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REVIEW PAPER

## Medicinal Value of *Centella Asiatic*: A REVIEW ARTICLE

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### ABSTRACT

As the world is advancing in researches related to plants, there are many plants which are being proved to have many therapeutic and pharmacological uses and are beneficial to the medicinal industry. Many plants are not known widely despite of having wide range of therapeutic use since they are still in their infancy stage in the research process. One such plant is *Centella asiatica*. The main objective of this article is to provide knowledge about the plant *Centella asiatica*. There are many common names but most commonly they are known as Indian Pennywort (common name), Gotukola or Mandukparni (both Hindi names). This article solely focuses on the therapeutic uses, history, pharmacognostic study, side effects and various marketed formulations of the concerned plant. *Centella asiatica* contains triterpenoid, saponins as its primary chemical constituent which is believed to be responsible for its wide range of therapeutic uses of this plant. The plant is locally known to be anti-biotic and anti-septic, but apart from that it is also known for curing various skin conditions such as leprosy, gastrointestinal diseases like diarrhea, gonorrhoea and also various other illnesses.

**Keywords:** - *Centella asiatica*, Gotukola, Pharmacognostic studies, Therapeutic uses, Interactions, Side effects.

### **INTRODUCTIO**

One of the widespread diseases, gastric ulcer, is supposed to be due to an imbalance between aggressive and protective factors [1].

*Centella asiatica* is a small perennial herbaceous plant from the wetlands of Asia which when consumed can have remarkable effects on the body. *Centella asiatica* is commonly known as Indian Pennywort which is widely native to the wetlands of Asia. They are also mostly found growing in marshy areas and water logged places. The plant belongs to the family of Apiaceae[1-3]. *Centella asiatica* is a widely known and used medicinal herb and in many Asian countries they

are also used in to make many traditional dishes. Since ancient times the herb is being used medicinally in the region of India, Sri Lanka, China, Nepal, Thailand and Madagascar. The mostly used therapeutic activity of this herb is for treating various skin problems and to heal wounds. *Centella asiatica*, also known as *Hydrocotyle asiatica*, in ancient times in India was majorly confused with *Bacopa monnieri* as both of the plants were sold under the local name 'brahmi'. Later *Centella asiatica* was started being called as 'jalbrahmi' in order to eradicate any type of confusion between the two plants. In the International Market of Medicinal Plant Trade, *Centella asiatica* is one of the important medicinal plants, according to the receipts submitted by Export and Import Bank of India. *Centella asiatica* is a creeper herb with reddish-

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green to greenish thin stolons and has the ability to attain height up to 15cm. *Centella asiatica* was included in the Indian Pharmacopoeia in the 19<sup>th</sup> century. Since many medicinal properties continued being proven it was gradually introduced in many other pharmacopoeias such as British Herbal Pharmacopoeia, Dutch Pharmacopoeia, German Pharmacopoeia, Chinese Pharmacopoeia, Martindale European Pharmacopoeia, Homoeopathic Arzneibuch and many more.

### What Is *Centella Asiatica*?

Gotukola is a very ancient herb which is used in the Ayurvedic System of Medicine to treat a variety of skin diseases, burns, scars, wounds, as an antipyretic, diuretic, rheumatic and many more. It is a perennial creeper herb which is found in the wetlands of mainland Asia. During summers they are grown outside. They are mainly propagated through seed system during the month of March. They are first grown in small pots. During the

**Table1:** Synonyms of *Centella asiatica*

Region/Language	Vernacular name	Region/Language	Vernacular name
Hindi	Gotukola, Mandhukpami, Khulakhudi, Brahma-manduki.	Sanskrit	Bheki, Supriya, Bhekapaarni, Tvasthi.
Marathi	Karinga, Karivana.	Tamil	Babassa, Vallarai.
Urdu	Brahmi	Bengal	Tholkuri, Thankuni.
Gujrati	Barmi, Moti brami.	Assam	Manimuni.

### Biological Source:

It is obtained from the aerial parts of the plant *Centella asiatica* belonging to the family Apiaceae (previously known as Umbelliferae).

