Medicinal and Aromatic Plant Series, No.1

GOTUKOLA

(*Centella asiatica*)

Information Services Centre
Industrial Technology Institute
(Successor to CISIR)
Colombo, Sri Lanka

Medicinal and Aromatic Plant Series, No. 1

Centella asiatica

- a literature survey –

Compiled by :
Purnima Jayasinha

Supervised by :
Dilmani Warnasuriya
and
Harshani Dissanayake

National Science Foundation Grant RG/IS/96/01

Published by :
Information Services Centre
Industrial Technology Institute
363 Baudhaloka Mawatha, Colombo 7, Sri Lanka

1999

Acknowledgements

The financial assistance by the National Science Foundation (grant number RG/IS/96/01) for the project is gratefully acknowledged. Sincere thanks are due to Mrs. Wathmanel Seneviratne and Mrs. Neranjani Mohottala for preparating the databases and Mr. K. R. Dayananda for editing the manuscript. The assistance and support given by the industries during visits are greatly appreciated. The secretarial assistance of Mrs. Srimani Senanayake is acknowledged.

Contents

Centella asiatica

1.0 INTRODUCTION

Gotukola is a slender-stemmed delicate perennial creeping herb, belonging to the family Umbelliferae. Originally, the plant was identified botanically as *Hydrocotyle asiatica* Linn., but subsequently, it was named *Centella asiatica*. Its use in ayurvedha dates from prehistoric times. In Sri Lanka, it has long been identified with longevity since its widespread use in the diet of the elephant, an animal renowned for long life spans. Since then its use has also been extended to other areas of herbal medicine. The edible qualities, pleasing taste and medicinal properties have rendered it popular as a green leafy vegetable in the diet of Sri Lankans.

2.0 HISTORY [9,10,33,34,69,70]

Gotukola (*Centella asiatica*) has been used as a medicine in India from time immemorial. In Indian ayurvedic practice as well, its use in promoting longevity was well known. With time it became popular, both internally and externally for treatment of skin diseases which include leprosy, lupus and eczema. It was thought to be the plant Manduka parni listed in the *Susuita samhita*, an ancient Hindu text. Close relatives of Centella also grow in the United States and American nineteenth century *Eclectice* were well aware of the medicinal properties of this plant in the treatment of leprosy. In the 1800s extracts of *Centella asiatica* were accepted as a drug in France. Also in the late 1800s Australian Richmond River described it as a valuable herbal medicine when applied to wounds and sores in the form of a salve or poultice. In 1852, Dr Boiteau of India, was cured from leprosy after having being affected for several years, when treated with *Centella*. In 1888, at the Centennial International Exhibition of Melbourne, Brisbane doctors exhibited the juice of *Centella* as a medicine.

It is also used in China to delay aging. In a report it was stated a Chinese herbalist Li Ching Yun, allegedly lived for 256 years, surviving 23 wives, as a result of his regular use of Centella.

3.0 BOTANY

3.1 TAXONOMY [9,10,28,40]

Genus *Centella* was separated from *Hydrocotyle* on the basis of their leaf, flower and fruit characters. In *Hydrocotyle*, the two mericarps have 3 ridges each, flowers are white, pericarp of seed is thin and the leaves are lobed while in *Centella* the two mericarps possess 7-9 ridges each, flowers are red or purple, pericarp is thick and leaves are unlobed.

Family : Umbelliferae
Genus : *Centella*
Species : *asiatica*

Botanical Names :
Centella asiatica, *Hydrocotyle asiatica* (Linn.); *Hydrocotyle coightiana* (Wall.) *Hydrocotyle lusida* (Hance), *Hydrocotyle nummularioides* (Rich.); *Hydrocotyle pallida* (DC)

Other names:

Sinhala	:	Gotukola; Hin-gotukola
English	:	Indian Pennywort
Tamil	:	Vallarai, Vallari, Babassa, Orila tamarai
Hindi	:	Vallarai
Sanskrit	:	Mandookaparni

3.2 PLANT DESCRIPTION [9,28,33,40,69]

It is a weakly aromatic, herbaceous, prostrate perennial creeping herb. It has a short vertical rootstock and glabrous axillary stems with long internodes. It is also found as a bush. The leaves are simple, alternate, stipulate, round to kidney-shaped smooth surfaced, and can reach a width of 1-3cm and a length of 15cm. Several leaves arise from the rootstock and 1 to 2 from each node of the runners. Leaf margins can be smooth, crenate or slightly lobed.
Petioles are 7.5 – 15 cm long, erect, glabrous, furrowed above, stipules short, adnate to petiole and forming a sheathing base.
The flowers are Irregular, bisexual, dark pink to purple, nearly sessile or on very short pedicels in axillary umbels, usually 3 together at ends of short, erect, pubescent pedundes. The flowering period is from May to October.
The fruits are formed throughout the growing season. They are about 0.3 – 0.4 cm long , dull brown, ovoid, hard, consisting of 2 mericarps attached to a slender, central axis with indehiscent, strongly thickened pericarps.
Seeds are solitary in each mericarp, pendulous and albuminous.

4.0 HABITAT [22,28,33,40,69,79]

It is found throughout the tropical Near & Far East, particularly in India, Pakistan, Sri Lanka, Indonesia, Madagascar, China, Australia, Malaysia, Southern Africa, Hawaii. This plant grows wild in damp, shady places up to 7,000ft and can be commonly seen along banks of rivers, streams, ponds and irrigated fields. It also grows along stone walls or other rocky areas at elevation of approximately 2,000m. in India and Sri Lanka

5.0 AGRONOMY [3,22,33,53,69]

5.1 SOIL AND CLIMATE

This plant is commonly found in the tropics. The plant grows well on sandy or clayey soils near water or marshy locations, with sufficient sunlight. The bush (large leaved type) is usually cultivated in beds and pots. A shady moist location is essential to induce profuse leaf growth.

