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# ANTIMICROBIAL PROPERTY OF KIRATATIKTA (SWERTIA CHIRATA): A PHYTOCHEMICAL AND PHARMACOLOGICAL REVIEW

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**Abstract:**

In Ayurveda and other traditional medical systems, Kiratatikta (Swertia chirata Roxb. ex Flem.), another name for Chirayita, is one of the most prized plants. Given the rise in antibiotic resistance worldwide, scientists have focused on its various pharmacological effects, especially its antimicrobial effectiveness. The antibacterial qualities of S. chirata are reviewed here, with a focus on the phytochemical composition, modes of action, and possible medicinal uses of the plant. Swertiamarin, amarogentin, mangiferin, and xanthones are examples of bioactive components that have antiviral, antifungal, and antibacterial properties against a variety of pathogenic microbes. The cumulative evidence suggests that S. chirata holds promise as a source of novel antimicrobial agents. However, standardization, clinical validation, and mechanistic studies remain areas requiring further exploration.

**Keywords:** Swertia chirata, Kiratatikta, antimicrobial, phytochemicals, herbal medicine, amarogentin, swertiamarin.

## Introduction:

Many modern drugs have been separated from natural sources, many of which have been based on their usage in traditional medicine. Nature has been a source of medicinal compounds for thousands of years. The availability and usage of suitable medications is one

of the requirements for primary health care to succeed.[1] In the primary healthcare system, traditional medicine continues to be the most affordable and accessible form of therapy. There are over 135 species of annual and perennial herbs in the genus Swertia, which is part of the Gentianaceae family. Many herbal treatments contain Swertia species as general ingredients. S. chirayita, often known as "Chiretta," is a highly endangered medicinal herb that grows between 1200 and 2100 meters above sea level in the subtemperate Himalayan highlands, spanning from Kashmir to Bhutan. [2]

A major worldwide health concern is antimicrobial resistance (AMR), which reduces the effectiveness of traditional antibiotics and calls for the development of substitute treatment medicines. Historically, medicinal plants have been a rich source of antibacterial chemicals due to their wide chemical diversity.[3] Because of its ability to treat fever, liver problems, skin infections, and microbiological diseases, Swertia chirata Roxb. ex Flem. (family: Gentianaceae), often referred to as Kiratatikta or Chirayita in Ayurveda, stands out among these..[4]

**Classical References of Kiratatikta:**[5,6,7]

| S.no. | Samhita/Nighantu | Gana/Varga |
|---|---|---|
| 1. | Charaka Samhitha | Tikta Skandha, Stanya Shodhana, Trisnanigrahana |
| 2. | Susrutha Samhitha | Aaragvadhadi Gana |
| 3. | Asthangasangraha | Aaragvadhadi Gana |
| 4. | Aaragvadhadi Gana | Aaragvadhadi Gana |
| 5. | Dhanvanthari Nighantu | Guduchyadi Varga |
| 6. | Nighantu Aadarsha | Kirathadi Varga |
| 7. | Madanapala Nighantu | Abhayadi Varga |
| 8. | Raja Nighantu | Prabhadradi Varga |
| 9. | Kaiyadeva Nighantu | Kaiyadeva Nighantu |
| 10. | Bhava Prakasha Nighantu | Harithakyadi Varga |

**RASA- PANCHAK:**[8]

| | |
|---|---|
| Rasa | Tikta |
| Guna | Laghu, Ruksha |
| Vipaka | Katu |
| Veerya | Ushna according to Bapalala G. Vaidya, Sheeta according to Kaiyadeva Nighantu |
| Dosha Karma | Tridoshashaamaka, Mainly Kaphapitha Shamaka and Vatha Vardhaka and therefore it is useful in diseases due to Kaphapitta |
| Karma | Saaraka, Krimighna, Paachaka |

**SUBSTITUTES and ADULTERANTS:**[9]

**Substitutes:** Swertia angustifolia Buch.-Ham. is also known as Mitha Chirayata. Swertia alata

Royle lacks the characteristic bitter taste. These two species are considered adulterants and substitutes. Swertia corymbosa is also regarded as a substitute for Swertia chirata.

