REVIEW PAPER

"Pharmacognosy, Phytochemical Composition, Pharmacological Activities, and Traditional Uses of *Swertia chirata* (Indian Gentian): A Comprehensive Review."

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Abstract

This research provides a comprehensive overview of *Swertia chirata* (Indian Gentian) a medicinal plant of significant importance in traditional medicine. The review details the pharmacognosy of the plant, encompassing its macroscopic, microscopic and organoleptic characteristics alongside its phytochemical composition. It focuses on essential bioactive substances such as xanthones, flavonoids and iridoids. It details numerous pharmacological functions, like how they help with inflammation, protect the liver, combat bacteria and lower blood sugar levels. Even though it has been used for a long time, modern science hasn't fully confirmed it yet, and more research is needed. The report identifies significant research gaps that require attention, particularly regarding clinical trials, the molecular mechanisms of bioactive compounds, and their bioavailability.

Keywords: *Swertia chirata*, whole plant, Pharmacognosy, Phytochemistry, Pharmacology

How To Cite This Article: Kaur J, Thapar S. Pharmacognosy, phytochemical composition, pharmacological activities, and traditional uses of swertia chirata (indian gentian): a comprehensive review. Int J Drug Deliv Technol. 2026;16(8s): 652-658; Doi: 10.25258/Ijddt.16.8s.71.

Introduction:

Swertia chirata, also known as Indian Gentian, is a plant that grows in the temperate parts of the Himalayas, especially in India, Nepal, and Bhutan. Traditional medical systems, including Ayurveda have long utilized in the treatment of malaria, fever, liver diseases and digestive problems. Folk medicine has long recognized its pharmacological qualities, such as being anti-inflammatory, protecting the liver, fighting diabetes, and killing bacteria. Despite its widespread traditional use and recognized medicinal potential, scientific validation for these traditional claims, particularly in terms of clinical safety and effectiveness, remains limited. (1,2, 3,4) People know that the plant has a lot of different chemicals in it, such as xanthones, flavonoids, and iridoids, which are bioactive. Some constituents which are responsible for its therapeutic activities are mangniferin, amarogentin and sweriamarin.

For instance, while certain bioactive compounds like xanthones, flavonoids and iridoids have been identified as responsible for its therapeutic activities, comprehensive research elucidating their mechanism of action, bioavailability and therapeutic efficacy remains inadequately explored. Scientists still did not know much about *Swertia chirata* even it has been used for long time and some recent evidences that it could work for medicine. Recent Research mainly focuses on in vitro studies and animal models, resulting in a substantial lack of clinical validation. (5,6) Also, scientists don't fully understand how the bioactive compounds in plants work on a molecular level to have their medicinal effects, which makes them less useful in modern medicine. It will also talk about the problems and limitations of current research, such as the fact that there aren't enough clinical studies and that we need better ways to measure the bioactive compounds in plants. This review aims to combine traditional knowledge with modern scientific proof and suggest new areas of research to fully explore the medicinal potential of *Swertia chirata.* (7,8,9)

Taxonomical Classification (10,11,12,13)

Taxonomically, it is classified as:
Kingdom: Plantae
Phylum: Tracheophyta
Class: Magnoliopsida
Order: Gentianales
Family: Gentianaceae
Genus: Swertia
SpeciesChirata
Binomial name: *Swertia chirata*

Habitat and Cultivation

To fully understand *Swertia chirata*'s therapeutic potential, it is essential to first detail its botanical characteristics, beginning with its habitat and cultivation. Chirata is an annual plant, typically growing up to one meter, and flourishes in woodland gardens, marshy areas, and humid, humus-rich soils. It tolerates full sun, partial shade, and a wide range of soil types—sandy, loamy, clay, and soils that are acidic, neutral, or alkaline. The plant blooms from September to October,

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producing greenish-purple hermaphroditic flowers, and grows best in cool summer climates. (14,15) Chirata can survive temperatures as low as –15 °C. It is propagated by seeds sown in spring when temperatures are below 10 °C. Once seedlings are strong enough, they are potted individually, then transplanted outdoors in early summer. The plants are harvested when seeds begin to form and are dried for later use. (16,17,18,19, 20)

Vernacular Names (21)