5.2 PROPAGATION

The plant is propagated through the seed and the stolon. The stolon with nodes and roots is placed in the sand or wet soil for 1 – 2 weeks. Young plants will appear and will be ready for planting in one week. The plants can be harvested 6 months after planting by digging a clump of plant. The whole plant is collected, washed thoroughly and dried in the mild sun.

5.3 DISEASES [3,81]

Bacterial wilt:

The wilting of the leaves manifests the disease, which gives the appearance of the water supply to the plant having being suddenly cut off. The leaves remain drooping and do not recover, so that ultimately the plant dies. The disease is due to the bacteria *Pseudomonas solanacearum*. There is no chemical control measure for this disease and the only method is to destroy the diseased plants as and when they appear.

Leaf spot disease :

The first indication of the disease is the appearance of small, water-soaked spots between the veins on the underside of the leaves. These spots become visible on the upper surface and resemble 'oil-spots'. As the disease progresses the spots coalesce to form large irregular dead areas, which eventually fall off, leaving a hole in the leaf. In wet weather, the leaves becomes slimy on the undersides. This slime is composed of bacteria, which have developed in the leaf tissue.

Since the bacteria are easily carried on the hands of the pickers, it is essential that strict hygienic measures should be adopted to prevent the spread of disease. Diseased leaves should be picked first and burnt. Leaf spot disease is caused by the bacteria *Cochliobolus geniculatus.*

Pesticides such as Profenofos, Endosulfan, Chlorpyrifos, Quinalphos, Carbofuran are used in Gotukola. On a research carried out by S.M.M Zaneer at CISIR on residual pesticides, it was found that Gotukola had a higher percentage of pesticide residues than other leafy vegetables, even after 14 days of spraying. It was deduced that this could be due to the fact that the leaves of Gotokola grow horizontally on the surface of the soil when compared to other leafy vegetables, and therefore permit the pesticides to remain for a longer time than other leaves. However further confirmation of these studies is necessary.

6.0 CHEMISTRY OF PLANT [3,8,10,31,32,36,54, 59,62,67,69,78,79]

6.1 CHEMICAL CONSTITUTENTS OF PLANT

Centella asiatica (L.) is commonly used in the Ayurvedic system of medicine as well as being a leafy vegetable. Various studies have shown that it is rich in triterpenoids, volatile oils and flavonoids. It is morphologically close to *Hydrocotyle* species.

It is frequently confused for *Bacopa monnieri* Wettst.,(lunuwila) which is sold as Brahmi as their therapeutic properties are the same.

The major triterpenoid components of *Centella asiatica* are asiatoside, asiatic acid, madecassic acid, asiaticoside and madicassoside. Asiaticoside is the active agent in the treatment of leprosy. Other terpenoids, such as madecassic acid, asiatic acid and asiaticoside also show bio-activity.

Centella contains, strongly volatile oil that contains an unidentified terpene acetate which accounts for 35% of the total oil. Vallerin is the most active component in Centella oil. It also contains glycerides of fatty acids, various plant sterols and polyacetylene compounds. *Centella* has net digestible protein calorie percentage values above the minimum of five required for maintenance of nitrogen balance. Amino acid studies of the plant indicated that in the leaf, petiole and stolon, percentage of glutamate and serin is more compared to other amino acids. Roots are rich in amino acids, aspartate, glutamate, serine, threonine, alanine, lysine, histidine and amino butyrate.

Air dried plants from Sri Lanka showed the presence of three triterpene acids; centic, centellic acid and centoic and a water soluble glycoside, centelloside whereas in the Malagasy variety of the plant the presence of the glycosides, asiaticoside and madecassoside is shown.

The chemical constitutents of the plants are as follows :
terpenoid compounds, Asiatoside, Asiatic acid, Madecassic acid, Asiaticoside, Brahminoside 0.16%, Brahmoside 0.37%, Centelloside, Brahmic acid 0.097%, Centellinic acid, Isobrahmic acid 0.9%, Betulinic acid 0.110%, Stigmasterol 0.004 – 0.2%, Sitosterol 0.2%, Centellic acid, Centic acid, Indocentellic acid, Centellose, Thankuniside, Thankunic acid, Hydro-cotylin 0.0016% , Glycerides of Oleic acid, Linolic acid, Linolenic acid, Palmitic acid and Stearic acid, Vallarine, Pectic acid, Aspartic acid, Glycine, Glutamic acid, α - alanine, Phenyl – alanine, Quercetin – 3 – glucoside, Kaempferol – 3 – glycoside.

6.2 CHEMICAL COMPOSITION OF LEAVES

Moisture	-	87.2 g/100g
Protein	-	1.7 g/100g
Fat	-	0.7 g/100g
Carbohydrates	-	4.8 g/100g
Crude fibre	-	3.4 g/100g
Àsh	-	2.3 g/100g
Ca	-	176.0 mg/100g
P	-	72.0 mg/100g
Fe	-	12.0 mg/100g
Vit.C	-	42.0 mg/100g
Niacin	-	0.8 mg/100g
Carotene	-	2400 g/100g
Energy	-	320 kCal/100g

6.3 CHEMICAL COMPOSTION OF ESSENTIAL OIL OF PLANT

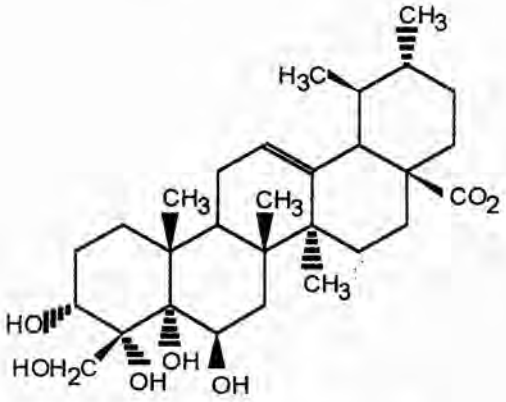
Pentanal	- 0.3%	2-methyl-2-butanol	- 0.8%
α - pinene	- t	β - pinene	- 0.1%
Toluene	- t	Camphene	- t
Hexanal	- 1.1%	m- xylene	- 0.2%

Essential oil (Contd.)