### Geographical Source:

*Centella asiatica* is usually grown in temperate and tropical regions with wet and marshy surrounding. This plant is mostly native to Indian subcontinent, Southeastern US and Southeast Asia.

month of April as they grow they are transferred into bigger pots. After almost two months they are transferred into fields as they start sprouting and need a bigger space to grow and start spreading. They grow in warm temperate and tropical places and require a decent amount of moisture to grow. It is considered to be a major rejuvenative, restorative, it helps to build energy reserves, calms the mind, improves circulation to the central nervous system, improving concentration and memory. It also helps to improve the immune system, concentration and memory. They can be formulated into gels, creams, capsules supplements, ointments and other forms to help with several ailments ranging from anxiety to cardiovascular conditions. The high concentration of unique triterpenoid compound also known as saponins found in it is the reason behind the plant's power.[16]

### Pharmacognostic Study:

**Table2:** Kingdom classification

Kingdom:	Plantae.
Clade:	Tracheophytes.
Clade:	Angiosperms.
Clade:	Eudicots.
Clade:	Asterids.
Order:	Apiales.
Family:	Apiales.
Genus:	<i>Centella</i> .
Species:	<i>C. asiatica</i> .

The countries where this plant grows is India, Pakistan, China, Indonesia, Japan, South Pacific, South Africa, Sri Lanka and Thailand.

In India it is grown almost in all the states with wetlands. It mostly thrives in summer climate and requires huge amount of water for its growth. The major states where Gotukola grows are in North Indian states like Uttarakhand, Himachal Pradesh and almost all the North-Eastern states like Sikkim, Assam, Nagaland, Arunachal Pradesh, etc. and also few South Indian states like Tamil Nadu, Maharashtra.[17]

**Description:**

Color: leaves are green, stems are reddish-green to green in color; flowers are white or crimson in color.

Odor: spicy/fragrant.

Taste: bitter/sweet.

Size: leaves are around 2cm; the height of the stems grows up to 15cm; the flowers are less than 3mm in size.

Shape: stem is glabrous and thin; leaves are circular or reniform and dentate; petiole is long with hairy ends and smooth upper surface; fruits are oblong.



**Figure1:.** Stems and Leaves

**Cultivation, Collection and Preparation:**

The plant naturally grows in marshy and wet areas with enough water and loose sandy loam and clayey soil. They are propagated by seeds and

rooted suckers. The seeds should be planted in small pots before transferring them to the field. The plantings are usually done in the month of February-March. After a month i.e., in April it is transferred into a new and bigger pot for letting its roots grow. The land is ready by ploughing and harrowing and the newly sprouted plants are transferred into the field in the month of June. These plants can grow under direct sun and also under shade. They are able to tolerate heavy shade and still grow well. As the plant start growing it requires continuous weeding and hoeing. Despite of requirement of huge amount of water there should be no water logging in the field during monsoon season. During dryer season irrigation should be done continuously and needs a drainage system during rainy season.

Tobacco cut-worms and grasshoppers affect the foliage during summers. Such pests can be controlled by spraying neem seed oil, keiseigur, pyrethrum or fertilizer for plant include vermicompost, wood ash, oil cakes and poultry manure. Light irrigation should be done immediately after plantation which further ensures better establishment of the plants for its further growth. Light irrigation is necessarily done at an interval of every 5-6 days interval after the plantation of the seed. After the plants start sprouting irrigation is provided whenever necessary.[19]

While harvesting Gotukola the parts usually used are leaves and stems, therefore the plants are cut at the base carefully removing the leaves and vines. The dirt or mud stuck on the leaves is gently washed off with cold or normal water. They are usually harvested when it is bright green

and healthy looking. Mostly Gotukola is cultivated and harvested for its leaves rather than the stem and vine. The method of drying of Gotukola leaves affects the final product and also its efficacy. Before the process of drying the leaves of the plant should be washed properly and the leaves should be placed properly in a shaded area with good ventilation.

#### **Chemical constituents:**

The leaves and stem of *Centella asiatica* mostly contains:

