



Review Article

A REVIEW ON *SWERTIA CHIRAYITA* (ROXB. EX FLEM.) KARSTEN: COMPARATIVE ANALYSIS OF AYURVEDIC PHARMACOLOGY, EXPERIMENTAL AND CLINICAL STUDIES

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Article Received on: 02/05/19 Approved for publication: 06/06/19

DOI: 10.7897/2230-8407.1007210

ABSTRACT

Ayurveda is holistic system of medicine which utilizes wide range of herbs occurring in nature to cure various diseases. Among them *chirayita* (*Swertia chirayita* Roxb) is one valuable herb which is used as single drug and in compound formulations for treatment of various diseases. It is also used as nutritive supplement. *Ayurveda* describes use of *chirayita* in wide range of ailments like jwar, kustha, kandu, pramehaswaasa, kaasa, aruchi, trishna, daaha, krimi, vrana etc. Modern researches have also highlighted those uses which have been described in *ayurvedic* classics. Some of them are fever, malaria, anaemia, bronchial asthma, liver disorders, hepatitis, gastritis, constipation, dyspepsia, skin diseases, worms, epilepsy, ulcer, scanty urine, hypertension. Current study attempts to compile properties and medicinal uses of *Swertia chirayita* described in *Ayurveda*, along with ethnobotanical uses phytochemical and pharmacological reports.

KEY WORDS: Chirayata, *Swertia chirayita* Roxb., phytochemicals, ethnobotanical uses, pharmacological.

INTRODUCTION

Swertia chirayita (Roxb. ex Flem.) Karsten is widely described in the *Ayurveda* classics. This herb has its own medicinal importance since it plays a significant role in the treatment of various diseases. It is used as single drug and in compound formulations. Various synonyms compiled from various ancient texts are given as Kiraatah (It grows in high altitude of Himalayas particularly in kiraata region i.e. north east), Anaaryatikta (It is a bitter herb which grows in Anaryakshetra i.e. kiraatadesh), Kaandatikta (Bitterness is present in whole plant including stem), Kiraatatikta (originating in kiraata region and is bitter in taste), Kairaata (originating in kiraata region), Bhunimba (small herb as bitter as nimba.), Raamasenaka, Haima (growing in Himalayan region).¹ Different vernacular names are Kirata (Sanskrit), Kirataka (Sanskrit), Bhunimba (Sanskrit), Kiratatiktaka (Sanskrit); Chirta (Assamese); Chirata (Bengal), Chireta (English); Kariyatu (Gujrati), Kariyatun (Gujrati); Chirayata (Hindi); Nalebevu (Kannada), Chirata Kaddi (Kannada), Chirayat (Kannada); Lose (Kashmiri), Chiraita (Kashmiri); Nelaveppu (Malayalam), Kirayathu (Malayalam), Nilamakanjiram (Malayalam); Kiraita (Marathi), Kaduchiraita (Marathi); Chireita (Oriya); Chiretta (Punjabi), Chiraita (Punjabi); Nilavembu (Tamil); Nelavemu (Telugu); Chiraita (Urdu).² Its parts used for medicinal purpose is panchanga (whole plant). Here, panchanga are phala (fruits), moola (root), pushpa (flower), kanda (stem) and patra (leaves).³

It is an erect, herbaceous, robust herb found in eastern temperate Himalayas at 1500-3000m altitude. It is found in Uttarakhand, Himachal Pradesh, Kashmir, Bhutan and in Nepal.⁴ *S. chirayita* Roxb. is herb 0.6–1.5 m tall growing annually or biennially. It has an erect stem which is around 2–3 ft long with cylindrical middle

portion and quadrangular in upper part. Stem has a prominent decurrent line at each angle. Color of stem is orange brown or purplish containing large continuous yellowish pith. Leaves are without stalks, lanceolate, arranged in opposite pairs. They are 4 cm long, acuminate, cordate at the base, sessile and five to seven nerved.⁵ The root is usually half an inch thick and simple. It is almost 7–8 cm long, yellowish, somewhat oblique, or geniculate, tapering and short.⁶ Flowers are small, numerous and tetramerous. They occur in large leafy panicles, green-yellow and tinged with purple and green or sometimes white hairs.⁷ Fruit contains 2-valved and egg-shaped capsules which have a transparent yellowish pericarp. Seeds of *S. chirayita* are dark brownish in color, numerous and very small in size.⁸

VARIOUS CLASSICAL USES OF *S. CHIRAYITA*⁹

Fever

Hot infusion of *chirayita* mixed with *dhaanyaka* leaves alleviates fever immediately.

