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Centella Asiatica: A Pharmaceutically Important Medicinal Plant

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Abstract

Centella asiatica (gotu kola) is one of the important rejuvenating herbs for nerve and brain cells and is believed to be capable of increasing intelligence, longevity, and memory. Important bioactive compounds are triterpenoid saponins, including asiaticoside, centelloside, madecassoside, and asiatic acid. It possesses anti-leprotic, anti-viral, anti-bacterial, anti-tumor activities. Due to its medicinal importance, this plant is used for several purposes. Synthesis of nanoparticles from this plant is one of the important applications in the field of nano-biotechnology. This review provides an overall summary of phytoconstitutes, pharmacological activity of Centella asiatica as well as its role in the silver nanoparticles synthesis.

Keywords: Centella asiatica; Asiaticoside; Pharmacological activity; Nanoparticles

Introduction

Medicinal plants are the traditional source of pharmaceutically important compounds which are utilized by the pharmaceutical companies for the preparation of several formulations. In the present time, there has been an increase in the use of herbal products around the world. World Health Organisation (WHO) also stated that more that 80% of the world's population relies on the herbal medicines [1]. The importance of medicinal plants is due to the presence of specific chemical compounds that produce a physiological effect on the human body. These bioactive chemical constituents of plants include saponin, flavanoids, alkaloids, sterols, tannins, phenols [2]. Medicinal plant-based drugs have an advantage over the other drugs because they are simple and offer a broad spectrum of activity. Furthermore, they have very less adverse side effects as compare to the chemotherapeutic drugs. India is rich in medicinal plant diversity and since the ancient times use of drugs of herbal origin is prevalent in the traditional system of medicines such as Ayurveda and Unani. There are about 426 biomes which comprise of different habitat diversity that gives rise to the richest centers for plant genetic resources in the world [3]. Out of 18,665 flowering species, only about 3000 plants has been used for the various formulations in classic system of medicines such as Ayurveda, Siddha and Unani [4].

Centella asiatica is one of the important traditional medicinal plant belonging to family Apiaceae and commonly known as 'Gotu kola', 'Indian Pennywort' or 'Mandookaparni' in India. It is an important perennial medicinal herb found in the tropical and subtropical countries like India, Sri Lanka and Bangladesh. C. asiatica contains several triterpenes, saponins like asiaticoside, asiatic acid, sapogenins, madecassic acid, vellarin, adecassoside, glycosides and centelloside [5]. In India, it grows up to an altitude of 600-1800 meters above the sea level [6,7] on moist, clayey or sandy soils forming a dense green carpet. Centella asiatica has a glabrous stem and long petiolated fleshy leaves rooting at nodes. It is a softly perfumed plant that attains height up to 15cm. Stem is smooth and rooting occurs at the nodes. It grows extensively in damp, marshy, and wet places and flowering occurs during April to June with white to purple or pink flowers [8]. The whole plant is used for medicinal purposes and widely used as a blood purifier as well as for treating high blood pressure, for memory enhancement and promoting longevity [9]. It possesses several important properties like antileprotic, antifeedant, antistress, anti-tuberculosis activities, wound-healing properties, atherosclerosis antibacterial and fungicidal activity [10] Srivastava et al. 1997. It is used in the treatment of leprosy, wound, cancer, fever, allergies, abscesses, asthma, catarrh, convulsions, dysentery, eczema, gonorrhea, hypertension, headache, bronchitis, jaundice, pleuritis, rheumatism, ulcers, spasms, tuberculosis, urethritis, etc. Due to its medicinal importance, this plant is also used for the synthesis of silver nanoparticles. Application of nanoparticles