- Asiatic acid: it is the major constituent of Gotukola (1-8%). Asiatic acid contains 26.7% of the total triterpenoid in Gotukola. Also contains its glycoside form Asiaticoside.
- Centellasaponins: saponin containing chemicals – Centellosaponin B and Centellosaponin C. it also contains Centellosides A and Centellosides B. The plant contains about 0.0063%-0.0084% of Centellasaponins.
- Madecassic acid: it is a natural triterpene. Also contains its glycoside form Madecassoside which is an isomer of Asiaticoside B. The plant has about 1.78% of Madecassic acid.
- Madasiatic acid: it is also a terpenoid found in Gotukola. The plant contains about 0.008% of Madasiatic acid.
- Thankunside and Isothankunside: they are glycosides found in minute quantity in the plant.
- Brahmoside and Brahminoside.
- Ursolic acid: triterpenoid.
- Centellin and Centellicin.
- Cetel centellin.
- Asiaticin.
- Betulinic acid.
- Terminolic acid.
- Rosmarinic acid.
- Ginsenosides.
- Other triterpenoids.
- Notoginsenoside ST-4 and Fe.
- The alkaloid hydrochotine.
- 8-acetoxy-1,9-pentadecadiene-4,6-diyne-3-ol.
- Apogenin.
- Irbic acid and other phenolic acids.
- Kaempferol and Castilliferol.
- Quercetin.
- Chlorogenic acid.
- Vitamin C in minute amount (0.25%).
- Beta-carotene, trans-leutin, trans-neoxanthin, trans-violaxanthin and other unidentified carotenoid structures.
- Anthocyanins.
- Campesterol and stigmasterol.
- Hydroxybenzoic acid.
- Vanillic acid.
- p-coumaric acid.
- Rutin.
- Apigenin.
- Castillicetin.
- Myricetin.

#### **History of Gotukola:**

Gotukola being a plant native to parts of Asia and Northern Australia has been a part of traditional medicines for centuries. This plant has been used in ancient Ayurvedic medicine system, Unani medicine as well as in Chinese medicine system because of its healing properties. This herb has been studied since 17<sup>th</sup> century and has proven to be a very useful drug in many ailments. So far the herb shows potential results not only when

ingested orally but also via topical application and intramuscular injections.[16]

In ancient times Gotukola was widely used to treat wounds as it showed anti-microbial and anti-bacterial activity. In Ayurvedic System of Medicine, it was also used to treat various digestive disorders such as diarrhea and gonorrhoea. In the 1800's, in Chinese Medicine System it was found Gotukola was also used to treat leprosy. In India, it was also used for revitalizing the nerves and brain cells, for this use of Gotukola it is known as 'Brain food' in India. For thousands of years, Gotukola has been used to treat asthma, skin disorders, body aches and ulcers, for improving memory and intellect, as a nervine tonic, in treatment of elephantitis, kidney troubles, leprosy and also in various culinary dishes.

Leaf extract of this herb is taken orally in order to cure diseases like dysentery and mental stress. In traditional Chinese medicine this herb is used for dysentery, diarrhea, vomiting, jaundice, scabies, fractures, tonsillitis, measles, and nosebleeds and in urinary difficulties and as endocrine tonic. Historically it was known as 'Snow plant' for the reason of its cooling properties. In Nepal this herb is used traditionally in the treatment of rheumatism, leprosy, poor memory and indigestion.[8]

In China, the infusion of Centella is known as 'miracle of elixirs' as it is known that a Chinese herbalist Chang-li-yun lived up to the age of 256 years and married 24 times attributing to the fact that he drank Centella infusion every day. The crushed leaf and root extracts are applied topically to the affected area in order to kill germs from

wounds. Dried herb is used as diuretic and also to lower high blood pressure and also in urinary tract infections.

#### **Pharmacodynamics:**

- Absorption: According to a study, it was found that Madecassoside, Asiatic acid, Asiaticoside and Madecassic acid showed a bioavailability of 30%-50%.
- Distribution: A Gotukola preparation, Madecassol showed that the peak plasma levels reached after 2-4 hours of oral ingestion, topical application or intramuscular injection according to a report submitted by Bosse et al. Asiatic acid binds to human serum albumin, particularly the IIA subdomain.[17]
- Metabolism: A study mentioned in 'The comparative steady-state bioavailability of the active ingredients of Madecassol by W.R. Rush, G.R. Murray and D.J. Graham' proved that in 12 volunteers asiaticoside is converted to asiatic acid *in vivo* by hydrolytic cleavage of the sugar moiety.
- Elimination: After ingestion, injection or application Madecassol is predominantly eliminated in the feces after 24-76 hours, with a little unspecified quantity that is metabolized by the kidney.

#### **Medicinal Uses:**

- Anxiolytic and sedative

Gotukola can have a positive effect on anxiety issue as it lowers the stress hormone cortisol and increases serotonin and dopamine levels in the body. It effectively decreases the frequency and severity of anxiety attacks and episodes in a group

of subjects who suffered from some form of GAD (General Anxiety Disorder).