Oedema

Paste of *chirayita* and *sunthi* destroys chronic oedema caused by three dosas.

Taking paste of *chirayita* and *sunthi* followed by intake of *punarnava* decoction removes generalised oedema.

For purifying breast milk

For purifying breast milk one should administer decoction of *chirayata*.

Intrinsic haemorrhage

Chirayata, *kramuka*, *musta* etc., separately mixed with sandal are beneficial in the disease.

Vomiting

Paste of *chirayita* mixed with equal quantity of sugar or honey checks vomiting and nausea.

Table-1: CLASSIFICATION OF S. CHIRAYITA UNDER VARIOUS GROUPS IN DIFFERENT TEXTS OF AYURVEDA¹⁰⁻²²

Samhita/ Nighantu	Gana / Varga	Reference
Charaka Samhita ^{10,11}	Tikta skandha; Stanyashodhana, Trishna nigrahan Maha kashaya	Cha.Su.4/14,4/12;Cha.Vi.8/143
Sushruta Samhita ^{12,13}	Arghvadhadi gana, Shaaka varg	Sutrasthan.38/6,46/262
Ashtanga Hridaya ¹⁴	Arghvadhadi gana	Sutrasthan.15/17
Dhanvantari Nighantu ¹⁵	Arghvadhadi gana	D.N.33-35.
Sodhala Nighantu ¹⁶	Guduchyadi gana	So.N.part-1,Guduchyadi varga121-122
Madanpal Nighantu ¹⁷	Abhayadi Varga	M.N.Abhayadi varga,143-144
Kaiyadeva Nighantu ¹⁸	Aushadhi Varga	K.N.Aushadhi varga 889-891
Bhavaprakasha Nighantu ¹⁹	Haritakyadi Varga	B.N. Haritakyadi varga ,153-155
Raja Nighantu ²⁰	Prabhadradi Varga	R.N. Prabhadradi varga 15-18
Nighantu Aadarsha ²¹	Kiraataadi Varga	Ni.A .Vol 1.
Hridayadipak Nighantu ²²	DwipaadVarga	Hr.Di.Ni.61.

Table-2: AYURVEDIC PROPERTIES (DRAVYA-GUNA) OF S. CHIRAYITA²³⁻²⁴

Rasa	Guna	Virya	Vipaka
Tikta	Laghu,Rukshya,Sara	Sita	Katu
Bitter	Light, dry	cold potency	Alkaline

Rasa: Taste appreciation of the substances by chemical receptors on tongue; sweet (madhura), sour (amla), salty (lavana), bitter (tikta), pungent (katu) and astringent (kasaya), Guna: Ten pairs of opposite or mirror image attributes; attribute or property of any substance, Virya: potency; ushna- hot, sheeta- cold, vipaka (intestinal digestion and tissue metabolism; madhura-neutral, amla- acidic, katu- alkaline).²⁵

Almost all classical ayurvedic texts have given its virya to be sita except Dhanwantari nighantu which states its virya to be anushna.²⁶In modern ayurvedic literature Dravya Guna Vigyan by Acharya P.V.Sharma²⁷ and Database on medicinal plants by CCRAS have stated its Ushna virya.²⁸