English: Chirata (Indian Gentian)
Hindi: Charayatah
Urdu: Chiarayata,
Sanskrit: Chiratika
Arabic: Qasabuzzarirah
Persian: Nenilawandi
Punjabi: Charaita
Bengali: Chireta
Burma: Sekhagi
Uu4uuMarathi: Chirayita
Tamil: Nilavembu,
Telugu: Nilavembu
Kannada: Nilavebu
Malayalam: Nilaveppa
Gujarati: Chirayata
Nepal: Cherata
Deccan: Charayatah

Botanical Description

This ancient herb was introduced to Europe in 1839.It is sometimes referred to as Nepali Neem due to its presence as an annual or biennial herb in Nepali forests. This annual plant, which is also called a shrub, grows up to 1.5 meters tall. It is usually found in the subtemperate Himalayan region at heights about 1200 and 1500 meters. It grows from Bhutan to Kashmir. (22, 23, 24) There are more than 135 kinds of annual and perennial herbs in this large group. People often use Swertia plants in herbal medicine. India has 40 different kinds of *Swertia chirata.* As depicted in Figure 1 depicted the Geographical distribution of *Swertia chirata* in the Himalayas.

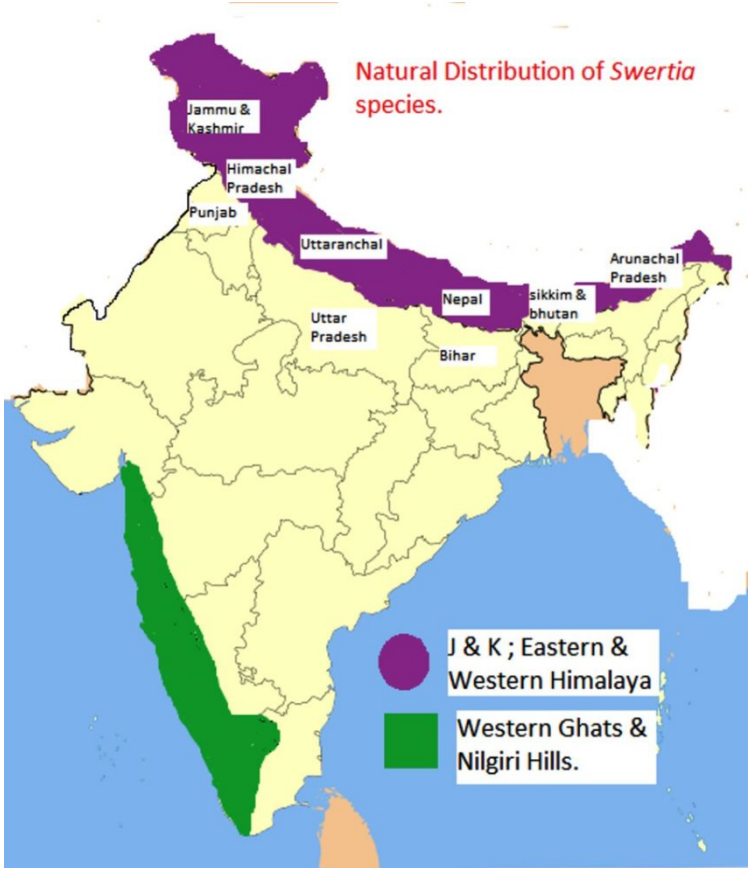


Figure 1: Geographical distribution of *Swertia chirata* in the Himalayas.

Figure 2(a)– Whole plant of *Swertia chirata*

Figure 2(b)– Flower of *Swertia chirata*

Figure 2(c)-Fruits of *Swertia chirata*

Figure 2 (d): Dried Sticks of *Swertia chirata*

Pharmacognostical Characteristics

Macroscopy

All parts of the *Swertia chirata* plant possess therapeutic properties. In the fresh sample, the herb has a specific kind of vivid yellowish colour throughout. The stem can grow up to 1 meter long and 6 millimetres wide. It is yellowish-brown to purplish in color and has a smooth surface with no hairs or bumps. The bottom of the stem is round, and the top is a little square. The yellow pith is big, continuous, and easy to pull off. The leaves of the plant are opposite, broad, smooth, narrow, oval, and come to a point at each end. There are usually five to seven veins on the sides of them. The flowers are round and 2 to 3 milli metre wide. There are two glandular depressions close to the base of each corolla lobe. The ovary is ovate acuminate with a point on the end. It has two carpels and one loculus. The fruit is a strange shaped capsule which holds a lot of seeds that are 0.25 mm long and 0.16 mm- 0.45 mm wide. (27) As depicted in Figure 2 (a, b, c, d) the whole plant of *Swertia chirata*.