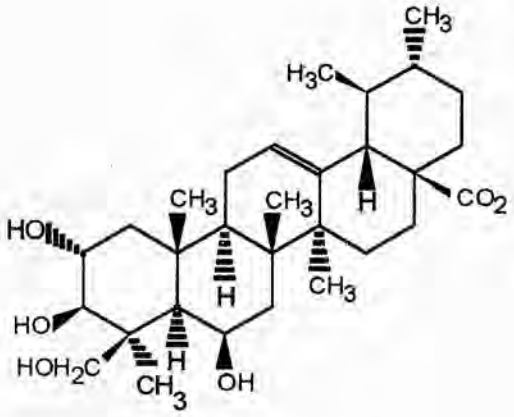
Myrcene	- 0.4%	Pyridine	- 0.3%
Heptanal	- 0.2%	Limonene	- 0.1%
3-hexen-2-one	- 0.1%	γ-terpinene	- 0.3%
(E) –2- heptena	- 0.1%	(E) – 2– octenal	- 0.2%
5-nonen-2-one	-1.5%	2-furancarboxaldehyde	- 0.6%
3-nonen-2-one	-1.5%	Linalool	- 2.1%
β - cacyophyllene	-26.8%	Widdrene	- 1.2%
(E) - β - farnesence	- t	α - humulene	- 33.7%
β - acoradiene	- t	β - chamigrene	- 0.2%
α terpineol	- 1.0%	Germacrene – D	- 10.0%
β - bisabolene	- 0.9%	α - chamigrene	- 1.9%
δ - cardinene	- 0.7%	β - sesquiphellandrene	- 0.9%
Nerol	- 0.5%	Nerolidol	- 1.2%

1-methyl - 4 - (1,2,2 – trimethylcyclopentyl) - benzene – 0.1%

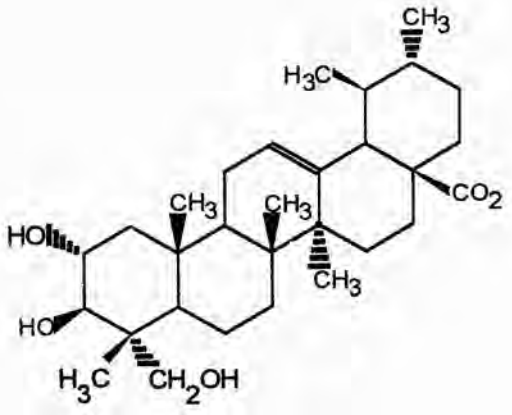
Geraniol	- 1.9%	Caryophyllene oxide	- 1.9%
Epi-globulol	- 0.1%	*p* - Vinylguaicol	- 1.7%
Farnesol	- 0.2%	2,3 - dihydrobenzofuran	- 0.2%



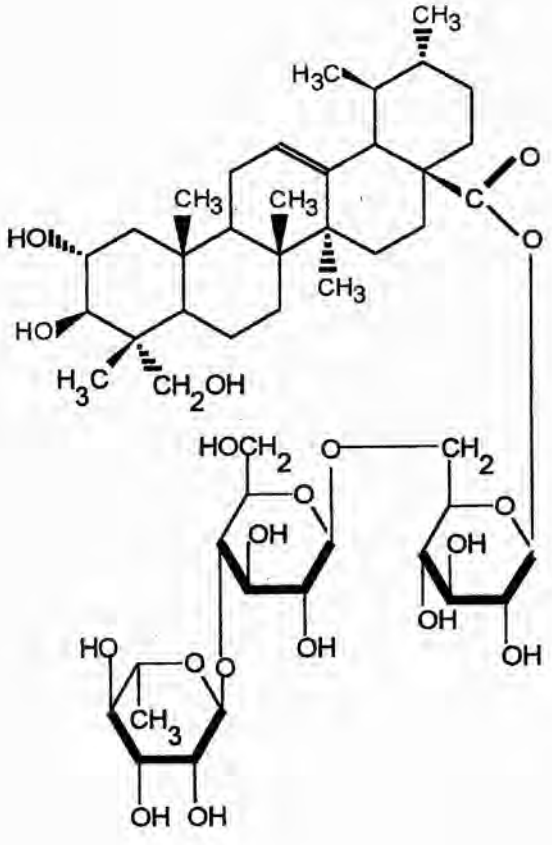
Thankunic acid



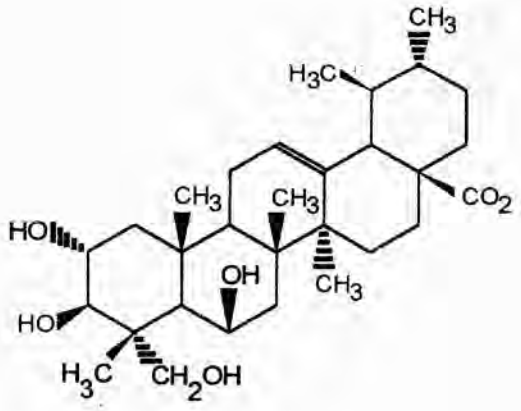
Brahmic acid



Asiatic Acid



Asiaticoside



Madecassic acid

7.0 BIOLOGY AND HEALTH ASPECTS [8,10,17,21,22,32,33,36,40,51,56,63,69,78,79]

7.1 BIOLOGICAL ACTIVITIY :

Centella asiatica has been used as a medicine since prehistoric times. In different parts of the world it is used for various illnesses.
In India, it is widely used for leprosy, other skin diseases such as lupus and skin disorders caused by syphilis and also as a diuretic. Chinese use it for colds, sore throat, fevers, sun-stroke, tonsillitis, urinary tract infection, hepatities, liver diseases such as jaundice and cirrhosis and dysentery. France, West Indies and Brazil use it to cure uterine cancer, leprosy and elephantiasis and in Central and East Africa, the leaf is used for fevers, bowel complaints and syphilitic and scrofulous conditions.