Table-3: KARMA (ACTION - PHARMACODYNAMICS) AND PRAYOGA (USES) OF S. CHIRAYITA²⁹⁻⁴⁵

Karma (Action - Pharmacodynamics)	Prayoga (Uses- Indication)	Classical references
Kapha pitta shaamak, saarak, rakta dushti and daaha naasak	Sannipaataj jwar, swaasa, daaha, kaasa, sotha, trishna, kushtha, jwar, vrana, krimi	Bhav.Prakash.Nighantu ²⁹ . Haritakyadi varga ,153-155
Sleshma pitta shaamak, rakta dushti har	Soka,arti, kaasa, trishna,jwar	Dhanwantari Nighantu ³⁰ .Guduchyadi Varga 33-35
Kapha pitta shaamak,vaata kaarak, saarak, rakta dushti har	Kustha, meha, swaasa, kaasa, trishaa, daaha, aruchi, sophha, jwar, krimi	Kaiyadev Nighantu. ³¹ Aushadhi varga 889-891
Vaata kaarak, kapha pitta har,pathya,vrana ropana	Jwar, kustha, kandu, sophha	Raj Nighantu ³² . Prabhadradi varga 15-18
Kapha pitta har,ati sara	Jwar, krimi, kustha, daaha, vrana	Priya Nighantu ³³ .Satapushpaadi varg.134
Vaatal, pitta shaamak	Sannipataj jwar, swaasa, kaasa, daaha	Madanpaal Nighantu ³⁴ . Abhayadi varga,143-144
Saarak,kapha pitta shaamak	Sannipataj jwar, swaasa, kaasa, daaha	Mahaushadh Nighantu ³⁵ Mahaushadhaadi Varga,91-92
Krimighna,Sleshmaha, mala dhvansi	Sannipaati, shulaapaha, jwar nidraapaha	Sodhal.Nighantu ³⁶ part-1,Guduchyadi varga121-122
Stanyasodhana,Trishna nigrahan	Agnimandhya, arochak, Grahani,Kamala	Charak Samhita. ³⁷⁻⁴⁰ Sutrasthan 4/12,14; Chikitsasthan15/132,137,181;7/146
Pittakaphaapahaa	Pandu, Apasmar, Unmad	Sushrut Samhita ⁴¹⁻⁴³ . Sutrasthan46/270, Uttartantra.44/28,62/35
Kapha naasak,dusta vrana vishodhan	Kandu, Prameha,Vishamjwar, Chhardi, kustha	Ashtang samgraha sutrasthan ⁴⁴ 16/11-12,Ashtang hridaya ⁴⁵ sutrasthan 15/17-18

CHEMICAL COMPOUNDS RESIDING IN S.CHIRAYITA ALONG WITH THEIR PHARMACOLOGICAL PROPERTIES⁴⁶

Amarogentin (chirantin)- It is secoiridoid glycoside, and is the most acerbic substance found. It tastes bitter even at a dilution of 1:58,000,000 and can be procured from, Swertia chirayita. It acquires Topoisomerase inhibition, chemo-preventive and antileishmanial effects.

Amaroswerin- It is a Secoiridoid glycoside collected from Swertia chirayita Roxb. and found to be gastro-shielding.

Gentianine - A sullen, translucent monoterpene alkaloid, obtained from several plant species of family Gentianaceae including Swertia chirayita Roxb. It possesses anti-inflammatory, anesthetic antihistaminic, anticonvulsant properties. And also having hypotensive, antipsychotic, lenitive, diuretic, antimalarial, antiamebic and antibacterial properties.

Swerchirin- A medicinally foremost xanthone, obtained from several plants of family Gentianaceae including Swertia chirayita Roxb.; having antimalarial, hypoglycemic, hepatoprotective, pro-heamatopoitic and weak chemo preventive pharmacological effects.

Swertiamarin- A Secoiridoid glycoside obtained from *Swertia chirayita* (Roxb ex. Flem) Karst; having analgesic property.

Xanthones- Over all Xanthones are important bioactive constituent present in the drug which shows CNS down regulation in mice and rats.

Mangiferin- This compound, which is isolated from chirayita species possesses strong anti-inflammatory activity in arthritic mice, and accounted for lowering down TNF-alpha, IL-1beta, IL-6, and IFN-gamma and up regulation of IL-10 in the joint homogenates of mice. It is also found to be a strong chemoprotective agent.

Lignan- A lignan (syringaresinol; a negligible fraction of herb) which is hepatoprotective in nature, and the ubiquitous β sitosterol are also present

Triterpenoids - Chirayita also contains triterpenoids namely; swertanone, swertenol, episwertinol, gammacer-16-en-3 β -ol, 21- a-H-hop-22(29)- en-3 β -ol, taraxerol, oleanolic acid, ursolic acid, swerta-7, 9(11)-dien-3 β -ol, pichierenol. Among them swertanone has got the anti-inflammatory property. Taraxerol and oleanolic acid are found to be analgesic and emollient respectively. Ursolic acid has anti-inflammatory, chemoprotective and anti-microbial activities.