is growing rapidly due to thier specific characteristics such a size, morphology, and distribution [11]. It gains application in various fields such as health care, biomedical, cosmetics, food and feed, drug environment, health, mechanics, optics, chemical industries, electronics, space industries, energy science, catalysis, etc. Tremendous increase in these technologies had opened applied frontiers and novel fundamentals. This includes the nanoscale materials production and utilization of their mysterious optoelectronic and physicochemical properties [12]. Nanoparticles are generally prepared by various chemical and physical methods which are potentially hazardous the environment. Development of biologically inspired process is an important branch of nanotechnology. Advantage of nanoparticle synthesis from biological source over chemical and physical method is: cost effect, eco-friendly and easily scaled up for large scale synthesis [13]. Use of plant extract for the synthesis of nanoparticles can be an advantageous over other biological processes by eliminating the elaborate process of maintaining cell culture. Reduction and stabilization of silver ions by combination of biomolecules such as proteins, enzymes, amino acids, polysaccharides, phenolics, terpinoids, saponins, alkaloids, tannins and vitamins which are already established in the plant extracts having medicinal values and are environmental benign, yet chemically complex structures Kulkarni & Muddapur 2014. Therefore this review provides an insight into the chemical constituents, pharmacological activity and silver nanoparticles synthesis from Centella asiatica.

Chemical Constituent

Glycosides

Various glycosides have been isolated from this plant which includes Asiaticoside, Madecassoside, Brahmoside, Centelloside, Thakuniside, etc (Srivastava et al., 1997). Among them, asiaticosside, asiatic acid, madecassoside and madecassic acid are the most biologically active compound [14]. Asiaticoside helps in collagen I synthesis in human clinically used as a wound healing agent in combination with madecassic and asiatic ascids [15].

Triterpenic acids

Several pentacyclic triterpenic acids have been isolated and characterized from this plant. They occur either in free state or as aglycones of the naturally occurring saponins.e.g. asiatic acid, madasiatic acid (Srivastava et al., 1997) brahmic acid, isobrahmic acid, thankunic acid, betulic acid , centoic acid, centellic acid, 6b-Hydroxiasiatic acid & terminolic acid [16].

Phytosterols

The plant is reported to possess Stigmasterol, Campesterol, Beta-sitosterol and stigma sterol-b-D-glucopyranoside (Srivastava et al., 1997). Phytosterols have the ability to reduce cholesterol levels and have potential to inhibit stomach, lunch, breast and ovarian cancers [17,18]. Phytosterols also have the potential to reduce the elevated triglyceride levels which is a risk factor for cardio vascular diseases [19]. It was found that the level of triglycerides reduced by 14% by supplementing 1.6g/day of plant sterols in a fermented milk beverage for six weeks [20].

Other constituents

Centella asiatica contains hydrocotylin, glycine, aspartic acid, glutamic acid, alanine and phenylalanine (Srivastava et al., 1997). Leaves contain 3- glucosylquercetin, 3-glucosylkaepferol and 7-glucosylkaempferol (Srivastava et al., 1997). It also contains volatile fatty acid which consists of steric, palmitic, oleic, lignoceric, linolenic and linoleic acids [18]. Amino acids such as glycine, aspartic acid, phenyalanine, glutamine acid and α-analine also found in this plant.

Pharmacological Activities

Wound healing

Titrated extract of Centella asiatica which consist of mixture of three triterpenes (asiaticoside, asiatic acid and madecassic acid) stimulates glycosaminoglycan and collagen synthesis in rats [21]. Asiaticoside and asiatic acid were more active than madacassic acid in wound healing thus it appers to be an effective treatment of wound healing disturbances [22].

Central Nervous System

Mook-Jung et al. [23] reported that asiaticoside derivatives reduce or inhibits H2O2 induced cell death and lower the intracellular free radical concentration and protect against the effects of beta amyloid neurotoxicity. Centella asiatica extract was found to increase brain GABA levels [24].

Memory enhancing

Aqueous extract of Centella asiatica showed significant effect in memory enhancement which is due to the presence of brahminoside, brahmic acid and brahmoside in the plant [25,26]. Rao et al. [27] reported that fresh leaf juice of Centella asiatica improves spatial learning performance and enhanced memory retention in neonatal rats.

Antibacterial

Anonymous [28] reported that asiaticoside was an active agent against Bacillus leprae, Mycobscterium tuberculosis and Entamoeba histolytica. Methanolic extract of Centella asiatica showed inhibition zone against V. alginolyticus, V. vulnificus and Streptococcus sp. [29]. Sankar et al. [30] reported that methanolic extract of Centella asiatica showed antibacterial activity against three Vibrio species that are V. harveyi, V. alginolyticus and V. parahaemolyticus but acetone, chloroform and hexane extract was not shown any antibacterial activity against these species.