In published literature, *Centella asiatica* shows, anti-bacterial anti-fungal, anti-cancer, anti-inflammatory, wound healing, tranquilizing anti-allergic, hypotensive, anti-pyretic, insecticidal and peptic ulcer cleaning properties.

The alcoholic extract of the whole plant has shown tranquilizing effect in rats and it is non toxic up to a dose of 350mg/kg, i.p., also the glycosidal – fraction and the brahmoside acts as a sedative like that of benzodiazepines on rats.

Asiaticoside is the active component in treatment of leprosy. It has the capability of dissolving the waxy covering of the bacteria, *Bacillus leproe*, so that it becomes fragile and may easily be destroyed by the tissues or by some other drug. Asiaticoside also improves general mental ability of mentally retarded children.

Brahmic acid has a therapeutic value in ulceration, extensive wounds, eczymas etc. It also has an inhibitory effect on the biosynthetic activity of fibroblast.
The crude extract of *Centella asiatica* and products derived from it, isothankuniside and BK compound, were screened as oral anti-fertility agents in albino mice. Both showed consistent reduction of fertility in female mice.
This plant also has insecticidal properties.

7.2 TOXICOLOGY

Subcutaneous injection of 0.04 – 0.05 g/kg proved toxic to the mouse and the rabbit while 0.2 – 0.25 g/kg results in increasing bleeding time and haemorrhagic accidents. An oral dose of 1g/kg is shown to be tolerated by both mouse and the rabbit. Asiaticoside is carcinogenic. Yet it is said to stimulate wound healing. It has been reported to contain the poisonous hydrocyanic acid. Two saponin glycosides, brahmoside and brahminoside show sedative activity.

7.3 PHARMACOLOGY

Wound healing:

The triterpenes in *Centella asiatica* have remarkable wound healing properties. Studies have shown that asiaticoside given to animals such as rats, guinea pigs and rabbits, stimulates hair and nail growth. It also increases vascularisation of connective tissue, increases the formation of mucin and structural components of connective tissue, and also increases the tensile integrity of the dermis, increases keratinization of the epidermis through stimulation of the stratum germinativum and possesra entrophic or balancing effect on connective tissue.

When triterpenoid extract of *Centella asiatica* is administrated to rats with wounds; it increased epithelialization, and allowed an early decrease in the found surface area.
Centella has been successfully used in treatment of cellulitis, phlebitis and varicose veins.

Burns:

Centella asiatica accelerates healing of burns and minimizes scarring and has been thus used in treatment of second and third degree burns. It can prevent or limit the shrinkage and swelling of the skin caused by infection and inhibits scar formation. Studies have also shown that it can accelerate healing of skin grafts.

A Japanese study has shown that triterpenoids, asiatic acid, madecassic acid and asiaticoside from *Centella* extract, applied on wounds of rats increases the proliferation of granulation of skin necrosis induced by burns.

Nervous system:

The triterpenes in *Centella asiatica* have mild tranquilizing, anti-stress and anti-anxiety action, by enhancing cholinergic mechanisms which probably account for the effect in improving mental function. It possesses special tonic properties for the brain and nervous system and promotes mental calm and clarity.
Studies have shown that *Centella* contains an abundance of B vitamins and it has tranquilizing, sedative and antispasmodic actions.

It has also shown that extracts of *Centella asiatica* are effective in treatment of venous insufficiency. Researches have observed improvement in numbness, heaviness in lower legs, night-time cramps, spider veins, skin ulcers and vein distensibility when treated with *Centella*.

Gyneacology:

With extracts of *Centella asiatica* a great variety of lesions and ulcerative problems associated with pregnancy and delivery have been successfully treated. It also has a

capability of producing a remarkable elasticity and mobility in the scar tissue. and quickens healing of surgical enlargement of the vagina during childbirth.

7.4 ETHNOMEDICINE [34,36,43,79]

7.4.1 HOME REMEDIES

The whole plant mixed with *Drynaria cardata* and *Oxalis corniculata* is boiled and taken to cure dysentery. A syrup of the leaves with ginger and black pepper is taken for coughs. The leaf juice with palm jaggery is given to women as a tonic after delivery.

Mixed with bath water, it is used in treatment for eczema. Pills prepared from a paste of leaves of the plant and *Ocimum sanctum* Linn. and black pepper are used in the treatment of intermittent fever.

The ointment prepared with clarified butter or vaseline containing 1 oz of powdered leaves of *Centella asiatica* is used as an external application for elephantiasis, enlarged scrotum and affections of the cellular tissues, while the liquid extract is given internally with a dosage of 1 –5 drops 3 times a day.

For leprous, scrofulous and syphilitic affections and ulcerations, the powder of the leaves is given in 3 – 5 grain doses 3 times a day. At the same time some of the powder may be sprinkled on the ulcers or a poultice made of the fresh leaves ground into a paste may be applied.

For ulcers and burns fresh ground flowers are applied to the affected parts and 0.5g powder is taken orally.
For syphilitic skin disease, 20 ml of leaf juice is taken orally and some of it is applied externally.

As a nervine tonic, about 1.5g dried powdered leaves are ingested per day.
To get relief from pain, about 10 ml of fresh plant juice is taken orally twice daily.
Powdered *Centella asiatica* mixed with lime has been used for the treatment of sores in babies.
Leaf juice stops irritation caused by prickly heat. Powdered leaves have been snuffed in cases of ozaena

Remedies for diarrhoea for one year old children

(i) One ounce quantities of Garlic, Sadhikka, Iriweriya, Asamodagam, Gotukola and raw ginger are pound together and steamed. The juice is squeezed and three tablespoonfuls at a time, administered twice a day.

