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HERBAL APPROCHES OF SWERITA CHIRAYITA AS TRADITIONAL MEDICATION: A STUDY OF PHYTOCHEMICAL AND PHARMACOLOGICAL ACTIVITY

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Abstract

Swertia chirayita (Gentianaceae), a popular medicinal herb indigenous to the temperate Himalayas is used in traditional medicine to treat numerous ailments such as liver disorders, malaria, and diabetes and are reported to have a wide spectrum of pharmacological properties. Its medicinal usage is well-documented in Indian pharmaceutical codex, the British, and the American pharmacopeias and in different traditional medicine such as the Ayurveda, Unani, Siddha, and other conventional medical systems. This ethnomedicinal herb is known mostly for its bitter taste caused by the presence of different bioactive compounds that are directly associated with human health welfare. The increasing high usage of *Swertia chirayita*, mostly the underground tissues, as well as the illegal overharvesting combined with habitat destruction resulted in a drastic reduction of its populations and has brought this plant to the verge of extinction. The increasing national and international demand for *Swertia chirayita* has led to unscrupulous collection from the wild and adulteration of supplies. The aim of this review is to provide a synthesis of the current state of scientific knowledge on the medicinal uses, phytochemistry, pharmacological activities, safety evaluation as well as the potential role of plant biotechnology in the conservation of *Swertia chirayita* and to highlight its future prospects. Pharmacological data reported in literature suggest that *Swertia chirayita* shows a beneficial effect in the treatment of several ailments. However, there is lack of adequate information on the safety evaluation of the plant. The pharmacological usefulness of *Swertia chirayita* requires the need for conservation-friendly approaches in its utilization. Providing high-quality genetically uniform clones for sustainable use and thereby saving the genetic diversity of this species in nature is important. In this regard, plant biotechnological applications such as micropropagation, synthetic seed production, and hairy root technology can play a significant role in a holistic conservation strategy. In

addition to micropropagation, storage of these valuable genetic resources is equally important for germplasm preservation.

Keywords: herbal plant, Chemical compound, Pharmacological activity, medication.

Introduction

Medicinal plants are conventionally used worldwide for treatment of different disorders related to human health. The demands of modern pharmaceutical industries for medicinal plants has also been increased several times. An imbalance between the production of free radicals and the endogenous action of antioxidant defense systems results in oxidative stress, which is divided into enzymatic and nonenzymatic systems. Compounds such as β-carotene, α-tocopherol (Vitamin E), sodium ascorbate (Vitamin C) and phenolic compounds which are widely found in medicinal plants contribute to non-enzymatic antioxidant defense systems3-5. The main function of antioxidant defense system is to prevent or reduce the extent of damage caused by free radicals and other reactive oxygen species. These damages may be responsible for a number of chronic diseases, including cancer, some cardiovascular and neurodegenerative diseases. One of the prerequisites for the success of primary health care is the availability and use of suitable drugs. Traditional medicine is still the most affordable and easily accessible source of treatment in the primary healthcare system. Medicinal plants have always been a potential source to cure different diseases, either in the form of traditional preparations or as pure active principles, and they are frequently the only source of medicine for the majority of people in the developing world. *wertia*, a genus in the family Gentianaceae include a large group of annual and perennial herbs, representing approximately 135 species. *Swertia* species are common ingredients in a number of herbal remedies. In India, 40 species of *Swertia* are recorded of which, *Swertia chirayita* is considered the most important for its medicinal properties. *S. chirayita* was first described by Roxburgh under the name of *Gentiana chyrayta* in 1814. *S. chirayita*, common name: "Chiretta" is a critically endangered medicinal herb that grows at high altitudes in the sub-temperate regions of the Himalayas between 1200 and 2100 m altitudes from Kashmir to Bhutan on the slopes of moist shady place. Its widespread uses in traditional medicine have resulted in over-exploitation from the natural habitat and it is now on the verge of extinction in the wild. *S. chirayita* is also known by an array of names such as Anaryatikta, Bhunimba, Chiratitka, Kairata in Sanskrit, Qasabuzzarirah in Arab and Farsi, Chiaravata in Urdu, Sekhagi in Burma, and Chirrato or Chiraita in Nepal.