Antioxidant

In a study, it was reported that asiaticoside significantly increased the levels of catalase, superoxide dismutase, glutathione peroxidase, ascorbic acid and vitamin E in excision

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type cutaneous wounds in rats. The level of antioxidant activity was highest during the initial stages of treatment [31]. Jayashree et al. [32] reported that crude extract of C. asiatica showed antioxidant activity in the lymphoma bearing mice.

Cardiovascular

Cesarone et al. [33] reported that in a clinical trial Centella asiatica extracts found to be efficacious in the treatment of reducing ankle, venous insufficiency, foot swelling, edema, improving capillary filtration rate and microcirculatory parameters. Alcoholic extract of whole plant showed cardioprotective activity in ischemia reperfusion induced myocardial infarction in rats [34].

Neuroprotective effects

Ramanathan et al. [35] reported that Centella asiatica extract protects monosodium glutamate-induced neurodegeneration. Water extract of Centella asiatica showed neuroprotective efficacy against 3-nitropropionic acid induced oxidative stress in brain of prepubertal mice enhanced glutathione levels, antioxidant defenses in brain regions [36,37].

Anti-diabetic

Chauhan et al. [38] reported that triterpenic fraction of Centella asiatica is useful in diabetic microangiopathy by improving the microcirculation and decreasing the capillary permeability. Also, a triterpenic fraction of Centella asiatica protects against the deterioration. Methanolic and ethanolic extracts had shown significant protection and lowered blood glucose levels to normal glucose levels in tolerance test. Kabir et al. [39] reported the anti-hyperglycemic activity of this plant in type II diabetic rats.

Application of C. asiatica in silver nanoparticles synthesis

In recent years, there is also a demand for nanoparticles in plant biotechnology. The advantage of using plant materials for the biosynthesis of nanoparticles is an interesting area for the development of new methods of nanomedicine. These particles can be prepared easily by different methods but the biological approach is one of the most effective, less time consuming and eco-friendly. Several nanoparticles have been synthesized by this plant like silver, gold, copper oxide, etc. Among several metal nanoparticles, silver nanoparticles have attained a special focus [40]. Silver nanoparticles are used in various technologies and incorporated into wide array of consumer products that take an advantage of their desirable conductive, optical and anti-bacterial properties. It is used in conductive inks and integrated into composites to enhance the thermal and electrical conductivity. It is used in biosensors and numerous assays where silver nanoparticles materials can be utilized as biological tags for quantitative detection. It incorporated in footwear, paints, wound dressing, cosmetics and plastics for their anti-bacterial properties. Logeswari et al. [41] reported that aqueous extract was utilized for the synthesis of silver nanoparticles and the size of the silver nanoparticles synthesized by Centella asiatica were 33nm and irregular in shape. Rout et al. [42] also reported that aqueous leaf extract was utilized for the synthesis of silver nanoparticles and the size was 30-50nm and spherical and cubic in shape. Palaniselvam et al. [43] reported that leave extract of Centella asiatica used for the silver nanoparticles synthesis and peak obtained at 430nm and the size of synthesized nanoparticles were 50-60nm. Kumar et al. [44] 2017 reported the synthesis of silver nanocollide from an aqueous extract of Centella asiatica and TEM results showed that these nanoparticles are almost spherical in shape with an average diameter of 15nm [45-48].

Conclusion

Centella asiatica has been used for many years for the treatment of various diseases. A significant amount of work has been done on its pharmacological activity and possible applications of chemical compounds from the whole part of the plant. The present review shows that Centella asiatica contains several different phytocompounds like saponins, glycosides, phytosterols, flavonoids, etc. Out of these phytocompounds saponins i.e. asiaticoside is an important one which is responsible for the different pharmacological activity. It was found that asiaticoside is the main phytocompound which helps in the wound healing activity. Centella asiatica also helps in the improvement of neurodegenerative disorder i.e Alzheimer's as it improves the memory. So it can be utilized as drugs for the treatment of neurodegenerative disorders. One of the important applications of this plant is in the synthesis of silver nanoparticles. Silver nanoparticles synthesis from plant source provides a greener approach as it eliminates the use of harsh chemicals.

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