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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 antioxidantive, 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 xanthones [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 tetrameraous, 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* germlasm 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, xanthones 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], chitratin, amaroswerin, chiratin, chiratogenin, kairatenol [4], swertin 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, antulcerogenic [18] and antiproteotoxic [19] activities. Apart from these pharmacological significance, this plant also has pesticidic 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 antiproteotoxic 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 xanthones are also present in these chirata plants. The aerial root part of this plant may produce several of polyoxygenated xanthones such as 1-hydroxy-3,5,8-trimethoxyxanthone, 1-hydroxy-3,7,8trimethoxyxanthone, 1,5,8-trihydroxy-3-methoxyxan- thone, 1,3,6,7-tetrahydroxyxanthone-C2β-D-glucoside (man- giferin), 1,3,8-trihydroxy-5-methoxyxanthone, 1,3,5,8-tet- rahydroxyxanthone, 1,3,7,8-tetrahydroxyxanthone, 1,8-dihy- droxy-3,5-dimethoxyxanthone and 1,8-dihydroxy-3,7-dime- thoxyxanthone [30]. There are several different kinds of ter- penoids 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 fulfill the industrial demands. 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 pharmaceutical 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 traditional propagation and germplasm conservation by using modern plant biotechnological concepts in order to reap the full benefits of this versatile medicinal herb.

**References**

1. Chakravarty AK, Das B, Masuda K, Ageta H (1990) Chiratenol, a novel rearranged hopane from triterpenoid Swertia chirata. Tetrahedron Lett 31: 7649-7652. https://doi.org/10.1016/S0040-4039(00)80040-9

2. Chakravarty AK, Das B, Mukhopadhyay S (1991a) Peracid oxidation products of swertanone, the novel triterpene of Swertia chirata. Tetrahedron 47: 2337-2350. https://doi.org/10.1016/S0040-4039(00)80040-9

3. Chakravarty AK, Mukhopadhyay S, Das B (1991b) Swertane triterpenoids from Swertia chirata. Phytochemistry 30: 4087-4092. https://doi.org/10.1016/0031-9422(91)85219-3

4. Chakravarty AK, Mukhopadhyay S, Masuda K, Ageta H (1992) Kairatenol, a novel rearranged hopane from triterpenoid from Swertia chirata. Tetrahedron Lett 33: 125-126. https://doi.org/10.1016/S0040-4039(00)80040-9

5. Asthana RK, Sharma NK, Kulshreshttha DK, Chatterjee SK (1991) A Xanthone from Swertia chirata. Phytochemistry 30: 1037-1039. https://doi.org/10.1016/0031-9422(91)85219-3

6. Koul S, Suri KA, Dutt P, Sambyal M, Ahuja A, et al (2009) Protocol for in vitro regeneration and marker glycoseide assessment in Swertia chirata. Indian J Pharm Sci 71: 60-66. https://doi.org/10.4103/0251-6977.62649

7. Joshi P, Dhawan V (2007a) Chiratenol, a novel rearranged hopane from triterpenoid Swertia chirata. J Nat Prod 70: 140-144. https://doi.org/10.1021/np060996p

8. Chaudhuri RK, Pal A, Jha TB (2007b) Regeneration and characterization of Swertia chirata Buch.-Hamm. ex Wall. plants from immature seed cultures. Sci Horticult 120: 107-114. https://doi.org/10.1016/j.scienta.2007.04.012

9. Friedhelm K, Hans GS (1956) Chemical classification of plants XII. Amarangetin. Chem Ber 89: 2404-2407.

10. Bhattacharya SK, Reddy PK, Ghosal SP, Singh AK, Sharma PV (1976) Chemical constituents of Gentianaceae XIX: CNS depressant effects of sertiamarin. J Pharm Sci 65: 1547-1549. https://doi.org/10.1002/jps.260651205

11. Khan A, Rahim A, Iqbal Z, Ghalani AH (2012) Insights into mechanisms underlying the gut and airways modulatory effects of Swertia chirata. J Nat Med 66: 140-148. https://doi.org/10.1007/s11418-011-0292-x

12. Khanom F, Kaharaha H, Tadasa K (2000) Superoxide-scavenging and prolyl endopeptidase inhibitory activities of Bangladeshi indigenous medicinal plants. Biosci Biotechnol Biochem 64: 837-840. https://doi.org/10.1271/bbb.64.837

13. Ghosh D, Bandyopadhyay SS, Chattjee RR, Caper P, Ray B (2012) Carbohydrate polymers of chirata (Swertia chirata) leaves: structural features, in vitro anti-oxidant activity and fluorescence quenching study. Food Sci Biotechnol 21: 409-417. https://doi.org/10.1007/s10068-011-0206-5

14. Chowdhry NL, Bandyopadhyay SK, Banerjee SN, Dutta MK, Das PC (1995) Preliminary studies on the antiinflammatory effects of Swertia chirata in albino rats. Indian J Pharmacol 27: 37-39. https://doi.org/10.1007/BF03399588

15. Saha P, Mandal S, Das A, Das PC, Das S (2004) Evaluation of the antitumorogenic activity of Swertia chirata Buch.han. An Indian medicinal plant, on DMBA-induced mouse skin carcinogenesis model. Phytother Res 18: 373-378. https://doi.org/10.1002/ptr.1102

16. Bhargava S, Rao PS, Bhargava P, Shukla S (2009) Antipyretic potential of Swertia chirata Buch Ham. root extract. Food Sci Pharm 77: 617–623. https://doi.org/10.1007/s11418-011-0292-x

17. Chandra Sekar BK, Bajpai MB, Mukherjee SK (1990) Hypoglycemic activity of Swertia chirayita (Roxb ex Flem) Karst. Indian J Exp Biol 28: 616–618. https://doi.org/10.1007/s11418-011-0292-x