1) Swertia purpurascens Wall.

2) S.decussata Nimmo ex Grah.

3) S.chinensisFranchet.

4) S.paniculata Wall

5) S.Perennis Linn

6) S.lawii Burkill

7) S.affinis C. B. Clarke

8) Exacum bicolor Roxb.

9) E.tetragonumRoxb

10) Erythraea roxburghiiG.Don

11) Enicostemma littorale Blume.

**Adulterants:**

1. Swertia angustifolia Buch.Ham.exD.Don

2. Swertia alata Royle ex.C.B.Clarke

3. Rubia cordifolia Linn

4. Andrographis panniculata Nees.

**Habit-** Kiratatikta is an erect, annual or biennial herb

**Habitat-** Kiratatikta is an upright herb that grows up to 1.5 meters tall and is native to the temperate Himalayas between 1,200 and 3,000 meters above sea level. The entire plant has therapeutic value, but the aerial sections are especially useful.

**Botanical description:**[10,11]

**Habit:** Kiratatikta is an erect, annual or biennial herb, growing up to 30–90 cm in height. The plant is slender, erect, and branched, with a characteristic bitter taste throughout.

**Stem:** The stem is quadrangular (tetragonal), greenish-yellow, and smooth, with opposite decussate branches.

**Leaves:** Leaves are opposite, sessile, lanceolate to ovate-lanceolate, entire, and exstipulate, about 4–10 cm long. The lower leaves are smaller and broad-based, while the upper ones are narrower. The veins are 3–5 prominent and parallel, giving a distinctive appearance.

**Inflorescence:** The inflorescence is a large, many-flowered terminal panicle, usually dichotomously branched. Flowers are small, greenish-yellow, often tinged with purple.

**Flowers:** Flowers are bisexual, actinomorphic, and tetramerous (rarely pentamerous). Calyx: Gamosepalous with 4 lanceolate lobes, green, persistent.

**Corolla:** Gamopetalous with 4 petals, united at base, greenish-yellow with purple streaks; each lobe bears two nectariferous glands.

**Stamens:** 4, alternating with corolla lobes, epipetalous, anthers 2-celled, dehiscing longitudinally.

**Ovary:** Superior, bicarpellary, syncarpous; style slender, stigma bifid.

**Fruit:** A capsule, oblong, 2-valved, and septicidal, containing numerous minute seeds.

**Seeds:** Minute, ovoid, brown, with a reticulate surface, and containing a small embryo embedded in fleshy endosperm.

**Root:** Slender, yellowish-brown, fibrous, and bitter in taste.

**Flowering and Fruiting Time:** Generally occurs from July to September.

**Phytochemical Constituents:**[12]

The therapeutic versatility of Swertia chirata is primarily due to its rich phytochemical

composition. Phytochemical studies have identified several bioactive classes, including:

**Secoiridoid glycosides:** Amarogentin, swertiamarin, gentiopicroside Xanthones: Mangiferin, bellidifolin, isobellidifolin

**Flavonoids and phenolics:** Luteolin, apigenin, and phenolic acids Alkaloids and **Terpenoids:** Gentianine and swerchirin

Amarogentin and swertiamarin are thought to be the main bitter and bioactive indicators that give these substances their antibacterial and anti-inflammatory qualities. Flavonoids and xanthones further increase antibacterial activity by disrupting cell membranes and acting as antioxidants..

**Pharmacological Activity:**[13,14,15,16,17]

**Hepatoprotective and choleretic effects**

S. chirata extracts have been shown in numerous animal tests to have hepatoprotective properties against hepatic injury caused by paracetamol and other toxins. Hepatic architecture preservation, lipid peroxidation inhibition, and antioxidant enzyme regulation (SOD, CAT, and GSH) are some of the mechanisms. Mangiferin and swertiamarin are commonly identified as active hepatoprotective components.