Pentacyclic triterpenoids- A class of pentacyclic triterpenoids also belongs to this herb including β -amyrin, friedlin, chiratenol, kairatenol, oleanolic acid, ursolic acid. Among them kairatenol is found to be hypoglycemic in nature.

Table-4: FOLKLORE USES OF *S.CHIRAYITA* (KIRAATATIKA)⁴⁷

Plant part used	Traditional uses
Whole plant	Used in several traditional and indigenous systems of medicines, such as Ayurveda, Unani, and Siddha
Whole plant	Used in British and American pharmacopeias as tinctures and infusions
Root	Serves as a drug and an effective tonic for general weakness, fever, cough, joint pain, asthma, and the common cold
Whole plant	Leaves and chopped stems are soaked overnight in water. A paste is prepared and filtered with 1 glass of water. This preparation is given once a day for 2-3 days in headaches and blood pressure.
Whole plant	For fever with tremor, whole plant cut into small pieces is boiled in 1/2 L of water until the volume is reduced to less than half glass. The filtered water is stored in a glass bottle and half spoon is given to children once a day for 2 days and for adult 1 spoon once in a day for 2 days or varies to three times a day until cured.
Whole plant	Boiled in water and one cup of decoction is taken orally to cure malaria
Whole plant	Paste of the plant is applied to treat skin diseases such as eczema and pimples
Whole plant	Liver disorders; stomach disorders like dyspepsia and diarrhoea, intestinal worms
Whole plant	Hiccups and vomiting, ulcers, gastrointestinal infections, and kidney diseases
Whole plant	Used in combination with other drugs in cases of scorpion bite.
Whole plant	Used in excessive vaginal discharge

PHARMACOLOGICAL ACTIVITIES AND CLINICAL CORRELATIONS

Antipyretic activity

S.chirayita is mentioned to treat jwar by various ayurvedic texts.[Table 3]. It is used traditionally to treat fever.⁴⁷The aqueous extract of *Swertia chirata* Buch Ham. Root (ASC) (Family: Gentianaceae) was evaluated for its antipyretic potential on Brewer's yeast induced pyrexia in albino rats and Typhoid-Paratyphoid A, B vaccine induced Hyperexia in rabbits. In both models, the extract, at dose of 200 mg kg⁻¹ body wt. and 400 mg kg⁻¹body weight, produced significant (p<0.001) reduction in elevated body temperature in a dose dependent manner. The antipyretic effect of the extract was comparable to that of paracetamol (150 mg kg⁻¹body weight, p.o.), a standard antipyretic agent.⁴⁸

Analgesic and Anti-Inflammatory Activities

S.chirayita is described to be pitta shaamak, sophahar in various Ayurvedic texts. [Table 3] Pharmacological screening of ethanolic root extract of *Swertia chirata* was chosen for analgesic and anti-inflammatory activities in animal models. For assessing anti-inflammatory activity carrageenan-induced rat paw edema model was used. The analgesic effect was measured using the acetic acid-induced writhing test and the radiant heat tail-flick method in rats. In the acetic acid-induced writhing test in mice, the extract at 200 and 400 mg/kg doses level showed 41.76% (p<0.001) and 58.29% (p<0.001) inhibition of writhing, respectively. In rat paw edema model induced by carrageenan, the extract was found to reduce significantly (p<0.001) the formation of edema at the 400 mg/kg dose level. It showed 57.81% (p<0.001) inhibition of edema volume at the end of 3 h. In radiant heat tail-flick method, the root extract produced 43.88% (p<0.001) and 64.81% (p<0.001) increase in reaction time 30 min after oral administration at the 200 and 400 mg/kg doses level,

respectively. The results signify the traditional uses of *Swertia chirata*, for inflammation and pain.⁴⁹

Blood Sugar Lowering Activity

S.chirayita is described to be useful in Prameha in various Ayurvedic texts [Table 3].Ninety five percent ethanol extract of *Swertia chirata* (Buch-Ham) was fed to healthy albino rats consisting of fed, fasted and glucose loaded models. Significant blood sugar lowering effect was observed in these models. *Swertia chirata* (Buch-Ham) fed orally caused enhancement of the blood sugar lowering effect of tolbutamide in healthy albino rats.⁵⁰