In humans who are given oral supplement of Gotukola anxiety reduction has been reported. This activity is seen due to the presence of saponin in the plant. The anxiolytic activity is due to the drug binding to cholecystokinin receptors which is a group of G-protein coupled receptors which bind to the peptide hormone cholecystokinin or gastrin.

In a research conducted by Bradwejn et al anxiolytic property of the drug was studied by performing a double placebo controlled trial on Acoustic Startle Response (ASR), an instrument to measure levels of anxiety. After 30 and 60 minutes of ingestion, subjects who consumed 12g dose of Gotukola experienced a decrease in their ASR. Although *Centella* shows significant decrease in anxiety, the exact mechanism of action remains unclear. According to the research conducted in animal study in 2016 it was proved that Gotukola had an anti-anxiety effect on mice which was deprived from sleep for 72 hours.

In Indian literature, *Centella asiatica* is described to possess CNS effect such as nervine tonic, stimulant, sedative, tranquilizer and rejuvenant. The chemicals in Gotukola namely Brahmoside and Brahminoside is responsible for its sedative action.[6]

Gotukola has helps prevent nervous disorders.

- **Cardiovascular effects**

The plant showed strong cardio protective activity by limiting ischemia – reperfusion induced myocardial infarction in rats, by using its alcoholic extract.

In cardiac tissue Madecassoside shows anti-inflammatory effects in immune cells. The oral ingestion of Madecassoside showed changes in blood pressure and heart rate. Madecassoside shows active effects.

In blood pressure Asiatic acid has shown to reduce slightly and acutely reduce systolic and diastolic blood pressure when 30mg/kg is administered. Taking Gotukola orally has proven to improve blood circulation by relieving the tension and anxiety in the arteries and blood vessels. Gotukola is able to regulate blood pressure and reduce strain in the cardiovascular system, thereby protecting the heart and prevents diseases like atherosclerosis, heart attacks and strokes from occurring. Ingestion of Gotukola has also proven to help increase circulation and decrease fluid retention in people suffering from diabetes whose blood vessels have been damaged by their disease.[12]

In chronic venous insufficiency, this is a circulation disorder which is caused by the obstruction or reflux of blood flow in the veins. This disorder is caused by various abnormalities of the venous wall and valves. This results in the formation of varicose veins and also venous ulcers. *Centella asiatica* has been used in various circulatory disorders since ancient times. Topical application and oral ingestion of Gotukola is said to relieve varicose veins and venous hypertension. It works by strengthening the weakened veins, maintenance of connective tissues, in treatment of scleroderma; stimulate the formation of hyaluronidase and chondroitin, stabilizing connective tissue growth as well as balancing the connective tissue.



In clotting Gotukola helps prevent blood clotting and as a herbal remedy may aid in alleviating the symptoms of thrombosis, which is defined as blood clotting in the blood vessel.

- **Anti-depressant:**

Orally ingested *Centella asiatica* tablets of 250mg -750mg showed significant changes in behavior. The changes recorded in individuals showed an increase in calmness, contentment and alertness. In a review study conducted in 2016 on people with generalized anxiety and depressive disorder showed that when the individuals ingested Gotukola instead of their regular anti-depressant medication for a period of 60 days later self-reported decreased anxiety, stress and depression. The result was attributed with behavioral changes along with changes positive effect on body temperature, body weight and heart rate. The effect of Gotukola as anti-depressant has been accredited to the presence of total triterpenes which causes significant decrease in the corticosterone level in the serum.[10]

The anti-inflammatory property of Gotukola can lower the signs of depression and despair. It is also known to enhance spirituality, thus it is sometimes also referred to as the 'Herb of Enlightenment'.

- **Wound healing and scar minimizing:**

A research conducted on rats in 2015 showed that the dressings which contained Gotukola showed significant healing on different types of wounds. The types of wounds that showed promising results are blunt force trauma, clean cut wounds and also infected tissues. Although the research showed incredibly positive result further research is required to confirm the end results.

Gotukola has been used as an anti-infective since ancient times in traditional medicines they are applied topically on the wounds by making a paste or dried extract is used. Gotukola is believed to reduce bacterial contamination, promoting fibrinolysis and also reducing inflammation on the wounded area.

An extract of this plant containing Madecassic acid, Asiaticoside and Asiatic acid has been proven to accelerate wound healing even though it cicatrises. The Asiaticoside is responsible for proliferation of fibroblasts and promote positive wound healing.[24]

Wound healing was more prominently reported with gel products of *Centella asiatica* extract. *Centella asiatica* extracts also have been recognized for its anti-oxidative property which plays a huge role in its wound healing property. The glycoside derivate of Gotukola, Asiaticoside is known for its anti-oxidative property. It heals the wounds by keratinizing and thickening the skin around the wound to treat the infection as well as increases the tensile strength of the newly formed and healed skin.

