers significant benefits, including enhanced wound healing, anti-ageing effects, and antioxidant protection. These properties make *C. asiatica* an invaluable addition to formulations aimed at soothing, hydrating, and revitalising the skin. Moreover, its proven efficacy in reducing inflammation and improving skin barrier function supports its use in treatments for sensitive and problem-prone skin. The increasing incorporation of *C. asiatica* into a wide array of cosmetic products from serums to sunscreens underscores its versatility and broad consumer appeal. As the demand for natural, sustainable ingredients in skincare continues to grow, *C. asiatica* stands out as a potent plant that harmonises traditional healing practices with innovative, evidence-based applications. Its continued exploration and use in cosmetics reflect a trend towards embracing holistic, plant-based solutions for achieving healthy, resilient skin.

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11. References

1. Benzie IF, Wachtel-Galor S. Herbal medicine: biomolecular and clinical aspects. CRC Press. 2011; pp. 500.
2. Gohil KJ, Patel JA, Gajjar AK. Pharmacological review on *Centella asiatica*: a potential herbal cure-all. Indian J Pharma Sci. 2010; 72(5):546. https://doi.org/10.4103/0250-474X.78519 PMid:21694984.
3. Diwan PV, Karwande I, Singh AK. Anti-anxiety profile of *Manduk Parni* (*Centella asiatica*) in animals. Fitoterapia. 1991; 62(3):253–257.
4. Chopra RN, Nayar SL, Chopra IC. Glossary of Indian medicinal plants (including the supplement). Council of Scientific and Industrial Research, New Delhi. 1986; pp. 77-100.
5. Brinkhaus B, Lindner M, Schuppan D, Hahn EG. Chemical, pharmacological and clinical profile of the East Asian medical plant *Centella asiatica*. Phytomedicine. 2000; 7(5):427-448. https://doi.org/10.1016/S0944-7113(00)80065-3 PMid:11081995.
6. Wankhade AM, Rahangdale PC. A review on *Centella asiatica*: a potential herbal cure. Res J Pharmacogn Phytochem. 2023; 15:235-240. https://doi.org/10.52711/0975-4385.2023.00037
7. Sun B, Wu L, Wu Y, Zhang C, Qin L, Hayashi M, Kudo M, Gao M, Liu T. Therapeutic potential of *Centella asiatica* and its triterpenes: a review. Front Pharmacol. 2020; 11:568032. https://doi.org/10.3389/fphar.2020.568032 PMid:33013406 PMCid:PMC7498642.
8. Singh S, Gautam A, Sharma A, Batra A. *Centella asiatica* (L.): a plant with immense medicinal potential but threatened. Int J Pharm Sci Rev Res. 2010; 4(2):9-17.
9. Seevaratnam V, Banumathi P, Premalatha MR, Sundaram SP, Arumugam T. Functional properties of *Centella asiatica* (L.): a review. Int J Pharm Pharm Sci. 2012; 4(5):8-14.
10. Singh P, Singh JS. Recruitment and competitive interaction between ramets and seedlings in a perennial medicinal herb, *Centella asiatica*. Basic Appl Ecol. 2002; 3(1):65-76. https://doi.org/10.1078/1439-1791-00085
11. Naveen K, Suresh C, Kumar SS, Chandra TR. Comprehensive literature review of *Mandukparni* (*Centella asiatica*) to its medicinal properties. Int J Ayurveda Pharma Res. 2017; 5(4):71-76.
12. Jamil SS, Qudsia Nizami QN, Mehboobus Salam MS. *Centella asiatica* (Linn.) Urban - a review. Indian J Nat Prod Resour. 6(2):158-170.
13. Gupta YK, Kumar MV, Srivastava AK. Effect of *Centella asiatica* on pentylenetetrazole-induced kindling, cognition and oxidative stress in rats. Pharmacol Biochem Behav. 2003; 74(3):579-585. https://doi.org/10.1016/S0091-3057(02)01044-4 PMid:12543222.
14. Belwal T, Andola HC, Atanassova MS, Joshi B, Suyal R, Thakur S, Bisht A, Jantwal A, Bhatt ID, Rawal RS. *Gotu kola* (*Centella asiatica*). Nonvitamin and nonmineral nutritional supplements. 2019; pp. 265-275.
15. Thomas MT, Kurup R, Johnson AJ, Chandrika SP, Mathew PJ, Dan M, Baby S. Elite genotypes/chemotypes, with high contents of madecassoside and asiaticoside, from sixty accessions of *Centella asiatica* of South India and the Andaman Islands: for cultivation and utility in cosmetic and herbal drug applications. Ind Crops Prod. 2010; 32(3):545-550. https://doi.org/10.1016/j.indcrop.2010.07.003
16. Rohini MR, Smitha GR. Studying the effect of morphotype and harvest season on yield and quality of Indian genotypes of *Centella asiatica*: a potential medicinal herb cum underutilized green leafy vegetable. S Afr J Bot. 2022; 145:275-283. https://doi.org/10.1016/j.sajb.2021.11.024
17. Bandara MS, Lee EL, Thomas JE. *Gotu Kola* (*Centella asiatica* L.): an under-utilized herb. Americas J Plant Sci Biotech. 2011; 5(2):20-31.
18. Gray NE, Alcazar Magana A, Lak P, Wright KM, Quinn J, Stevens JF, Maier CS, Soumyanath A. *Centella asiatica*: phytochemistry and mechanisms of neuroprotection and cognitive enhancement. Phytochem Rev. 2018; 17(1):161-194. https://doi.org/10.1007/s11101-017-9528-y PMid:31736679 PMCid:PMC6857646.
19. Prakash V, Jaiswal NI, Srivastava MR. A review on medicinal properties of *Centella asiatica*. Asian J Pharm Clin Res. 2017; 10(10):69-74. https://doi.org/10.22159/ajpcr.2017.v10i10.20760
20. Johnson Jr W, Bergfeld WF, Belsito DV, Hill RA, Klaassen CD, Liebler DC, Marks Jr JG, Shank RC, Slaga TJ, Snyder PW, Gill LJ. Safety assessment of *Centella asiatica*-derived ingredients as used in cosmetics. Int J Toxicol. 2023; 42(1_suppl):5S-22S. https://doi.org/10.1177/10915818231158272 PMid:36812692.
21. Ghosh K, Indra N. Phytochemistry, *in vitro* free radical scavenging, chelating and toxicity of *Centella asiatica* L. (*Apiaceae*) ethanolic leaf extract. Int J Pharm Sci Rev Res. 2014; 29(1):328-334.
22. James JT, Dubery IA. Pentacyclic triterpenoids from the medicinal herb, *Centella asiatica* (L.) Urban. Molecules. 2009; 14(10):3922-3941. https://doi.org/10.3390/molecules14103922 PMid:19924039 PMCid:PMC6255425.
23. Torbati FA, Ramezani M, Dehghan R, Amiri MS, Moghadam AT, Shakour N, Elyasi S, Sahebkar A, Emami SA. Ethnobotany, phytochemistry and pharmacological features of *Centella asiatica*: a comprehensive review. Pharmacological Properties of Plant-Derived Natural Products and Implications for Human Health. 2021; pp. 451-499. https://doi.org/10.1007/978-3-030-64872-5_25 PMid:33861456.
24. Rumalla CS, Ali Z, Weerasooriya AD, Smillie TJ, Khan IA. Two new triterpene glycosides from *Centella asiatica*. Planta Med. 2010; 76(10):1018-1021. https://doi.org/10.1055/s-0029-1240864 PMid:20143295.