Protective effect in gastric ulcers

S.chirayita has been described as useful in agnimandhya, arochak, grahani separately and in the form of various formulations in Ayurveda. [Table 3] The effect of *S. chirayita* has been studied on experimentally induced gastric ulcers in rats. The ethanolic extract of chirata significantly reduced the intensity of gastric mucosal damage induced by indomethacin and necrotizing agents. It produced a significant decrease in gastric secretion in pylorus-ligated rats. The extract inhibited acetylcholine-induced contraction of guinea pig ileum, suggesting its anti-cholinergic activity. Pre treatment of rats with the extract significantly prevented ethanol-induced gastric wall mucus depletion and restored the non-protein sulphhydryl (NP-SH) content in the glandular stomachs. These findings support the use of chirata for the treatment of gastric ulcers in traditional medicine.⁵¹

Anticarcinogenic activity

The present study reports the anticarcinogenic activity of *Swertia chirayita* Roxb., an Indian medicinal plant. All the four detoxification enzymes studied viz, GST, GPx, SOD and CAT were found to be activated in different degrees following treatment with infusion of *Swertia chirayita* Roxb., its crude extract and a purified 'Amarogentin' rich extract. The activation

of the enzymes was accompanied by significant reduction in lipid peroxidation and inhibition of incidence as well as multiplicity of Dimethylbenz(a)anthracene (DMBA) induced papillomas. The effect of *S.chirata* (Buch-Ham) on apoptosis and cell proliferation was also studied in mice skin exposed to DMBA. Both the crude and purified extracts significantly inhibited cell proliferation and induced apoptosis. This is the first report of its kind and the observation suggests the chemopreventive potential of *Swertia chirayita* Roxb.⁵²

Antihepatotoxic activity

S.chirayita has been described as useful in kamala and pandu in the form of various formulations in Ayurveda [Table 3] The methanol extract of *Swertia chirayita* Roxb. was evaluated for antihepatotoxic activity against carbon tetrachloride induced liver toxicity in experimental rats. The extract was found to be active and on fractionation into butanol soluble and chloroform soluble fractions, the activity was traced and found more profound in the chloroform soluble fraction. The butanol soluble bitter rich fraction showed marginal activity. The results based on biochemical estimations have been expressed statistically and are additionally supported by histopathological examination of the liver of experimental rats and pentobarbitone induced sleep time studies in mice.⁵³

Antiviral activity

Krimighna property of *S.chirayita* is described in various texts of Ayurveda.[Table 3]The antiviral activity of *Swertia chirata* (Buch-Ham) was tested against Herpes simplex virus (HSV) type-1, using multiple approaches both at cellular and molecular level. Cytotoxicity, plaque reduction, virus infectivity, antigen expression and polymerase chain reaction (PCR) assays were conducted to test the antiviral activity of the plant extract. *Swertia* plant crude extract (1gm/mL) at 1:64 dilution inhibited HSV-1, plaque formation at more than 70% level. HSV antigen expression and time kinetics experiments conducted by indirect immunofluorescence (IFA) test, revealed a characteristic pattern of small foci of single fluorescent cells in *Swertia* extract treated HSV-1 infected cells at 4 hours post infection dose, suggested drug inhibited viral dissemination. Infected cell cultures treated with *Swertia* extract at various time intervals, tested by PCR, failed to show amplification at 12, 24-72 hours. HSV-1 infected cells treated with Acyclovir (antiviral drug) did not show any amplification by PCR. In this preliminary study, extract of *Swertia chirata* (Buch-Ham) showed antiviral properties against Herpes simplex virus type-1.⁵⁴

Anticholinergic activity

The ethanolic extract of *S.chirata* (Buch-Ham) showed anticholinergic activity.⁵⁵