In various researches Asiatic acid and Madecassic acid is known to have collagen producing properties which promotes the healing of scars left behind by various wounds. *Centella asiatica* has also been used to reduce stretch marks when used in combination with Vitamin E, rosehip oil etc. While this combination therapy has shown many results and is proven to be highly effective there are no studies to prove the individual efficacy of *Centella asiatica* when used in isolation.

- **Skin care:**

Gotukola is rich in anti-oxidants and contain saponin which improves the appearance of skin. Many cosmetic and pharmaceutical companies are interested in it because of its ability to reduce the appearance of scars, wrinkles and other blemishes. According to research, Gotukola is also effective in the treatment of burns, wounds and hypertrophic scars. Some studies also suggest that the use of Gotukola or its components may be useful in the treatment of psoriasis and scleroderma.[4]

Gotukola is a common ingredient of cosmetics applied to skin photo aging also in cellulite and striate. Gotukola can also inhibit cell reproduction. Although not potent, Gotukola can be used as an herbal aid in providing relief from symptoms of psoriasis which is a hyper proliferative skin disorder.

- **Memory enhancer:**

A research study based in the 'Evidence Based Complimentary and Alternative Medicine Journal' shows that according to the Ayurvedic System of Medicine, Gotukola is one of the most important herb for nerve and brain cells and is capable of increasing intelligence, longevity and memory. The Gotukola extract has been traditionally used to improve memory in India as Ayurvedic treatment. Studies done on lab rats confirm that it has memory enhancing property, and therefore can slow down the effects of Alzheimer's disease, schizophrenia and dementia.

*Centella asiatica* has shown to enhance memory and nerve function which shows that this plant can be used as a suitable drug in treatment of Alzheimer's disease. According to a study on

mice conducted in 2012, Gotukola extract was found to have a positive feedback on behavioral abnormalities in mice suffering from Alzheimer's disease. The extract of the Gotukola herb showed to have a good effect on protecting the brain cells from toxicity which could further enhance the power of memory in individuals with or without Alzheimer's disease. There are many more researches to be conducted to prove its potential effect to act as a first choice Ayurvedic drug for the treatment of Alzheimer's condition.

According to a study published by 'K. Nalini, A.R. Aroor, K.S. Karnath and A. Rao – Effect of *Centella asiatica* fresh leaf aqueous extract on learning and memory and biogenic and amine turnover in albino rats (1992)' showed that aqueous extract of the herb had positive effect on the learning and memory and it also decreased the levels of dopamine, norepinehrine and 5-HT and its metabolites in the brain.

The drug has showed improvement in learning, memory and concentration in children with learning disability.[7]

- **Anti-leprotic and anti-tuberculosis:**

*Centella asiatica* has been used in the treatment of leprosy in Chinese medication since the 1800's. The traditional use of *Centella asiatica* as an anti-leprotic is due to its effect in increases the cerebral levels of GABA. The chemical responsible for treatment of leprosy is Asiaticoside. Asiaticoside showed increase in RBC level when a clinical trial was conducted on normal adults. Oral administration of *Centella asiatica* and Asiaticoside proved to be efficacious against leprosy. [21]In a clinical study conducted for treatment of leprosy with Asiaticoside for one



year showed improvement in the patient faster as compared to dapsone & showed good tolerance to the drug derived from *Centella asiatica* and the therapeutic effect was comparable to dapsone as it showed similar results.

The glycoside derivative of *Centella asiatica*, Asiaticoside is also proven to have anti-tuberculosis effect. In a research study, when a drug derived from *Centella asiatica* was injected to test subjects inoculated with *Mycobacterium* it showed decrease in size and number of tubercular lesions present in lungs.

- **Circulation:**

*Centella asiatica* plays two very important role in the circulatory system:

- i) Firstly, the plant extract can protect and strengthen the wall of blood vessels and capillaries, which prevent leakage and optimize the circulatory system.
- ii) Secondly, it stimulates the flow of blood which increases the oxygenation in different parts of the body and important organ systems. This also alleviates the problems caused due to poor blood circulation such as swelling, leg heaviness and pain.