**Antimalarial and antipyretic activity**

Numerous in vitro and in vivo results showing Plasmodium inhibition and symptomatic antipyretic effects in animal models support its traditional usage as an antimalarial. Although the majority of the evidence is still preclinical, several xanthones and secoiridoids exhibit antiplasmodial action.

**Antioxidant and anti-inflammatory effects**

In cellular models and animal investigations, crude extracts and isolated constituents (mangiferin, swertiamarin) demonstrate scavenging of free radicals and a decrease of inflammatory mediators (e.g., TNF-α, IL-6) that support traditional claims for inflammatory disorders and as a tonic.

**Antidiabetic and metabolic effects**

Extracts from S. chirata increase insulin sensitivity, improve glycemic indices, and alter enzymes that break down carbohydrates in mouse models. Modification of glucose

absorption routes and antioxidant protection of pancreatic β-cells are two suggested methods.

**Antimicrobial and anthelmintic actions**

In vitro tests of extracts against a variety of pathogens reveal antibacterial and antifungal activity; anthelmintic effects have also been documented. There are no standardized clinical data, and the activity spectrum varies depending on the extract solvent and concentration.

**Anticancer potential**

Limited in vivo antitumor studies and in vitro cytotoxicity against multiple cancer cell lines point to antiproliferative effects. Among the suggested mechanisms are cell-cycle arrest, apoptosis induction, and suppression of tumor promotion linked to oxidative stress. These results are preliminary, and more translational and mechanistic work is needed.

**CNS and analgesic effects**

Some studies report anti-nociceptive and CNS-depressant effects in animal models, potentially mediated by modulation of central neurotransmitter systems and inflammatory mediators.

**Antimicrobial Studies on Swertia chirata:**

Research has demonstrated inhibition against Pseudomonas aeruginosa, Bacillus subtilis, Escherichia coli, and Staphylococcus aureus. Additionally, fungal suppression against Aspergillus niger and Candida albicans has been noted.

**Antibacterial Activity**

Several studies have demonstrated potent antibacterial activity of S. chirata extracts against both Gram-positive and Gram-negative bacteria. Methanolic and ethanolic extracts typically show stronger inhibition zones compared to aqueous extracts.

- Gupta et al. (2011) reported that methanolic extract inhibited Staphylococcus aureus, Bacillus subtilis, and Escherichia coli with inhibition zones ranging from 15–20 mm.
- Dey et al. (2014) found comparable results, with MIC values between 125–250 µg/mL for common pathogenic bacteria.
- Khatoon et al. (2015) observed that purified amarogentin exhibited strong inhibitory action on S. aureus by interfering with DNA gyrase activity.

These findings suggest a broad-spectrum antibacterial potential of S. chirata, which may stem

from multiple mechanisms, including cell wall disruption, protein denaturation, and interference with nucleic acid synthesis.

**Antifungal Activity:** The antifungal properties of S. chirata have been comparatively less explored but remain significant.

- Bhattacharya et al. (2018) reported that ethanolic extract exhibited notable inhibition against Candida albicans and Aspergillus niger.
- Phenolic compounds and xanthones were identified as key antifungal constituents, likely disrupting fungal cell membrane integrity and inhibiting ergosterol synthesis.

**Mechanism of Antimicrobial Action:**[18,19,20]

The antimicrobial mechanism of S. chirata is multifaceted and primarily attributed to its polyphenolic and secoiridoid constituents. The following mechanisms have been proposed:

**Cell membrane disruption:** Xanthones and phenolics cause leakage of cellular contents and depolarization of microbial membranes.

**Enzyme inhibition:** Amarogentin interferes with bacterial ATPase and DNA gyrase enzymes, suppressing energy metabolism and replication.

**Nucleic acid interference:** Swertiamarin binds to microbial DNA and RNA, preventing transcription and translation processes.

**Metal ion chelation:** Polyphenolic compounds bind essential ions ($Fe^{2+}$, $Mg^{2+}$), inhibiting enzyme cofactors critical for microbial metabolism.

