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## Mini Review

# Pharmacognostic and Conservational Overview of *Swertia chirata* Buch.-Ham. ex Wall., A Critically Endangered Himalayan Herb

## Abstract

**Background:** *Swertia chirata* Buch.-Ham. ex Wall. is an endangered medicinal herb native to the temperate Himalayan region. The species holds immense ethnobotanical importance in India, Nepal, Bangladesh and Bhutan. The herb is known to host a plethora of bioactive phytoconstituents that imbue it with a wide variety of medicinal properties. Modern research has proven that extracts of *S. chirata* possess antioxidative, anticarcinogenic, antimalarial, anti-inflammatory and hypoglycaemic activities. The present article aims at highlighting the medicinal importance of *S. chirata* along with a brief discussion about its bioactive phytoconstituents. The research work carried out for improving the germplasm conservation strategies for *S. chirata* have also been elucidated in this review.

**Methods:** In-depth analyses of *S. chirata* have been performed to outline its phytochemical profile in order to gain a better understanding about its medicinal attributes. Various techniques have also been applied for *in vitro* germplasm conservation of *S. chirata*.

**Result:** *S. chirata* contains numerous potent bioactive compounds that contribute to its medicinal value. The unsupervised exploitation of natural reserves of *S. chirata* by pharmaceutical companies has driven the species on the verge of extinction, thus making *in vitro* germplasm conservation of the same essential.

**Conclusion:** The importance of *S. chirata* as a cure for numerous ailments and health disorders has been well documented in traditional and modern medicine. The application of various modern techniques has not only allowed scientists to identify numerous medicinally important compounds present in *S. chirata*, but also created a platform for maintaining adequate production of this versatile medicinal plant species.

## Introduction

*Swertia chirata* Buch.-Ham. ex Wall., family Gentianaceae, is a small annual medicinal herb indigenous to the foothills of Himalayas. In Ayurveda, the ancient medical science of India, it has been mentioned as 'Kiraata', whereas the Unani medicine has recorded it as 'Chiraitaa'. Several regional names are present for the genus *Swertia* but it is most commonly known as 'chirata'. The genus *Swertia* consists of both annual and perennial species traditionally used as medicines in India, Japan, Nepal, China, Bhutan and Bangladesh. Other species of *Swertia*, viz. *Swertia japonica* and *Swertia pseudochinensis* are found in Japan and China, respectively. The plants belonging to this genus have been known to possess a wide range of medicinal attributes and have been used as a herbal analeptic

since centuries. Regular oral consumption of this plant acts as an effective liver tonic. In China the roots of *Swertia* are consumed as a food supplement. Extracts from various parts of the plant have been used as a cure for numerous physiologic disorders including constipation, malaria, skin diseases, diabetes and anemia. *Swertia chirata* is rich in several alkaloids [1-4] and polyoxygenated xanthenes [5] whose medicinal attributes are well explored. Unregulated exploitation of the natural reserves of *Swertia chirata* and the inadequate germinability of its seeds has led to drastic reduction in its availability. It has been declared as a critically endangered plant species by the International Union for Conservation of Nature and Natural Resources (IUCN) and the Government of India. Considering the medicinal significance of this plant the Indian National Medicinal Plant Board, the Government of India and

the IUCN have laid emphasis on the conservation of this plant species [6]. The aim of this study is to highlight the medicinal properties of *S. chirata* as a health tonic and discuss the ongoing and required biotechnological conservative strategies for its preservation and commercial exploitation.

### Phytogeography and botany

*S. chirata* is mostly found in the temperate Himalayan region of north India, Bhutan and Nepal at the midaltitudes. It is a branch producing herb with vertically growing orange-brown or purple coloured stems [7]. The leaves are soft, oval and stalkless in nature. The flowers are tetramerous, symmetric, axillary, greenish-yellow in colour with a purple tinge. The roots of chirata plants are fibrous and yellow in colour. Flowering commences after July and fruits mature around October. The plants are harvested just before or during the flowering stage. Seeds are small (300 µm in diameter) capsulated, brownish in colour and the fertility of these seeds is very low (around 2–3%). The *S. chirata* germplasm consists of 13 pairs of chromosomes [8].

### History and medicinal significance of *S. chirata*

In ancient India, chirata was used as an 'herbal drug' as reported in Ayurveda and Unani medicine. Charaka and Sushruta prescribed the use of these plants for its health benefits. Several different kinds of diseases and infections may be cured by oral consumption of this herb. The whole plant is rich in several secondary metabolites and thus has diverse medicinal potentials. The root extracts of this plant are used for treating asthmatic patients, whereas extracts of leaves are useful for blood pressure patients. Fever, dyspepsia, bronchial asthma, acidity, diabetes and abdominal diseases are the main physiological disorders in which the plant has therapeutic effects. Not only that, *S. chirata* also has a pivotal role in blood purification, preventing skin diseases and purification of breast milk. The bitter taste of chirata is mainly due to the presence of several bioactive components. Iridoid, secoiridoid glycosides, xanthenes and xanthone derivatives are the major families of compounds produced by these plants that are utilized for the treatment of several ailments.