- **Gastrointestinal diseases:**

Traditionally, *Centella asiatica* leaves have been used as a remedy for severe pain in the stomach which we now link to gastric ulcers. This treatment is still considered viable and the anti-inflammatory and anti-oxidant properties of the leaves can clearly improve the health of the gut and the colon.

The alcoholic extract of the whole plant *Centella asiatica* is proven to have anti-protozoal activity against *Entamoeba histolytica* which can be a possible treatment for various amoebic diseases such as dysentery, chronic nondysenteric colitis, toxic megacolon, perianal ulceration and more. This healing property of Gotukola can also be held responsible for the treatment of bladder wounds caused by parasitic infection called schistosomiasis by injecting Gotukola.[17]

The most important activity of Gotukola in treatment of gastrointestinal diseases is the treatment to gastric ulcers. In a research report, it was shown that extracts of *Centella asiatica* showed to have protective and therapeutic effect on the mucosal layer of stomach and helped to reverse the gastric mucosal damage. This research also showed that when *Centella asiatica* extract was administered orally in doses of 200 and 600mg/kg twice daily for five days produced therapeutic effect towards cold restraint stress-induced gastric ulcer, pyloric ligation induced peptic ulcer and aspirin induced gastric ulcers. It treated the mucosal layer by presumably strengthening the gastric mucosal barrier and also by reducing the damaging effects of free radicals to the mucosal layer. The extracts of *Centella asiatica* increased the levels of GABA in the brain and protecting the individual from cold restraint stress-induced ulcers. No effects were seen on offensive acid- pepsin secretion by Gotukola extracts, but showed prominent decrease in cell shedding which indicated fortification of mucosal barrier. Asiaticosides have been proven to have anti-inflammatory activity which further aid the healing of the mucosal ulcers.

- **Radioprotection:**

In previous studies, *Centella asiatica* has been suggested to be useful in preventing radiation induced behavioral change during clinical radiotherapy. A sub lethal dose of Co 60 gamma radiation was introduced to test the radioactive property of the plant extract which proved that a dose of 100mg/kg significantly increased the survival time of the mice. The animals that were treated with *Centella asiatica* extracts differed in body weight from those animals which only received radiation.[13]

- **Boosts cognition:**

The extract of *Centella asiatica* has a positive impact on the circulatory system, thereby oxygenating more of the brain and allowing cognition to improve. The anti-oxidant property effects of this herb are also somewhat responsible, as they can stimulate neural pathways by eliminating plaque and free radicals from the brain. Gotukola has an anxiolytic activity that helps relieve stress, enhance mood, induce sleep, thereby calming the nervous system. For those suffering from disorders like epilepsy, it can have a profound effect on the quality of life and the severity of condition if taken regularly.

- **Anti-cancer and cytotoxic activity:**

A new study has evaluated that the methanolic extract of *Centella asiatica* had the ability of inducing cell apoptosis in different cancer cell lines. The *Centella asiatica* extract induced apoptosis of cells by nuclear condensation in cell, weakening mitochondrial membrane potential, increase in annexin staining and induction in DNA breaks reactivity. Asiatic acid and other extracts of *Centella asiatica* was found to have anti-cancer

effects on breast cancer, skin cancer, lung cancer, prostate cancer, liver cancer and melanoma.[20]

- **Detoxifier:**

Gotukola has long been known as a mild diuretic and can, therefore stimulate the release of excess toxins, salts, water and even fat from the body through urination. This release helps ease tension of the kidneys and generally removes toxins quickly while keeping our energy up and our fluid balance even. A research study conducted on animal study in 2017, Gotukola proved to be beneficial in suppressing the toxic side effects of antibiotics like isoniazid, which is an antibiotic used to treat tuberculosis.

- **Side Effects:**

Gotukola has very few side effects since it is very well tolerated. It is recorded in very few cases to cause headaches, upset stomach and dizziness. Doctors usually recommend starting with a low dose and gradually increasing the dose to lower the possibility of potential side effect of the drug. Usually Gotukola is recommended not to be taken for more than two to six weeks at a time. The patient should take some interval before resuming Gotukola intake since it can reduce the risk of side effects.

Application of topical preparation of Gotukola has the potential to cause skin irritation, therefore a patch test is always recommended before starting topical use of *Centella asiatica*.

Various side effects of Gotukola are:

- Nausea.
- Vomiting.
- Upset stomach.
- Itching.