Fig1: flower of S. chirayita

Botanical description

S. chirayita is an annual/biennial herb 0.6–1.5 m tall. It has an erect, around 2–3 ft long stem, the middle portion is cylindrical, while the upper is quadrangular, with a prominent decurrent line at each angle. Its stem is orange brown or purplish in color with large continuous yellowish pith. Leaves are lanceolate, in opposite pairs, no stalks, acuminate, cordate at the base, sessile, five to seven nerved and 4 cm long. The root is simple, yellowish, somewhat oblique, or geniculate, tapering and short, almost 7–8 cm long and usually half an inch thick. Flowers are small, numerous, tetramerous, large leafy panicles, green-yellow, and tinged with purple and green or white hairs. The calyx is gamophyllous with four lobes, corolla-lobes four twisted and superimposed, united at the base where they have pairs of nectaries on each lobe covered with long hairs. Stamens 4, opposite the corolla lobe, at the base of the corolla. Ovary unilocular with ovules laminal placentation parietale; two stigmas. Capsules are egg-shaped, 2-valved with a transparent yellowish pericarp. Seeds are numerous, very small and dark brownish in color. Multi-colored corolla and the presence of nectaries support cross-pollination in *S. chirayita*.

Medicinal uses

- The herb Swertia chiretta (S. chirayita) possesses digestive, hepatic (conditions pertaining to the liver) and tonic properties. In fact, this bitter herb promotes digestion, particularly of fats, and aid in regulating blood sugar levels. At the same time, the herb is an effective medication for leishmaniasis - a parasitic disease usually found in tropical regions.
- Chiretta is especially beneficial for certain health conditions, including diabetes and nausea. Here is a brief discussion regarding the use of this herb to treat these precise health problems.
- Laboratory tests with animals having excessive baseline blood sugar levels have demonstrated diminished blood sugar levels following healing with chiretta.
- The astringent flavor of chiretta sets of an impulsive response that promotes the production of saliva and gastric enzymes. This reflex reaction owing to the use of the herb not only stops nausea (queasiness), but also helps to cure indigestion, bloating and hiccups. In addition, chiretta also encourages the secretion of bile that promotes digestion as well as improves appetite.
- Swertia chiretta has an attractive chemistry that is to a great extent akin to gentian (Gentiana lutea), a widely used healing tonic for the digestive system. The plant also encloses xanthones that are supposedly effectual against malaria and tuberculosis.
- In addition, chiretta also contains amarogentin - a glycoside that perhaps fortifies the liver against toxicity caused by carbon tetrachloride. The entire herb possesses therapeutic properties and the bitter digestive tonic obtained from it is considered to be an effective medication for lessening fevers as well as stimulants. As discussed earlier, this herb also has a valuable impact on the liver, encourages the flow of bile and heals constipation. It is also beneficial for curing dyspepsia .
- Chirayata is a valuable bitter tonic. It is laxative and an appetizer. It also corrects the disordered process of nutrition and restores the normal fuction of the system.
- Chirayatra is an effective drug for reducing fevers. It is especially beneficial in the treatment of malarial fevers. It is also effective in hysteria and convulsion.

- The herb is an excellent drug for strengthening the stomach and promoting its action. It is used in the treatment of dyspepsia and diarrhoea.
- Chirayata possesses anthelmintic that is, worms destroying, properties and is used in killing intestinal worms. An infusion of the herb is taken for this purpose.

Habitat and cultivation

- The chiretta thrives as well as flourishes in woodland gardens having a sunny edge, partial shade, in shade as well as in marshy lands. It is an annually growing plant that normally grows up to a height of three feet or one meter.
- The plants are in bloom between the period September and October. The flowers are greenish in color with a purple tinge and hermaphrodite in nature. In other words, the chiretta flowers possess both the male and female organs.This plant has a preference for sandy (light), loamy (medium) as well as clay (heavy) soil conditions. In addition, the chiretta plant thrives and flourishes well in acidic, neutral as well as basic or alkaline soils.
- The plant can grow well in semi-shade or somewhat woodland conditions and needs humid or damp soil. Precisely speaking, the plant thrives well in a humid and humus-rich soil in damp light woodlands along the streams or in marshlands. The plant actually develops best in areas where the summers are cool. Hence, it is no surprise that the chiretta can thrive and flourish both in conditions where there is full sunlight as well as partial shade.
- The chiretta plants are able to withstand temperatures as low as -15° C and still continue to grow well. The chiretta herb (S. chirayita) is propagated by its seeds. Sowing is generally done during the spring when the temperature is not above 10° C and in a situation when the soil contains plenty of humus. When the seedlings have grown adequately to be handled, they are taken out individually and planted into separate pots or containers. The young plants are re-planted outdoors during the early part of summer.