### Ethnopharmacology of phytoconstituents

Several secondary plant metabolites are produced by these plants which are mainly utilised in pharmaceutical applications. Amarogentin [9], chiratol, swerchirin, swertianin [5], swertanone [2], swertane [3], chiratanin, amaroswerin, chiratin, chiratogenin, kairatenol [4], swertinin and swertiamarin [10] are the major secondary metabolites and bio-active compounds produced by this plant [11]. These compounds have several impacts on the human physiology due to antioxidative [12,13], anti-inflammatory [14], anti-carcinogenic [15], antimalarial [16], hypoglycaemic [17], anticholinergic, antiulcerogenic [18] and antihepatotoxic [19] activities. Apart from these pharmacological significance, this plant also has pesticidal and antimicrobial [20] properties. Researchers reported that *Swertia chirata* also had a property to stimulate the nerve cells while taking it in adequate amount [21]. *chirata* possesses

the bitter taste due to amarogentin which is mainly good for anticancer [15] and antileishmanial [22] activities. Regular oral consumption of this plant may result in proper discharge of the bile salts and curing various gastric problems. Swertiamarin is one of the signature secondary metabolites produced by this plant prescribed as a treatment for anxiety and acute stress due to its impact on central nervous system [10]. Another major phytoconstituent of this plant is swerchirin, a member of the xanthone family, which has been found to exhibit antimalarial and hypoglycaemic properties [23]. Further, other bio-active compounds such as amaroswerin, swertanone and chiratol are present in this plant that protect against gastro-intestinal [24] problems and shows anti-inflammatory [25,26] properties as well.

### Evaluation of bioactive compounds and their prospects

Chloroform extracted *Swertia chirata* roots have an inhibitory effect on neuromuscular cells of rat species [27] but have an excitatory effect on bronchi and bronchioles dilation for the acute bronchial asthmatic patient [11]. When the extraction of *S. chirata* is done by methanol and this extract is solubilized in chloroform, it exhibits antihepatotoxic potential [28]. The methanolic extract of *Swertia* are able to scavenge the superoxide radicals [12]. Ethanolic extracts of chirata have an ability to reduce the gastric ulcer [18]. From previous knowledge we know that chirata has a chemical constituent present in it, named amarogentin which may be the bitterest compound in the present world. It was found that this compound has an inhibitory effect on DNA topoisomerase I (ATP independent) which may reverse the effects of leishmaniasis [22]. Ether extracted *S. chirata* has an anthelmintic activity. *Swertia chirata* extracts also have the potential to be utilized in nanotechnology to produce and stabilize gold nanoparticles [29], which may open new vistas in nanobiotechnology.

Several other types of xanthenes are also present in these chirata plants. The aerial root part of this plant may produce several of polyoxygenated xanthenes such as 1-hydroxy-3,5,8-trimethoxyxanthone, 1-hydroxy-3,7,8-trimethoxyxanthone, 1,5,8-trihydroxy-3-methoxyxanthone, 1,3,6,7-tetrahydroxyxanthone-C2β-D-glucoside (mangiferin), 1,3,8-trihydroxy-5-methoxyxanthone, 1,3,5,8-tetrahydroxyxanthone, 1,3,7,8-tetrahydroxyxanthone, 1,8-dihydroxy-3,5-dimethoxyxanthone and 1,8-dihydroxy-3,7-dimethoxyxanthone [30]. There are several different kinds of terpenoids are also produced by this plant. A scientific report was published in 1990 by Chakravarty et al. and they demonstrate the presence of a novel triterpenoid, chiratenol, in *S. chirata* [1].

### Conservation strategies

*Swertia chirata* is mainly native in the Himalayan regions. Climate changes and human interference have affected this plant species drastically. Several factors are responsible for its endangerment including global warming, urbanization, poor seed germination, lack of viable seed production and the decreasing number of pollinators. Due to the low seed germination percentage of this plant there is a limitation on propagation through seeds. Plant biotechnology offers several

alternative methods for preserving the germplasm of this important plant species. *In vitro* micropropagation and somatic embryogenesis are the most reliable techniques which can be utilized for germplasm conservation of *S. chirata*. In the recent years, this ethnomedicinal herb has received commercial attention for the production of medicines from the crude sample of the plants in the Indian subcontinent and beyond. So, *in vitro* conservation of *S. chirata* is needed for supplying the plantlets at a sufficient amount and to fulfil the industrial demands [31]. The genetic study was conducted on *Swertia* by Chaudhuri et al., (2007) and Joshi and Dhawan (2007), to explore the conservation strategy of this critically endangered plant species [7,32,33]. The increasing pharmaceutical demand of *Swertia chirata* may lead to a focus on regeneration of these plants by *in vitro* micropropagation [34,35] as well as improvement in strategies for seed germination [8]. A patent was registered in the year of 2003 describing the media composition for micropropagation of *S. chirata* by Ahuja and his co-workers [36]. In the year of 2009 Koul et al., developed a robust biotechnological method for *in vitro* regeneration of *S. chirata* shoots through an alternate way for the production of amarogentin [6].

## Conclusion

Non-herbal medicinal products are often cytotoxic in nature and therefore using plant extracts as a medicine has more significant beneficial impacts on human health. Furthermore, the synthetic medicines are disease specific and narrow spectrum. Thus, in the present day herbal compounds are getting more focus for pharmacological research due to the wide array of physiologic benefits. Therefore pharmacological companies are now trying to produce drugs from medicinal herbs. *Swertia chirata* is an endangered plant and one of the most potent medicinal herb which can be used to cure several ailments. No reports are present against the side effects and toxicity nature of this ethnobotanical herb. There is a need to conserve this plant species from extinction by clonal propagation and germplasm conservation by using modern plant biotechnological concepts in order to reap the full benefits of this versatile medicinal herb.

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