- Sensitivity to sunlight (photosensitivity).
- Allergic contact dermatitis when used topically.
- Burning.
- Drowsiness, sleepiness.
- High blood sugar (hyperglycemia).
- Hypercholesterolemia.
- Hypertriglyceridemia.
- Dark urine (sign of liver problem).
- Low fever.
- Nausea.
- Stomach pain.
- Loss of appetite.
- Clay colored stool (another indication of liver problems).
- Yellowing of the skin and eyes (indication of liver problems).

#### **Dosage:**

Dosage of *Centella asiatica* is different for various illnesses. For general use of Gotukola the dosing varies from person to person. It is used recommended to take 20 – 30mg twice a day.

Few of the dosage system according to their function are as follows:

##### **i) To help boost cognitive function:**

Recommended dose is 750 to 1000 mg of Gotukola per day for up to 14 days at a time.

##### **ii) In treatment of Alzheimer's disease:**

Recommended dose is to take 30 to 60 drops of liquid extract of *Centella asiatica* at least 3 times a day. Different manufacturers have different dosing instructions depending on the concentration of the liquid extract so it is advised to always follow the directions in the bottle.

##### **iii) To reduce anxiety:**

Recommended dose is to take 500 mg of Gotukola extract twice a day for at least 14 days at a time. In cases of extreme anxiety disorders up to 2000 mg of Gotukola extract per day is recommended but it is also advised to counsel with a health-care provider first.

##### **iv) As an anti-depressant:**

Recommended dose is to take 500 mg of Gotukola twice a day for up to two weeks at a time. Just like in serious case of anxiety, in serious cases of depression a person can take up to 2000 mg per day.[10]

##### **v) To improve circulation:**

Recommended dosage is to take 60 to 100 mg of Gotukola extract for three times a day for a week, especially if the person is making any flight travel. Massaging of affected area with a topical cream containing 1% Gotukola extract can also be taken into consideration.

#### **Skin Patch Test:**

Before applying any topical preparation of Gotukola a skin patch test is necessary as it can sometimes cause itching, redness and allergies. To test the topical preparation, rub a coin sized amount on the inside of your forearm. If there is no visible irritation or inflammation within the next 24 hours after application, the topical preparation is safe to be used elsewhere on the skin.

##### **vi) To ease insomnia:**

Recommended dose to treat insomnia is to take 300 to 680 mg of *Centella asiatica* extract 3 times daily for at least up to two weeks at a time.

##### **vii) To reduce stretch marks and scars:**

In order to reduce stretch marks first a Skin Patch Test should be conducted to check if there is any irritation, redness or inflammation in the applied area.

For stretch marks, apply a topical cream containing 1 percent Gotukola extract to the affected area several times a day.[14]

**viii) To promote wound healing:**

A Skin Patch Test is necessary before applying a topical preparation of *Centella asiatica*. Application of ointment containing 1% of *Centella asiatica* is preferred on the affected area several times a day depending on the size and severity of the wound.

If the affected wound is deep then consulting with a health care provider is preferred before applying the ointment on the wound.[28]

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**ix) To relieve joint pain:**



Recommended dose for joint pain is to take 300 to 700 mg of *Centella asiatica* extract for at least two weeks at a time for three times a day.

**x) To detoxify:**



To have a detoxifying effect you need to take 30 to 60 mg of liquid extract of Gotukola for three times a day daily for up to two weeks at a time.

Different manufacturers have different dosage instructions depending on the concentration of Gotukola in their product, so it is recommended to follow the direction of use on the bottle.

**Table3:** Marketed Preparations and their Uses [20-29]

PRODUCT:	MANUFACTURER:	APPLICATION:
 <p>Gotukola Powder</p>	Herbal Hills.	Memory enhancer, improve cognitive function.
 <p>Gotukola liquid extract.</p>	Horbaach.	Herbal supplement, daily balance and mental wellness,

 <p>Centella asiatica tea.</p>	<p>Cha Flora Tea.</p>	<p>Protector of blood veins, relieve stress, helps in varicose veins and tired legs and reduces cellulite.</p>
 <p>Gotukola night cream.</p>	<p>Omved, India.</p>	<p>Removes scars, blemishes</p>
 <p>Gotukola day cream.</p>	<p>ACURE.</p>	<p>Removes blemishes,</p>
 <p>Gotukola dry extract.</p>	<p>Anastore, France.</p>	<p>Venous insufficiency, wound healing, anxiolytic, anti-depressant, anti-oxidant.</p>
 <p>Himalaya Mindcare Capsules</p>	<p>The Himalaya Drug Company, USA.</p>	<p>Mental alertness, focus, memory enhancer, cognitive wellness.</p>