(ii) Gotukola stems, Walangassal, dry ginger, Garlic, Kalanduru ala, Elabatumul in equal quantities of 1 oz. are boiled and simmered in six cups of water, bringing it down to ½ a cup. The dosage to be given is three tablespoonfuls at a time, twice a day

(iii) If diarrhoea is not very strong, Gotukola and Kalanduru ala in equal quantities of two ozs., pounded together and the juice (2 tablespoons.) with one teaspoonful of bee's honey should be given twice a day.

For Cattarh:
Three kalandas each of Red onions, Pitawakka, Gotukola and Hingurupiyalia (*Globba bulbifera*) are taken and boiled together in 3 cups of water and simmered down to one cup. A quarter cup is taken at a time, three times a day.

For eye diseases:
Equal quantities of inflorescence of *Sphaeranthus indicus* L, leaf and flower buds of *Calotropis procera* and leaves of *Centella asiatica* are dried in shade and then powdered. A pinch of this powder with 250 ml cow's is milk taken orally twice a day for about 2 months to treat eyesight disorder.

Juice of fresh leaves of *Centella asiatica* is used as eyedrops, particularly for cataracts. It is also given to relieve fever. Fresh leaves are said to be a tonic for the brain.

7.4.2 AYURVEDIC PREPARATIONS

Centella asiatica had been used in Ayurveda medicine for a very long time in Sri Lanka and India.

Native Ayurvedic Preparation:
Juice of the leaves of *Centella asiatica* is given in ½ oz doses with cow's milk and powdered root of *Glycyrrluiza glabra* liquorice root as an alternative tonic.

Some of Ayurvedic preparations using Gotukola

Preparation	Uses
1. Siddhajeewa Murthaya	as a tonic
2. Gotukola Beatha	catarrh, nervous diseases, epilepsy
3. Gotukola Paniya	catarrh, nervous diseases, piles
4. Gotukola Kwatha	catarrh

7.5 SURGICAL USES

An injectable extract of *Centella asiatica* has been used to accelerate the healing of post-surgical wounds, to inhibit hypertrophic formation of scar tissue in the treatment of second and third degree burns as well as for general use in wounds, ulcers and scleroduma.

The leaf extract is shown to have a successful affect in clinical patients with soiled wounds and chronic atony, resistant to treatment.

The benefits have been shown to act on chronic lesions such as cutaneous ulcers, surgical wounds, fistulas and gynecological wounds. It has also been used with success to improve the blood circulation in the lower limbs where the stimulation of

collagen synthesis in the vein wall resulted in an increase in vein tonicity and a reduction in the capacity of the vein to distend, as in vericose veins and phlebitis.

7.6 COSMETIC USES

Centella asiatica with astringent tannins and soothing essential oils, which are excellent ingredient for toning and stimulating the skin, is ideal for skin care formulations and also offers protective care.

The flavonoids are also used in hair care products where it stimulates the peripheral circulation of the scalp and will promote healthy scalp condition and prevent hair loss.

It is also reported to aid capillary growth in psychomatic alopecia in the case that the piliferous papillac are not atrophied.
It is also responsible for accelerated growth of hair and nails.

Formulations for Hair Care:

(i) *To promote hair health:*
The whole plant is extracted in water, filtered through a cloth and filtrate is semi-dried and then mixed with til oil (*Sesamum indicum*) and stored for curing for about two months, after which the product is rubbed on the head. The paste of plant made in water is also used to wash the hair.

(ii) *For falling hair and to promote hair health:*
2600g *Eclipta alba*
650g *Centella asiatica*
1300g *Sesamum indicum*
10g each of :

Terminalia chebula	*Santalllum album*
Prunus cerasoides	*Terminalia bellirica*
Hemidesmus indicus	*Cyperuc scariosus*
Lawsonia inermis	*Curcuma zedoaria*
Aglaia roxburghiana	*Symplocos maniculata*
Glycyrrhiza glbra	*Rulria cordifolia*
Nardostachys jatamaansi	*Psoralea corylifolia*
Susssurea lappa	*Sida acuta*

All the ingredients are finely powdered and added to four times til oil and the mixture is kept in sunlight for a week. The oil suspension is then filtered. The oil is massaged on the scalp to prevent dandruff and falling off of the hair and for restoring hair health.

(iii) *For Hair Growth*:
150g *Terminalia chebula*
150g *Cyperus rotundus*
150g *Centella asiatica*
10g *Nardostachys jatomansi*
30g Camphor
500ml Til oil (*Sesamum indicum*)

The fine powder of the above ingredients is mixed with 300 ml of water to form a pulp. The pulp is mixed with til oil for two hours after which it is heated on a low flame with intermittent stirring. When all the water has evaporated the oil is filtered through a cloth. To the oil is then added 1g of green pigment and 3g peppermint and stored in a glass bottle.5 ml of this oil is applied daily on the head. It helps in the growth of hair, is a memory enhancer and is a tonic for eyes.