18. Rafaullah S, Tariq M, Mosa MJ, Al-Yahya MA, Al-Said MS, et al. (1993) Protective effect of Swertia chirata against indomethacin and other urogenic agent-induced gastric ulcers. Drugs Exp Clin Res 19: 69–73. https://doi.org/10.1007/s11418-011-0292-x

19. Karan M, Vasisht K, Handa SS (1999a) Antihelminthic activity of Swertia chirata buch. ham. root extract. J Ethnopharmacol 66: 140–148. https://doi.org/10.1016/S0378-8741(99)00102-1

20. Bhargava S, Garg R (2007) Evaluation of antibacterial activity of aqueous extract of Swertia chirata Buch. Ham. root. Int J Green Pharm 1: 51–52. https://doi.org/10.1007/s11418-011-0292-x

21. Ghosal S, Sharma PV, Jaiswal DM (1978) Chemical constituents of Gentianaceae xiii tetraoxygentated and pentaoxygentated xanthone-o-glucosides of Swertia angustifolia Buch Ham. J Pharm Sci 67: 55–60. https://doi.org/10.1007/s11418-011-0292-x

22. Ray S, Majumder HK, Chakravarty AK, Mukhopadhyay S, Gil RR, et al. (1996) Amarogentin, a naturally occurring secoiridoid glycoside and a newly recognized inhibitor of topoisomerase I from Leishmania donovani. J Nat Prod 59: 27–29. https://doi.org/10.1007/s11418-011-0292-x

23. Ray S, Majumder HK, Chakravarty AK, Mukhopadhyay S, Gil RR, et al. (1996) Amarogentin, a naturally occurring secoiridoid glycoside and a newly recognized inhibitor of topoisomerase I from Leishmania donovani. J Nat Prod 59: 27–29. https://doi.org/10.1007/s11418-011-0292-x
23. Bajpai MB, Asthana RK, Sharma NK, Chatterjee SK, Mukherjee SK (1991) Hypoglycemic effect of swerchirin from the hexane fraction of Swertia chirayita. Planta Med 57: 102–104. Link: https://goo.gl/y8FSu0

24. Niiho Y, Yamazaki T, Nakajima Y, Yamamota T, Ando H, et al. (2006) Gastroprotective effects of bitter principles isolated from Gentian root and Swertia herb on experimentally-induced gastric lesions in rats. J Nat Med 60: 82–88. Link: https://goo.gl/ssylRL

25. Kumar IV, Paul BN, Asthana R, Saxena A, Mehratra S, et al. (2003) Swertia chirayita mediated modulation of interleukin-1beta, interleukin-6, interleukin-10, interferon-gamma, and tumor necrosis factor alpha in arthritic mice. Immunopharmacol Immunotoxicol 25: 573–583. Link: https://goo.gl/SyfJQV

26. Banerjee S, Sur TP, Das PC, Sikdar S (2000) Assessment of the antiinflammatory effects of Swertia chirata in acute and chronic experimental models in male albino rats. Indian J Pharmacol 32: 21–24. Link: https://goo.gl/8Cid7i

27. Khare CP 2004 Indian Herbal Remedies Rational Western Therapy, Ayurvedic and Other Traditional Usage, Botany, 1st edition. Springer-Verlag, New York 438-439. Link: https://goo.gl/ecj0Op

28. Karan M, Vasisht K, Handa SS (1999b) Antihepatotoxic activity of Swertia chirata on carbon tetrachloride induced hepatotoxicity in rats. Phytother Res 13: 24–30. Link: https://goo.gl/OV5soH

29. Saha N, Dutta Gupta S (2016) Biogenic synthesis and structural characterization of polyshaped gold nanoparticles using leaf extract of Swertia chirata along with process optimization by response surface methodology (RSM). J Clust Sci 27: 1419–1437. Link: https://goo.gl/YUYAjp

30. Ghosal S, Sharma PV, Chaudhuri RK, Bhattacharya SK (1973) Chemical constituents of the gentianaceae V: Tetraoxygenated xanthones of swertia chirata buch.-ham. J Pharm Sci 62: 926-930. Link: https://goo.gl/3X7TJY

31. Rai LK, Prasad P, Sharma E (2000) Conservation threats to some important medicinal plants of the Sikkim Himalaya. Biological Conservation 93: 27-33. Link: https://goo.gl/x3aLCo

32. Chaudhuri RK, Pal A, Jha TB (2007) Production of genetically uniform plants from nodal explants of Swertia chirata Buch.-Ham. ex Wall.— a critically endangered medicinal herb. In vitro Cell Dev Biol 43: 467–472. Link: https://goo.gl/3LyBGs

33. Joshi P, Dhawan V (2007b) Assessment of genetic fidelity of micropropagated Swertia chirayita plantlets by ISSR marker assay. Biol Plantarum 51: 22-26. Link: https://goo.gl/uwe271

34. Wawrosch C, Maskay N, Kopp B (1999) Micropropagation of the threatened Nepalese medicinal plant Swertia chirayita Buch.—ex Wall. Plant Cell Rep 18: 997–1001. Link: https://goo.gl/Izgi6i

35. Balaraju K, Agastian P, Ignacimuthu S (2009) Micropropagation of Swertia chirata Buch.-Hams. ex Wall.: a critically endangered medicinal herb. Acta Physiol Plant 31: 487–494. Link: https://goo.gl/6wKDQ

36. Ahuja A, Koul S, Koul BL, Verma NK, Kaul MK, et al. (2003) Media composition for faster propagation of Swertia chirayita WO 2003045132 A1.