Pharmacology activity

The varied ethnobotanical uses of *S. chirayita* have led to the initiation of various pharmacological investigations. Previous research demonstrates that the *S. chirayita* extracts exhibit a wide range of biological activities, such as antibacterial, antifungal, antiviral, anticancer, anti-inflammatory, and others like antidiabetic and antioxidant activities. Concurrently, a diverse range of *in vitro* and *in vivo* test systems has been used to evaluate the pharmacological properties of *S. chirayita*. Evidence-based laboratory investigations indicate that aqueous, alcoholic and methanolic extracts of *S. chirayita* possess a number of promising pharmacological properties. The whole plant of *S. chirayita* have been reported to be used for the treatment of antibacterial and antifungal activity. Anti-hepatitis B virus activity of *S. chirayita* extracts was also studied on HepG 2.2.15 cells line. The whole plant of *S. chirayita* has been reported for the anti-inflammatory and hypoglycemic activity investigated the 70% ethanolic extract of *S. chirayita* for antioxidant activities by using antioxidant tests including reducing power and beta-carotene assay. The results showed that 70% ethanolic extracts exhibited high DPPH scavenging activity (IC_{50} = 267.80 µg/mL).

Table: Evaluation of the biological activities of *Swertia chirayita*

Bioactive test	Plant part tested	Test system	Extracting solvent	Toxicity test	Control
Anti oxidant	Whole plant	In vitro	Et OH	None	Ciprofloxacin
Anti bacterial	Stem	In vitro	Me OH	None	ceftriaxone
Anti fungal	Whole plant	In vitro	Me OH	None	Gentamycin
Anti malarial	Leaves / stem	In vitro	Me OH	None	Kanamycin 30
Anti helmintic	Whole plant	In vitro	Me OH	None	Amphotericin
Anti inflammatory	Root	In vivo	Et OH	None	-

Anti oxidant: Antioxidants have been of interest to pharmacologists, biochemists,and other health professionals because they are supposed to reduce oxi-dative damage and protect the cell against oxidative stress caused by active free radical. The natural antioxidants in fruits, vegetables, spices and herbal medicines gained increasing interestamong food scientists, nutrition specialists, and consumers, as they re-duce the risk of chronic diseases and promote human health. In this context, various Swertiaspp. extracts were investigated fortheir free radical scavenging activities. The antioxidant capacity can be determined through various in vitro and in vivo antiox-idant assays such as 1,1-diphenyl-1-picrylhydrazyl or 2,2-diphenyl-1-picrylhydrazyl (DPPH), 2,2'-azino-bis(3-ethylbenzothiazoline- 6-sulphonic acid) (ABTS), superoxide (O2•−), nitric oxide, hydroxyl radi-cal scavenging activity, ferric reducing antioxidant power, metal ionchelating activity, anti-lipid peroxidation, chemilumine scence methods were utilized.

Antioxidant: The antibacterial activities of the several extracts and phytochemicals from different parts of the Swertia species against different pathogenic strains. The antibacterial activities are frequently evaluated by using inhibition zone diameter (IZD) and minimum inhibitory concentration (MIC) approaches. The xanthone,1,2-dihydroxy-6-methoxyxanthone-8-O-β-D-xylopyranosylisolated from Swertia corymbosa. It is necessary to purify antibacterial compounds extracted from Swertia, characterized for targeting specific set of harmful bacteria. This will be more precise for demonstrating the antibacterial activity of Swertia.

Anthelmintic activity

The effect of the crude aqueous and methanolic extracts of S. Chirata whole plant showed an anthelmintic effect on live Haemon chuscontortus. However, in thein vivo study, whole plant crude powder of S. Chirata administered crude aqueous and methanolic extracts at the dose of 3 g/kg to sheep naturally infected with

mixed species of gastro-intestinal nematodes. A single oral dose of 7.5 mg/kg levamisole HCl used as a positive control. In vitro results indicated the crude methanolic extract (25 mg/ml) of S. chirata whole plant inhibited completely the mobility of isolated worms.