7.7 Commercial preparations of Gotukola:

Product	Description	Uses
Gotukola Capsules	100mg Gotukola extract Standardized to 10% Asiatiocoside/16%triterpenes	As an energy tonic; an aphrodisiac; as a treatment for high blood pressure and mental disorders
Thuja-Gotukola Compound (Connective Tissue Tonic)	A blend of the liquid ext. of Gotukola herb & roots along with Thuja leaf, Hawthorn berry, leaf & flowers, Eclunacea root and horsetail herb	Used in the maintenance of healthy connective tissue integrity; to facilitate its healthy regeneration in cases of injury & disease; as a tonic for minimizing the aging and wrinkling of skin, stomach, duodenal & intestinal ulcers
Gotukola-Ginkgo Compound (Brain & Memory Tonic)	A blend of the liquid extracts of Gotukola herb & roots, Ginkgo leaf, Passionflower flowering tips, Skullcap flowering tips & herb, Calamus rhizome & Rosemary flowering branches	In mental fatigue from studying & other memory work; failing memory of old age; Alzheimer's disease and to enhance meditation for mental work
Gotukola Herbal Tea	Dried & cut into small pieces and poured like tea.	Remedy for worm diseases in children; enriches the appetite in children; also effective for those who suffer from Hay fever & Catarrh
Gotukola Kanda	Prepared by boiling raw rice & mixing with coconut milk & the juice of the Gotukola leaves. Instant Gotukola kanda is available in market	As a part of the morning meal; and has a high demand in Oman, Dubai, Japan, Sweden, UK, USA & Canada

Bibliography

1. Abddul, Shakoor; Mahmood, Akram; Ashraf, C.M. and Siddiqui, M.R.
   Pharmacognostic study & chemical/pharmacological evaluation of Bramibuti. *Hamdard-Medicus* **37**(3) p.92-109 (1994)
2. Ahmad, S.; Atiq-ur-Rahman and Qadeer-Ur-Din Badar, Y.
   Element analysis of a herbal drug: 'Intellan' A neuro-energiser. *J.Fac.of Pharmacy of Gazi Univ.* **11**(1)p.83-90 (1994)
3. Agricola
   Handbook for the Ceylon farmer. Ceylon Printers Ltd. 1978
4. Anbuganapathi, G.
   The synergetic effect of Vallarai & Brahmi on learning ability of albino mice & school children. *Int.Sem.on Recent Trends in Pharmaceutical Sci.*, Ootacamund, Abs.No.A34 1995
5. Asakawa, Yoshinori; Matsuda, Reiko and Takemoto, Tsunematsu
   Mono-& sesquiterpenoids from *Hydrocotyle* & *Centella* species. *Phytochemistry* **21**(10) p.2590-2 (1982)
6. Babu, T.D. and Padikkala, J.
   DNA fragmentation is Ehrlich Ascites tumour cells by extract of herbal plant *Centella asiatica* (L.).*Amala Research Bulletin* **14** p.52-56 (1994)
7. Babu, T.D. Padikkala, J.
   Anticancer activity principle from *Centella asiatica*. *Amala Research Bulletin* **13**(August) p.46-49 (1993)
8. Babu, T.D.; Kuttan, G. and Padikkala, J.
   Cytotoxic & anti-tumour properties of certain taxa of Umbelliferae with special reference to *Centella asiatica* (L.) Urban *J.Ethnopharmacology* **48**(1) p.53-57 (1995)
9. Bagchi, G.D. and Puri, H.S.
   Centella asiatica I. *Herba Hung.* **27**(2-3)p.137-140 (1988)
10. Bagchi, G.D. and Puri, H.S.
    Centella asiatica II. *Herba Hung.* **28**(1-2) p.127-134 (1989)
11. Basu, N.K. and Lamsal, P.P.
    Investigations on Indian medicinal plants II, *Hydrocotyle asiatica* *Quart.J.Pharm.Pharmacol* **20** p.135-6 (1947)
12. Bhardwaj, S.K. and Srivastava, K.K.
    Effect of a composite Indian herbal preparation, CIHP(III)on avoidance learning during endurance performance of rats. *Indian J.Exp.Biol.* **33**(8) p.580-589 (1995)
13. Bhattacharyya, S.C.
    Constituents of *Centella asiatica* I .Examinationof the Ceylonese variety *J.Indian Chem.Soc* **33** p.579-86 (1956)
14. Bhattacharyya, S.C.
    Constituents of *Centella asiatica* III. Examination of the Indian variety. *J.Indian Chem.Soc* **33** p.893-8 (1956)
15. Boiteau, P. and Ratsimamanga, A.R.
    Cicatrizants of vegetable origin & the biostimulins of Filatov. *Bull.Soc.Sci.Bretagne* **32** p.28 (1957)

16.Boiteau, P. and Ratsimamanga, Rakoto.A.
Asiaticoside,extracted from *C.asiatica*,its therapeutic uses in the healig of expl. or refractory wounds,leprosy,skin tuberculosis & lupus. *The'rapie* 11p.125-49 (1956)

17.Bonte, F.; Dumas, M.; Chaudagne, C. and Meybeck, A.
Influence of asiatic acid, madecassic acid & asiaticoside on human collagen I. Synthesis. *Planta Medica* **60**(2) p.133-135 (1994)

18.Castellani, C.; Marai, A. and Vacchi, P.
Centella asiatica Boll.Chim.Farm **120**(10) p.570-605 (1981)

19.Castillo, Amorita V.; Castillo, Socorro, F. and Mislang, Teresita, G.A.
Phytochemical study of *Centella asiatica* Linn. *NRCP Res.Bull* **35**(2) p.214-20 (1980)

20.Chakrabarty, T. and Deshmukh, S.
Centella asiatica in the treatment of leprosy. Science & Culture **42**(11) p.573 (1976)

21.Chatterjee, T.K.; Chakraborthy, A. and Pathak, M.
Effect of plant extract *Centella asiatica*(Linn.) on cold restraint stress ulcer in rats. *Indian J.Exp.Biol* **30**(10) p.889-891 (1992)

22. Chopra, Col.R.N. and Chopra, I.C.
A Review of work on Indian Medicinal Plants. Indian Council of Medical Research, New Delhi. 1955

23.Conti, M.; Cristoni, A. and Magistretti, M.J.
Activity of delphinidin on microvascular damage models in rodents. *Phytotherapy Research* **6**(2) p.99-103 (1992)

24.Craker, L.E.(ed.) Simon, J.E.
Herbs, spices & medicinal plants.Vol.3, Oryx Press, 1986