25. Bylka W, Znajdek-Awiżeń P, Studzińska-Sroka E, Brzezińska M. *Centella asiatica* in cosmetology. Postępy Dermatol Alergol. 2013; 30(1):46-49. https://doi.org/10.5114/pdia.2013.33378 PMid:24278045 PMCid:PMC3834700.
26. Ramli S, Xian WJ, Abd Mutalib NA. A review: antibacterial activities, antioxidant properties and toxicity profile of *Centella asiatica*. EDUCATUM J Sci Math Technol. 2020; 7(1):39-47. https://doi.org/10.37134/ejsmt.vol7.1.5.2020
27. Ratz-Łyko A, Arct J, Pytkowska K. Moisturizing and antiinflammatory properties of cosmetic formulations containing *Centella asiatica* extract. Indian J Pharm Sci. 2016; 78(1):27. https://doi.org/10.4103/0250-474X.180247 PMid:27168678 PMCid:PMC4852572.
28. National Institutes of Health. National institute of diabetes and digestive and kidney diseases. US Renal Data System, USRDS 1998 Annual Data Report. 2010.
29. Legiawati L, Bramono K, Indriatmi W, Yunir E, Setiati S, Jusman SW, Purwaningsih EH, Wibowo H, Danarti R. Research article oral and topical *Centella asiatica* in type 2 diabetes mellitus patients with dry skin: a three-arm prospective randomized double-blind controlled trial. Evidence-based Complementary and Alternative Medicine. 2020; p. Article 7253560.
30. Mariano LN, Boeing T, da Silva RD, da Silva LM, Gasparotto-Júnior A, Cechinel-Filho V, de Souza P. Exotic medicinal plants used in Brazil with diuretic properties: a review. Chem Biodivers. 2022; 19(6):e202200258. https://doi.org/10.1002/cbdv.202200258 PMid:35544364.
31. Puttarak P, Dilokthornsakul P, Saokaew S, Dhippayom T, Kongkaew C, Sruamsiri R, Chuthaputti A, Chaiyakunapruk N. Effects of *Centella asiatica (L.)* Urb. on cognitive function and mood related outcomes: a systematic review and meta-analysis. Sci Rep. 2017; 7(1):1-2. https://doi.org/10.1038/s41598-017-09823-9 PMid:28878245 PMCid:PMC5587720.
32. Savai J, Varghese A, Pandita N, Chintamaneni M. *In vitro* assessment of CYP1A2 and 2C9 inhibition potential of *Withania somnifera* and *Centella asiatica* in human liver microsomes. Drug Metab Pers Ther. 2015; 30(2):137-141. https://doi.org/10.1515/dmdi-2014-0035 PMid:25938222.
33. Vattanajun A, Watanabe H, Tantisira MH, Tantisira B. Isobolographically additive anticonvulsant activity between *Centella asiatica*'s ethyl acetate fraction and some antiepileptic drugs. J Med Assoc Thai. 2005; 88:S131-S140.

Author Contribution

All authors contributed equally to the conceptualisation, methodology, data curation, formal analysis, writing, review, and editing of the manuscript. All authors have read and approved the final version of the manuscript.