Phyto- chemical study

The widespread uses of *S. chirayita* as a traditional drug and its commercialization in modern medical systems have led to a rise in scientific exploration of its phytochemistry in order to identify the active phytochemicals. This has resulted in a considerable body of literature exploring the chemical constituents of this plant The wide-range biological activities of *S. chirayita* are attributed to the presence of a diverse group of pharmacologically bioactive compounds belonging to different classes such as xanthones and their derivatives, lignans, alkaloids, flavonoids, terpenoids, iridoids, secoiridoids, and other compounds such as chiratin, ophelicacid, palmitic acid, oleic acid, and stearic acid . The first isolated dimeric xanthone was chiratanin present in different parts of *S. chirayita*. The pharmacological efficacy of *S. chirayita* has been partly attributed to the biological activity of major phytoconstituents including amarogentin, swertiamarin, mangiferin, swerchirin, sweroside, amaroswerin, and gentiopicrin Amarogentin is reported to be anti-diabetic, anticancerous and antileishmanial, whereas swertiamarin has been tested for its anti-hepatitis, anticancer, anti-arthritic activities It has been shown to exhibit anti-diabetic properties. Mangiferin is also reported to have anti-diabetic, antiatherosclerotic, anticancer, anti-HIV antiparkinson and chemopreventive activities. Swerchirin is known to be antimalarial, hypoglycemic, hepatoprotective, pro-heamatopoietic , with blood glucose lowering activity and weak chemo preventive pharmacological effects Swerchirin at different concentrations (1, 10, and 100 μM) significantly enhanced glucose stimulated insulin release from isolated. Sweroside is reported to be antibacterial, hepatoprotective , preventative in treatment for hyperpigmentation, and is also suggested as a promising osteoporosis therapeutic natural product. Amaroswerin is known for its gastroprotective effects of the bitter principles provides a summary focusing on the biological activity of the phytochemicals present in *S. chirayita*.