Microscopy

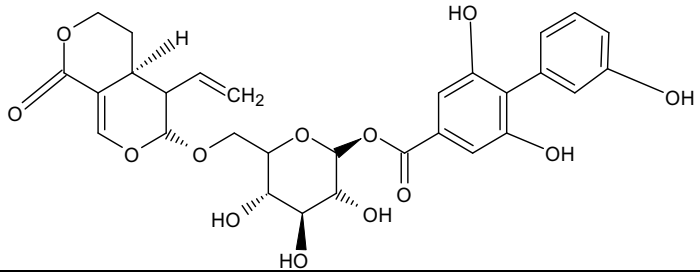
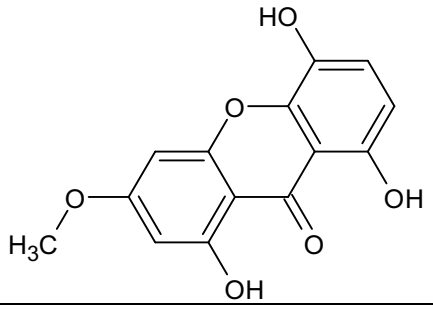
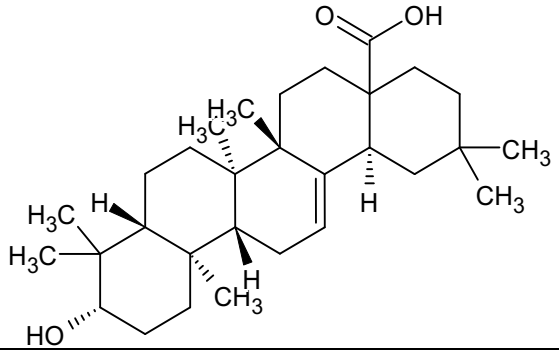
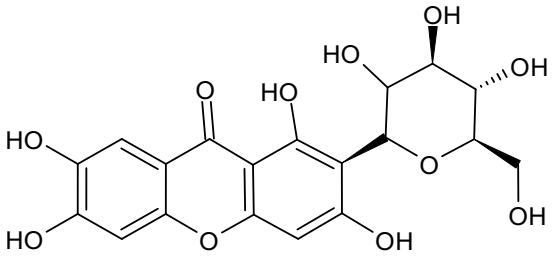
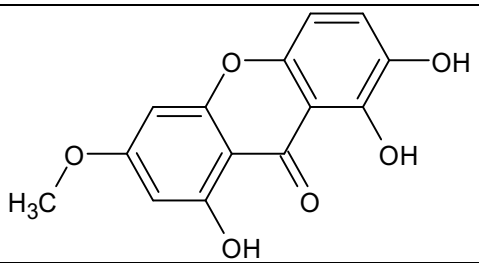
The leaf's inner parenchyma issue is rich in chloroplasts and shows minimal differentiation within the mesophyll tissue. The epidermis has only one layer and a thick cuticle covers from outside. The cuticle is thicker on the adaxial surface. The upper epidermal cells have straight walls and are bigger than the lower epidermal cells, which have a sinusoidal shape. The stomata are of the cruciferous type and are only found on the abaxial surface.