Antimalarial activity

S.chirayita is described to be used in sannipataj jwar and visham jwar by various Ayurvedic texts.[Table 3] Swerchirin a tetraoxygenated xanthone from *S.chirayita*(Buch-Ham) was tested for antimalarial activity by Goyal *et al.* Compound was proved to be effective even at 1/5 of standard dose primaquine by both oral and subcutaneous routes. The drug is effective at both oral and subcutaneous routes. The drug is effective at both the routes i.e at 1.6 mg/kg and 320 micro gm/kg by reaching nil parasitaemia in infected rats.⁵⁶

Antimicrobial activity

Krimighna property of *S.chirayita* is described in various texts of Ayurveda.[Table 3] *S.chirayita* (Buch-Ham) extracts are more active against gram positive than against gram negative bacteria. They were inactive against all the fungi.⁵⁷

CNS depression activity

S.chirayita is used for the treatment of soka, artipasmara, unmad.[Table 3]Alcohol and water extracts of *S.chirata* (Buch-Ham) showed that it possesses CNS depressant activity. Higher dose produced CNS depression without loss of reflexes.⁵⁸

Anti oxidant activity

S.chirayita is used for the treatment of kasa (cough) and swasa (asthma), which is described in various texts of Ayurveda[Table 3]. *Swertia chirayita* Roxb. extract-SCE exhibited strong antioxidant ability invitro. The liver and kidney of CCl₄-intoxicated animals exhibited a significant ($p < 0.001$) decrease in SOD, CAT, and GSH levels. Additionally, these organs exhibited a significant ($p < 0.001$) increase in MDA level. CCl₄ did not exhibit toxicity on mice treated with SCE and Vitamin E. The effects of *Swertia chirayita* (three dosages) were comparable to those of Vitamin E, except in MDA level in the liver and GSH level in the kidney ($p < 0.05$).This study suggests that the ethanolic extract of *Swertia chirayita* Roxb. possessed in vitro and in vivo antioxidant effects.⁵⁹

Anti-hepatitis B virus activity

Krimighna property of *S.chirayita* is described in various texts of Ayurveda.[Table 3] Four new compounds swertiachiralatone A (1), swertiachoside A (2), swertiachirdiol A (3) and swertiachoside B (4), together with twenty-six known ones were isolated from the ethanol extract of *Swertia chirayita* Roxb. Their structures were elucidated by extensive spectroscopic analyses (1D- and 2D-NMR, HRESIMS, UV, IR and [α]_D). All compounds were evaluated for anti-hepatitis B virus (anti-HBV) activities on HepG 2.2.15 cells line *in vitro*, of which compounds 14 and 19 showed inhibitory activity on hepatitis B surface antigen (HBsAg) secretion with IC₅₀ values of 0.31 ± 0.045 and 1.49 ± 0.033 mM; compounds 14 and 28 exhibited activity against hepatitis B e antigen (HBeAg) secretion with IC₅₀ values of 0.77 ± 0.076 and 5.92 ± 1.02 mM; and eight compounds (8,9,13,14,24-26,29) possessed activity against HBV DNA replication with IC₅₀ values of 0.07–0.33 mM. In particular (+)-cycloolivil-4'-O- β -d-glucopyranoside (14) exhibited inhibition not only on the secretions of HBsAg and HBeAg with IC₅₀ values of 0.31 ± 0.045 mM (SI = 4.29) and 0.77 ± 0.076 mM (SI = 1.75), respectively, but also on HBV DNA replication with an IC₅₀ value of 0.29 ± 0.034 mM (SI = 4.66).⁶⁰

CONCLUSION

Swertia chirayita Roxb. has been widely described in Ayurveda texts. Due to its wide pharmacological properties and therapeutic uses it has been popularly used in various diseases since ancient time. Modern pharmacological researches have also revealed a range of promising biological compounds which have wide range of medicinal properties. The pharmacological actions of *S.chirayita* in Ayurvedic texts have been validated by a wide range of modern evidence suggesting that this drug has immense potential in modern pharmacotherapeutics.

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Cite this article as:

Sapkota Sabita et al. A review on *Swertia chirayita* (Roxb. Ex Flem.) Karsten: Comparative analysis of Ayurvedic pharmacology, experimental and clinical studies. *Int. Res. J. Pharm.* 2019;10(7):15-20 <http://dx.doi.org/10.7897/2230-8407.1007210>

Source of support: Nil, Conflict of interest: None Declared

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