25.Dandekar, U.P. ; Chandra, R.S.; Dalvi, S.S.; Joshi, M.V.; Gokhale, P.C.; Sharma, A.V. and Shah, P.U.
Analysis of a clinically important interaction between phenytoin & shankhapushpi, an Ayurvedic preparation. *J.Ethnopharmacology* **35**(3) p.285-288 (1992)

26.Danese, P.; Carnevali, C. and Bertazzoni, M.G.
Allergic contact dermatitis due to *Centella asiatica* extract. *Contact dermatitis* **31**(3) p.201 (1994)

27.Das, A. and Malick, R.
Correlation between genomic diversity & asiaticoside content in *Centella asiatica* (L.) *Urban.Botanical bulletin of Academia Sinica* **32**(1)p.1-8 (1991)

28.Dassanayake, M.D.and Fosberg, F.R.
Flora of Ceylon Vol.3 p.484 Amerind Publishing Co. Pvt. Ltd. New Delhi 1981

29.Diwan,P.V., Karwande, I. and Singh, A.K.
Anti-anxiety profile of *Centella asiatica* in animals. *Fitoterapia* **62**(3)p.253-257 (1991)

30. Duke, James A.
Handbook of medicinal herbs. p.109-110 CRC Press, Inc. Boca Raton, Florida. 1987

31.Dutta, Tapan and Basu, U.P.
Thankuniside & thankunic acid-a new triterpene glycoside & acid from *Centella asiatica*. *J.Sci.ndust.Res.* **21**(13) p.239-40

32.Dutta, Tapan and Basu, U.P.
Crude extract of *Centella asiatica* & produccts derived from its glycosides as oral antifertility agents. *Indian J.Exp.Biol.* **6**(3) p.181-2 (1968)
33.Dweck, Tony
Centella asiatica SPC Asia (Oct/Nov) p.41-2
34.Fernando, Seela
Traditional herbal food & medicine The National NGO Council of Sri Lanka 1982
35.Fischer, D.C.H.; Kato, E.T.M. and Schleier, R.
Pharmacobotanical study of *Centella asiatica* (L.) *Revista de Farmacia e Bioquimica da Universidade de Sao Paulo* **31**(1) p43 (1995)
36.Gunawardana, G.W.G.
Medicinal Plants of Ceylon & Sinhalese Medicines in English The Sastrodaya Press, Colombo 1971
37.Grimaldi, R.; Ponti, F.de; D'Angelo, L *et al*
Pharmacokinetics of the total triterpenic fraction of *C.asiatica* after single & multiple administrations of healthy volunteers. *J.Ethnopharmacology* **28**(2) p.235-241 (1990)
38.Handa, S.S.
Rasayana drugs Part-II. *Pharma Times* **26**(3) p.17-25 (1994)
39.Hansen, K.; Nyman, U.; Smitt, U.W.; Adsersen, A.; Gudiksen, L.; Sreedharan, R. and Palpu, P.
In vitro screening of traditional medicines for anti-hypertensive effect based on inhibition of the angiotensin converting enzyme. *J.Ethanopharmacology* **48**(1) p.43-51 (1995)
40.Jayaweera, D.M.A.
Medicinal plants Part V. The National Science Council of Sri Lanka, Colombo 1982
41.Kakkar, K.K.
Mandukaparni-medicinal uses & therapeutic efficacy. *Indian Drugs* **26**(3) p.92-97 (1988)
42.Karnick, C.R
.Studies on standardisation of Ayurvedic crude drugs.series X. Brahmy-*Hydrocotyle asiatica* Linn. *Indian Medicine* **1**(2) p.21-23 (1989)
43.Kumar, Shuhil; Akhila, A.; *et.al.*
Medicinal plants in skin care CIMAP, India 1994
44.Kuppurajan, K.
Anti-anxiety effect of an ayurvedic compound preparation-a cross-over trial. *Seminar on Res.in Ayurveda & Siddha*, CCRAS, New Delhi-p.40, 20-22 March,1995
45.Kuppurajan, K. Seshadri; C. Rajagopalan; V. Srinivasan; K. Sitaraman, R.and Indurthi, J.
Anti-anxiety effect of an ayurvedic compound drug-a cross over trial. *J.Res.in Ayurvveda & Siddha* **13**(3-4) p.107-116 (1992)
46.Luo, Si-Qi and Chin, Huei-Fang
Isolation & identification of asiaticoside from *Centella asiatica*(L.) ***Chung Ts'ao Yao*** *11*(6) p.244-6 (1980)
47.Luo, Siqi and Jin, Huifang
Isolation & identification of madecassoside in *Centella asiatica. Zhongcaoyao* **12**(6) p.5-6 (1981)