Upon transecting the stem, one observes a unlayered epidermis, externally enveloped by a robust cuticle in the juvenile phase, while in the mature epidermis, it remains intact, albeit with flattened and slightly stretched cells. The 4 ribs comprise both epidermal and parenchymatous cortical cells, the endodermis is separate and has either anticlinal or periclinal walls. There are many tiny needle-like crystals present. The cells are cortical, and resin is inside some of the cortical cells. Small drops of oil are found in a dark brown mass. Upon examination, the roots contain two-four layers of

cork, the secondary cortex is characterized by four to twelve layers of thick-walled parenchymatous cells. A minority exhibit radial wall formation, elongated tangentially with undulating walls. (28)

Phytochemistry

The phytochemical profile of *Swertia chirata* reveals the presence of several bioactive compounds, including xanthones, flavonoids, and iridoids. The major xanthone, amarogentin, has demonstrated potent anti-inflammatory and hepatoprotective effects (29, 30,31,32,33,34,35) Other significant compounds include swertiamarin, a secoiridoid glycoside with antidiabetic properties, and mangniferin, a flavonoid with antioxidant and anti-inflammatory effects. These compounds are responsible for the plant's wide pharmacological effects. (36-49). (Table-1)

Compound	Chemical Structure	Reported Activity	Reference
Amarogentinin		Antileishmanial, Anticancer, Anti-diabetic, Gastro protective, Anthelmintic.	Brahmachari *et al.,* 2004.
Bellidifolin		Hypoglycemic.	Arya *et al.,* 2011.
Oleanolic acid		Antimicrobial, Antitumor, Anti-inflammatory, Antioxidant.	Chen *et al.,* 2011.
Mangniferin		Anti-viral, Immune modulating, Anti-inflammatory, Antioxidant, fights diabetes, Antitumor, Anti-HIV, Chemo preventive, Anti atherosclerotic, Anti-parkinson.	Saxena *et al.,* 1991.
Swertiatin		Anti-inflammatory, anti-diabetic	Saxena *et al.,* 1991.

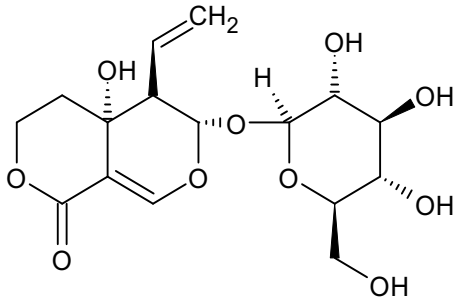
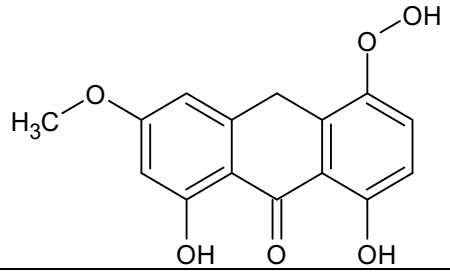
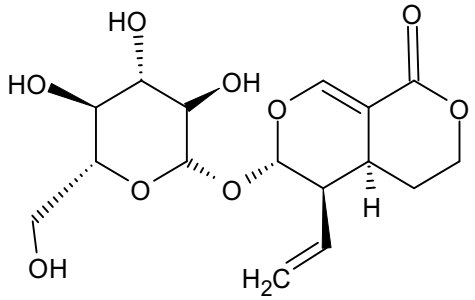
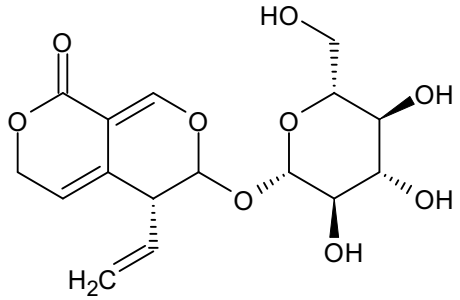
Swertiamarin		CNS depressive, Anticholinergic, Antibacterial, Anticancer, Anti-hepatitis, Protects the heart, Anti-atherosclerotic, fights diabetes, fights arthritis.	Saxena *et al*., 1993.
Swerchirin		Hepatoprotective, Hypoglycemic, Pro-hematopoietic, Chemo preventive, Blood glucose lowering activity.	Ray *et al*., 1996.
Sweroside		Hepatoprotective, Antibacterial, Hyperpigmentation, Osteoporosis, Anthelmintic.	Medha *et al.,* 1999.
Gentiopicrin		Hepatoprotective, Anti-inflammatory	Ray *et al.,* 1996.