 <p>Gotukola capsules by Organic India.</p>	<p>Organic India, India.</p>	<p>Helps calm mind, ease stress, powerful adaptogenic, nervine tonic, for insomnia, brain tonic. Claims to be Vegan, Gluten free and GMO free.</p>
 <p>Gotukola capsules.</p>	<p>Nature's Way.</p>	<p>Used for longevity, vitality, Homeopathic medication.</p>

Herbal medicine has seen an exponential growth over the last decade and since they show lesser side effects than allopathic medication, herbal medicines and herbal supplements have seen an increase in demand even for many serious neurodegenerative illnesses such as Alzheimer’s disease, dementia, ADHD, schizophrenia and many more.

*Centella asiatica* also known as Gotukola is known to contain asiatic acid and asiaticoside as its main chemical constituents. In the case of Alzheimer’s disease Gotukola extract works by inhibiting beta – amyloid cell death in-vitro, suggesting a possible role for Gotukola in the treatment and prevention of Alzheimer’s disease and beta – amyloid toxicity. Gotukola has been proven to be potential herb drug which is useful in increasing intelligence, longevity and memory in patients with Alzheimer’s disease and dementia.

One of the major causes of blood circulation problem is the formation of clot (thrombus) in the blood vessels and blocking the flow of blood in that locations depriving the tissues of its normal blood

flow and oxygen. When clot is formed in the blood vessel for a long period of time it may result in damage, destruction or even necrosis of the localized tissue in that area. Formation of thrombus occurs from fibrinogen by thrombin and is lysed by plasmin, which is activated from plasminogen by tissue plasminogen activator. In this study it was proved through various experimental methods that the plant *Centella asiatica* and its extracts showed potential thrombolytic activity.

Plants which provide antioxidant properties have started being prioritized over allopathic medications since they contain many additives which can have adverse effect on human health. Anti-oxidants present in plants also provide health – promoting ingredients and benefits in human diet which is also responsible for the prevention and treatment of radical mediated disorders. In this study it was proved that the plant Gotukola and its extracts showed anti-oxidant properties.

Various pre-clinical and clinical studies on Gotukola found oral and treatment of controlled



doses of *Centella asiatica* to assist with antioxidant production and alleviate slow wound healing. An *in-vivo* and *in-vitro* study of Gotukola found that it was able to decrease the side effects of radiotherapy such as nausea and vomiting. A study was also conducted on rats who were exposed to radiation and were given Gotukola prior to radiation showed that they experienced less side effects of radiation as compared to those rats that were exposed only to the radiation without Gotukola. Later when Gotukola was administered on the remaining rats they also showed improvement in the side effects and also had an increased life span.

A study by Mato et al. suggested that due to the high concentration of antioxidant in Gotukola it improved physicality in healthy elderly as found in a series of test performed over a period of two months. The test volunteers were asked to perform a series of physical strength tests while taking controlled doses of the herb. At the end of the test physical strength was improved in the volunteers as it took lesser amount of time to complete the tests.

## CONCLUSION

In this article, the various therapeutic uses of *Centella asiatica* has been explained. Along with its pharmacological actions, its pharmacodynamics, interactions as well as side effects have also been mentioned. After going through many review articles and research articles on Gotukola this article focuses on a more simplified version of many articles combined.

Gotukola has an immense power to treat many diseases with very little side effect and sometimes no side effect at all if the patient is careful enough.

The many uses of Gotukola are its ability to treat wounds, decrease the visibility of scars, decrease

blemishes, etc. Gotukola is also a 'cure-all' herb as it has also been proven to improve blood circulation, decrease anxiety, as an antidepressant, cytotoxic activity, lowering of blood pressure, treatment of Alzheimer's disease, dementia, ADHD, schizophrenia, decrease side effects of radiotherapy as well as cardioprotective.

Most of the pharmacological activities of Gotukola has been proven due to the presence triterpenoids, glycosides and saponins. The main constituents which shows huge pharmacological action are – Asiatic acid, Madecassic acid, Asiaticoside, Madecassoside, etc.

The above mentioned chemicals are the main reason for Gotukola's huge range of activity. With further development in the research sector, more researches should be done on Gotukola for its pharmacological uses and more unknown used yet to be identified.

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