48.Malek, A., Rashida, Begum and Ahmad, K.
Analysis of some food of East Pakistan. *Pakistan J.Biol.Agr.Sci* **9**(1) p.25-9 (1966)
49.Mehta, S.P.; Viswanathan, M.V. and Singh, H.B.
On the identity of market sample of Brahmi in Delhi. *Bulletin of Medico-Ethnobotanical Res.* **12**(1-2) p.83-86 (1991)
50.Moharana, D. and Moharana, S.
A clinical trial on Mentat in patients with various types of epilespy. *Probe* **33**(2)p.160-162 (1994)
51.Nalini, K.; Aroor, A.R.; Karanth, K.S. and Rao, A.
Effect of *Centella asiatica* fresh leaf aqueous extract on learning & memory & biogenic amine turnover in albino rats. *Fitoterapia* **63**(3) p.232-237 (1992)
52.Pant, P.C. and Joshi, M.C.
Studies on some controversial indigenous herbal drugs based on ethnobotanical research : a review *J. Research & Education in Indian Medicine* **12**(2) p.19-29 (1993)
53. Perera, K.D.A.
Characterization & evaluation of bush type of *Centella asiatica. Tropical Agriculturist* **146** p.127-131 (1990)
54.Perera, W.D.A.; Jayasekera, Padmini M.; Thaha, Sithy Z.
Tables of food composition for use in Sri Lanka World Health Foundation of Ceylon 1979
55.Plohmann, B.; Bader, G.; Steich, S.; Hiller, K. and Franz, G.
Immunomodulatory effects of triterpenoid saponins. *European J. Pharmaceutical Sci* **2**(1-2) p.120 (1994)
56.Ponglux, Dhavadee; Wongseripipatana, S. *et.al.*
Medicinal Plants *Princess Congress 1*, Thailand. 1987
57.Prum, N.; Illel, B. and Raynaud, J.
Flavonoid glycosides from *Centella asiatica* L. *Pharmazie* **38**(6)p.423 (1983)
58.Rajagopalan, V.
Effect of Ayushman-8 in *Manasa Mandata*(mental retardation*). Seminar on Reseach in Ayurveda & Siddha,* CCRAS, New Delhi,p.34, 20-22 March 1995
59.Rastogi, R.P.; Sarkar, B. and Dhar, M.L.
Chemical examination of *Centella asiatica* I.Isolation of the chemical Constitutents *J.Sci.Ind.Res. (India)* **19B** p.252-7 (1960)
60.Reddy, M.N. and Rao, A.S.
A new leaf spot disease of *Centella asiatica* L. *Current Sci.* **44**(6) p.206-207 (1975)
61.Rivera, I.G.; Martins, M.T.; Sanchez, P.S.; Sato, M.I.Z.; Coelho, M.C.L.; Akisue, M. and Akisue, G.
Genotoxicity assessment through the Ames test of medicinal plants commonly used in Brazil. *Enviromental Toxicology & Water Quality* **9**(2) p.87-93 (1994)
62.Sahu, N.P.; Roy, S.K. and Mahato, S.B.
Phytochemistry **28**(10) p.2852-54 (1989)
63.Sakina, M.R. and Dandiya, P.C.
A psycho-neuropharmacological profile of *Centella asiatica* extract. *Fitoterapia* **61**(4) p.291-296 (1990)
64.Sarma, D.N.K.; Khosa, R.L.; Chansauria, J.P.N. and Sahai, M.
Antiulcer activity of *Tinospora cordifolia* Miers & *Centella asiatica* Linn extracts. *Phytotherapy-Research* **9**(8) p.589-590 (1995)

65..Sharan, R. and Khare, R.
A clinical trial of Mentat in children with behavioural problems. *Probe* **31**(1) p.12-22 (1991)
66.Sharma, R; Jaiswal, A.N.; Suresh Kumar Chaturvedi, C. and Tewari, P.V.
Role of *Centella asiatica* in educable mentally retarded children. *J.Res.Edu.Indian Med.* (1-6) p.55-77 (1985)
67.Singh, Bhagirath and Rastogi, R.P.
Chemical examination of *Centella asiatica* III. Constitution of Brahmic acid. *Phytochemistry* 7(8)p.1385-93 (1968)
68.Tennekoon, K.H.; Jeevathayaparan, S. and Karunanayake, E.H.
Evaluation of possible galactogoguic activity of a selected group of Sri Lankan medicinal plants. *J.of the Nat.Sci.Council of Sri Lanka* **20**(1) p.33-41 (1992)
69.Turton, S.
Centella asiatica Australian J.Medical Herbalism **5**(3) p.57-61 (1993)
70.Tyler, V.E.
The Honest herbal Haworth Press, Inc. New York 1993
71.Upadhyaay, S.C.; Nandkumar Sharma, D.; Mahesh Kumar Chansauria, J.P.N. and Khosa, R.L. Chemical & experimental studies on *Centella asiatica* Linn. *Proceedings of 42 Indian Pharmaceutical Congress,Manipal*, E12,p.40 (Dec '90)
72.Upadhyay, S.C.; Khosa, R.L.; Sharma, D.N.; Kumar, M. and Chansauria, J.P.N. Total glycoside content & antistress activity of Indian & Mauritius *Centella asiatica*-a comparision. *Indian Drugs* **28**(8) p.388-389 (1991)
73.Viala, A.; Cano, J.P. ;Durand, A.; Paulin, R.; Roux, F. et al.
Animal study of the transcutaneous passage of tritium-labeled active principles from Centella.asiatica applied in a continuous oil phase. *Therapie* **32**(5) p.573-83 (1977)
74.Vogel, H.G.; Souza, N.J.de and D'Sa, A.
Effect of terpenoids isolated from *Centella asiatica* on granuloma tissue. *Acta Therapeutica1* **6**(4) p.285-298 (1990)
75.Vohora, S.B. and Dandiya, P.C.
Herbal analgesic drugs. *Fitoterapia* **63**(3) p.195-207 (1992)
76.Wankhar, B. and Tripathi, R.S.
Competitve fitness of *Centella asiatica* populations raised from stem cuttings & seedlings. *Proceedings of the Indian Academy of Sci.(Plant Sci.)* **100**(4) p.239-245 (1990)
77.Wankhar, B. and Tripathi, R.S.
Growth & reprodutive allocation pattern of *Centella asiatica* raised from stem cuttings of different sizes in relation to light regimes,soil texture. *Acta-Oecologica* **11**(5) p.683-692 (1990)
78.Watt, J.M.; Breyer-Brandwijk
The Medicinal & Poisonous Plants of Southern & Eastern Africa E&S Livingstone Ltd., London 1962
79.Wealth of India.
Raw materials, Vol.2. CSIR , New Delhi
80.Wong, K.C. and Tan, G.L.
Essential oil of *Centella asiatica* (L.) Urb. *J.Essent.Oil Res.* **6**(3) p.307-309 (1994)

81.Zaneer, Segu M.M.
M. Phil. Thesis on `pesticide residue trials on selected low country vegetables'.
.82.Zoyza, I.J.de. and Liyanage, H.T.K.
Bacterial wilt of *Centella asiatica* in Sri Lanka. *Bacterial Wilt Newsletter* (10) p.5 (1994)