Table 1: Summary of Key Bioactive Compounds in *Swertia chirata* and Their Therapeutic Activities
Pharmacology activity

1.Anti-Bacterial Activity

Ethanolic and Methanolic extract of leaves of *Swertia chirata* have demonstrated anti-bacterial properties. The anti-bacterial activity was evaluated usimg the agar well diffusion method against gram positive organisms (specifically Staphylococcus aureus and Bacillus species) and gram-negative organisms (Escherichia coli, Klebsiella pneumoniae, and Pseudomonas aeruginosa) with evaluations based on the inhibition zone. The results indicated moderate activity efficacy against Staphylococcus aureus, Escherichia coli and Klebsiella pneumoniae and no significant activity was observed against Bacillus species. [50,51].

2.Hepatoprotective Activity.

Ethanolic extract of *Swertia chirata* has shown hepatoprotective activity in albino rats. Ethanolic extract of *Swertia chirata*, administered at a dose of 20 mg/kg, 50mg/ and 100 mg/kg body weight daily for sixteen days, dose dependently increased alanine aminiotransferease, serum aspartate aminotransferase and alkaline phosphatase, while decreasing serum cholesterol and liver glycogen levels. [52-59].

3. Antileishmanial Activity

Methanolic extract of Swertia chirata has shown anti-leismanial activity Leishmania parasite. The methanolic extract of it at a dose of 1000 µg/ml has exhibited anti-leishmanial activity. (60)

4.Anti –Inflammatory Activity

The ethanolic root extract of *Swertia chirata* has demonstrated anti-inflammatory properties through carrageenan-induced rat paw edema model. The ethanolic extract at doses of 200mg/kg and 400 mg/kg has demonstrated anti-inflammatory properties. It has

showed that ethanolic root extract of *Swertia chirata* contains xanthones which is responsible for anti-inflammatory activity. (61,62, 63)

5.Antimalaraial Activity

The aqueous extract of *Swertia chirata* has demonstrated anti-malarial efficacy against the Plasmodium falciparum in vitro. The assessment of plant extract on thin blood smears utilizing 35S- methionine incorporated into parasite proteins showed significant inhibitory effect on Plasmodium falciparum in vitro. (64,65,66,67)

6.Anthelmintic activity

Methanolic extract of *Swertia chirata* has shown anthelmintic activity. The studies revealed that a 25 mg/ml Methanolic extract of *Swertia chirata* has showed an anthelmintic effect on live *Haemonchus contortus*. Evaluation showed a significant reduction in egg per gram of faeces. [68,69,70,71]

7.Anti-pyretic activity

Aqueous extract of *Swertia chirata* has shown anti-pyretic activity using albino rats and rabbit. The aqueous extract of it at a dose of 200 and 400 mg/kg body weight in both models has produced significant reduction elevated body temperature. *Swertia chirata* is rich in xanthones and triterpenoids, Swertiamarin might be responsible for the anti-pyretic activity. (72)

8.Anti-viral activity

Crude extract of *Swertia chirata* has shown anti-viral activity against herpes simplex virus type-1 both at cellular and molecular level. The crude extract of it at a dose of 1gm/ml at 1:64 dilution inhibited herpes simplex virus type. *Swertia chirata* has showed antiviral properties against Herpes simplex virus type-1. (73,74)

9.Anti-carcinogenic activity

Crude extract of *Swertia chirata* has shown anti-carcinogenic activity using induced mouse skin carcinogenesis model. The crude plant extract influenced apoptosis and cell growth in the skin of DMBA-exposed mice, significantly inhibiting cell proliferation and inducing apoptosis (75,76)

Traditional Uses

Traditionally, *Swertia chirata* is used to treat liver diseases, digestive problems and fevers. Modern pharmacological research show that the plant protects the liver and reduces inflammation, which backs up its traditional applications. Traditional remedies include decoctions of the entire plant for malaria treatment, aligning with recent research that demonstrate its efficacy against Plasmodium falciparum

Conclusion

In Conclusion, *Swertia chirata* exhibits wide range of pharmacological activities, including anti-inflammatory, hepatoprotection and antibacterial properties. Nevertheless, clinical trials are still needed to confirms its therapeutic activities. Furthermore, future research should focus on the pharmacokinetics, bioavailability and therapeutic efficacy of plants bioactive constituents. More molecular research is needed to fully to understand the mechanisms of action and what causes these effects.

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