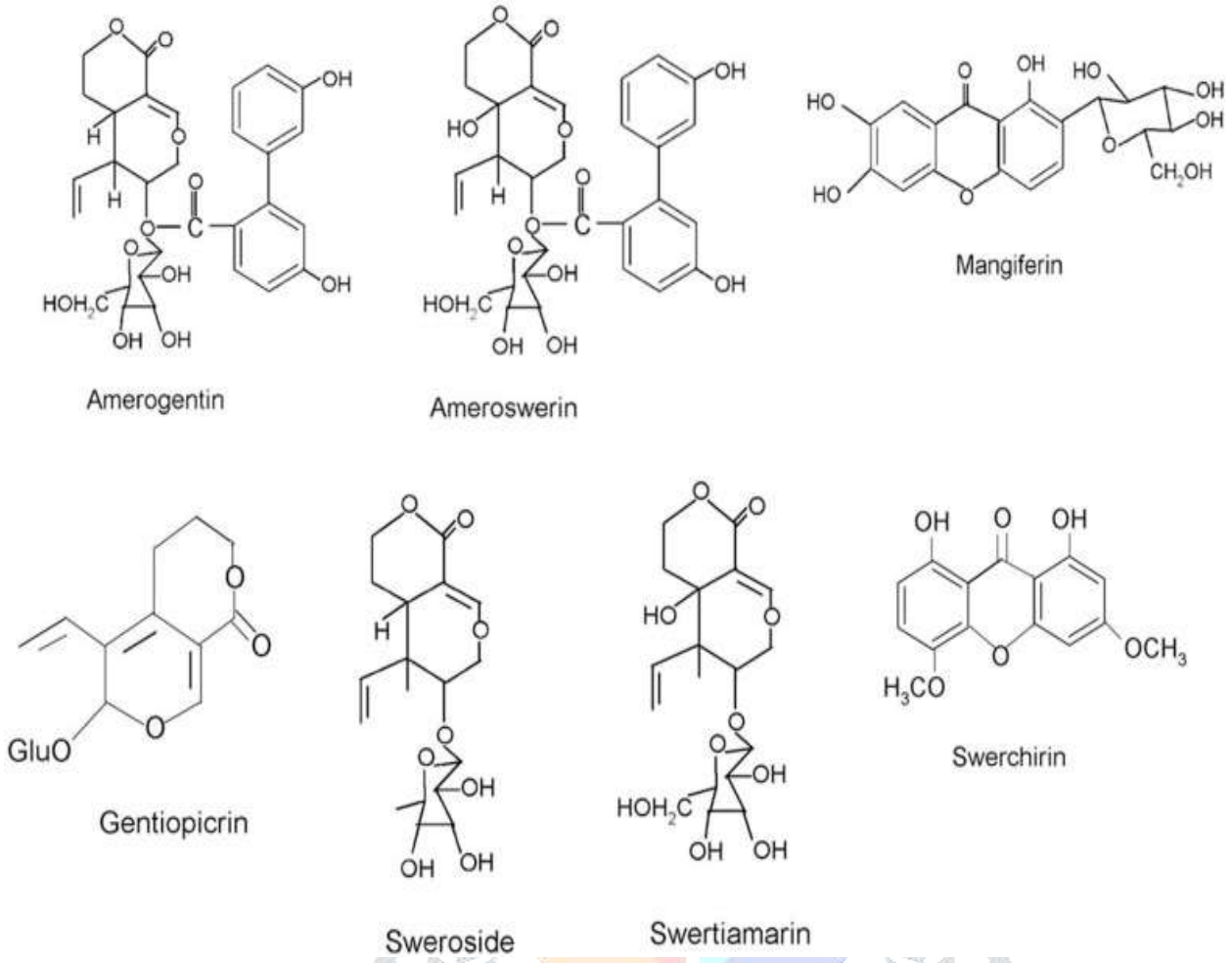

Fig 2: important phyto constituents chemical structure

Future prospective

S. chirayita offers many promising prospects for both traditional and modern medicine. *S. chirayita* is apparently a potential herbal therapy for many ailments. This review summarized the existing ethnobotanical uses, phytochemistry, pharmacological activities, safety evaluation, and conservation status on *S. chirayita*.

So far no serious side effects or toxicity of *S. chirayita* have been reported, but further toxicological studies are still needed to confirm the safety of *S. chirayita* in humans. Efforts are required for further studies, especially evaluating its biological activities *in vivo* and toxicological and mutagenic properties in order to better validate the safety of these different plant-derives compounds. In all probability there is a need for clinical trials to establish the efficacy of using *S. chirayita* in medicine. Due to its multiple uses the demand in both national and international markets is constantly on the rise. Overexploitation combined with habitat destruction has resulted in the drastic reduction of its population. For the successful commercialization of this critically endangered medicinal plant any proposed research must be viewed in a wider context that includes conservation practices and sustainable supply of raw plants. This will require innovative tools, which utilize biotechnological interventions, including micropropagation, cryopreservation, and bioreactors for the conservation, as well as for raising commercial production. In synthetic seed technology more detailed research is required mainly for improvement in germination frequency of synthetic seeds and subsequent plantlet growth in soil so that it can be used on a commercial scale. Additionally, in the near future, hairy root technology can be used as a model system and will also provide plant biotechnologists with powerful tools to improve the valuable phytochemicals of *S. chirayita*. Although efficient

micropropagation protocols have been established, further studies focusing on seed biology and ways of improving bioactive secondary metabolites in cultivated *S. chirayita* would be beneficial for their commercialization. Quality control protocols to prevent misidentification and possible adulteration of *S. chirayita* are also needed. In summary, *S. chirayita* have been studied extensively in terms of taxonomy, ethnobotany, phytochemistry, biological activities, and conservation. However, new findings may increase the present therapeutic importance of *S. chirayita* and promote their future use in modern medicine, while novel biotechnological approaches are required for further conservation.

Conclusion

Basically, Swertia chiretta is a conventional Ayurvedic therapeutic plant. An astringent stimulant prepared with the plant is an outstanding medication for weak stomach, particularly when it results in indigestion, bloating and nausea. In addition, this bitter tonic is also said to be effective in protecting the liver. Chirayata is a valuable bitter tonic. It is laxative and an appetizer. It also corrects the disordered process of nutrition and restores the normal function of the system. An infusion of the herb is taken for this purpose. It is an effective herb for reducing fevers. It is especially beneficial in the treatment of malarial fevers. It is also effective in hysteria and convulsions.

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