**Oxidative stress induction:** Mangiferin enhances reactive oxygen species (ROS) production, causing oxidative damage and apoptosis in microbes.

**Correlation Between Traditional Use and Modern Findings**

Kiratatikta's proven antimicrobial qualities closely match its traditional uses in fever, digestive infections, and skin conditions. Similar to how its contemporary medicinal activity eradicates microbial infections, its bitter and purifying character (tikta rasa) is thought to purge the body of pathogenic doshas in Ayurveda.

**Analytical and Quality Control Studies**

The phytochemical content of Swertia chirata varies depending on environmental and geographic factors, making standardization difficult. Analytical techniques like LC-MS, HPTLC, and HPLC have been developed to quantify marker chemicals, especially

swertiamarin and amarogentin. Standardized extraction procedures and quality standards must be established in order to guarantee antimicrobial potency uniformity.

**Limitations and Future Prospects:**

The antibacterial activity of S. chirata has not been confirmed by many in vivo or clinical research, despite encouraging in vitro results. Future studies should focus on clinical trials, molecular docking studies, developing nanoformulations for improved bioavailability, and isolating and structurally characterizing active molecules.

**Discussion-**

One of the most important pharmacological properties of the well-known Ayurvedic bitter tonic kiratatikta (Swertia chirata) in recent years has been its antibacterial action, which has been the subject of much research. This herb's rich phytochemical profile, which includes xanthones (bellidifolin, mangiferin), flavonoids, phenolic acid compounds, and secoiridoid glycosides (swertiamarin, amarogentin), is largely responsible for its antimicrobial properties. These compounds are known to interfere with the growth and metabolism of microorganisms. Methanolic, ethanolic, and aqueous extracts of S. chirata have been shown in experiments to have significant antibacterial and antifungal properties against strains of bacteria and fungi, including Pseudomonas aeruginosa, Bacillus subtilis, Escherichia coli, Staphylococcus aureus, and Aspergillus niger. Synergistic or adjuvant potential is suggested by the zone of inhibition seen in these trials, which frequently resembles or enhances that of conventional antibiotics.

According to current observations, Kiratatikta's krimighna (antimicrobial) and rakta shodhana (blood cleansing) properties are attributed to its tikta rasa (bitter taste) and ushna virya (hot potency) from an Ayurvedic perspective. Long before contemporary pharmacology clarified the processes, its application in skin infections, ulcers, and chronic inflammatory disorders indicates an empirical grasp of antibacterial and anti-inflammatory synergy. Limitations still exist despite encouraging results. Standardization of extracts, measurement of active compounds, and clinical validation are still required, and a large number of antibacterial investigations on S. chirata are still conducted in vitro. The repeatability of results is limited by the absence of thorough MIC (Minimum Inhibitory Concentration) and MBC (Minimum Bactericidal Concentration) profiling across a wide range of pathogens. Furthermore, there may be promising approaches to combating antimicrobial resistance through possible synergistic interactions with traditional antibiotics that have not yet been thoroughly investigated.

## Conclusion-

Both traditional use and contemporary pharmacological research support the significant antibacterial activity of Kiratatikta (Swertia chirata). The synergistic effects of bioactive substances such as amarogentin, swertiamarin, mangiferin, and xanthones are responsible for its efficacy against a broad range of bacterial and fungal infections. These substances work by interfering with the integrity of microbial cells, blocking enzyme systems, and altering reactions to oxidative stress. S. chirata is a valuable source of natural antibacterial agents and a possible complement to conventional therapy, especially in light of the global rise in antibiotic resistance. However, standardized extract formulations, dose optimization, and clinical trials to confirm efficacy and safety in humans are urgently needed for effective therapeutic application. Its antibacterial actions may be better understood with additional research that combines phytochemical profiling, molecular docking, and in vivo infection models. This would also help it become a supplemental antimicrobial resource in contemporary medicine.

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