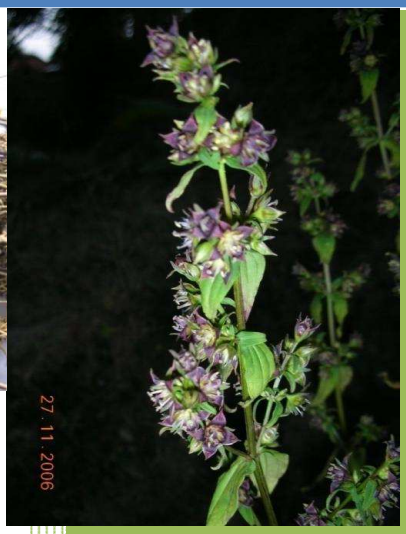
2011

Quality Standard, Good Agricultural and Collection Practice *Swertia chirayita* (Roxb. ex Fleming) Karsten



Government of Nepal
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Department of Plant Resources
Thapathali, Kathmandu, Nepal

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Introduction

Swertia chirayita (Eng. Chiretta) is a valuable medicinal plant of Nepal having multiple influences on environment, biodiversity, rural economy and health. Nepal is the leading supplier of Chiretta to the world markets sharing about 45 percent of the international trade (Joshi and Dhawan 2005). Although many closely related species are traded in the name of Chiretta, the species in demand is *Swertia chirayita* that constitutes about 80% of the traded volume in the country. About 90% of the Chiretta produced in the country are exported including 80% to India and variable quantities to other countries including China, Sweden, Holland, Malaysia, Singapore, Germany, Italy, France, Switzerland, Sri Lanka, Bangladesh, Pakistan, USA and many others (Phoboo *et al.* 2008). The domestic market consumes only 5-10% of total production. Government royalty rate for the plant is NRs. 15/kg (ESON 2009).

Due to its increasing commercial demand and price in the international markets, over-harvesting and unscientific collection of Chiretta has been taking place in Nepal that has contributed in rapid depletion of this species from its natural habitat. It has exerted adverse effects on the local biodiversity, environment and rural livelihood. In Nepal, *Swertia chirayita* has been categorized as 'vulnerable' species based on the IUCN Threat Categories - version 3.1 (Bhattarai *et al*. 2001). Recently, as a result of demonstrations, training and capacity building efforts done by various governmental, non-governmental and international organizations involving local

collectors and producers throughout the country, the scenario has improved and cultivation practices have evolved to supplement wild collections at many places.

Many community forests, especially in the eastern hill districts have been conserving and managing the species in the wild, including enrichment plantations in its natural habitats. Likewise, many farmers have started its cultivation on their private land as well.

Currently the community forest user groups and local farmers in far west Nepal including districts like Doti, Dadeldhura, Baitadi and Darchula have considered Chiretta as one of the viable medicinal plant in terms of local livelihood enhancement. Seedling production in community-managed nurseries, cultivation and enrichment plantation in community forests and cultivation on private land has been the established trend in far west Nepal. Chiretta, thus produced, is being traded through community-owned and community-managed non-timber forest product-based cooperatives, benefiting the community forest user group members and local farmers alike (Personal communication: CFC/ICIMOD/HNCC project on Medicinal Plant in Far-west Nepal)

But the safety and quality of raw medicinal plant materials and finished products depend on genetic, environment, collection, cultivation methods, harvest, post-harvest processing, transport and storage practices etc. Inadvertent contamination by microbial or chemical agents during any of the production stages can also lead to deterioration in safety and quality. Therefore, it has been felt necessary that detail information on the species, especially its good

agricultural and collection practices, post-harvest procedures and quality standards be documented for wider dissemination to facilitate all the related stakeholders for the identification, conservation, cultivation, and trade of the highly valuable Nepalese medicinal plant species.

1. Plant Identity

Scientific name:	*Swertia chirayita (*Roxb. ex Fleming) Karsten
Synonym:	*Swertia chirata* (Wall.) C.B.Clarke; *Gentiana chirata* Wall.; *Gentiana chirayita* Roxb. ex Fleming; *Gentiana cherayta* Roxb; *Agathotes chirayta* D.Don ex G.Don; *Ophelia chirata* Griseb.
Family	Gentianaceae
English name	Chiretta
Vernacular name /Local name	Chirata (Hindi), Chirayito (Nepali), Tite, Tikta (Amchi), Tikta, Katu tikta (Sanskrit), Khalu (Newari), Ranka (Magar), Sung Khimba (Limbu), Timda (Tamang), Tento (Gurung), Tigta (Sherpa).
Trade name	Chiretta
Indian Pharmacopoeial Name	Chiretta

2. Parts Used Whole plant including leaves, stem bark and root.

3. Uses

Medicinal uses

Chiretta is used in different codified systems of traditional medicine, such as Ayurveda, Unani, Homoeopathy, Siddha, Amchi and many other folk herbal traditions and local healing systems mainly as a tonic, febrifuge and laxative. The use of this drug has been mentioned in the Charak Samhita, *Susrutha Samhita, Bhava Prakash Nighantu, Drabya Guna Sangraha* and many other codified Ayurvedic literature as 'Kirata-tikta' i.e. the bitter plant of the Kiratas. Its usage has been recorded in the Indian Pharmaceutical Codex, and the British and American Pharmacopoeias. In the Tibetan system of traditional medicine, chirata is used to relieve various problems related with bile and to relieve fever (Arya 1998).

Chiretta has been a popular broad spectrum herb. All parts of the plant including leaves, flowers, stem and roots are used in medicine. It is used for numerous purposes including as a bitter tonic, to increases appetite, to control malarial and other types of fever, hepatitis, inflammation, burning sensation during urination, etc. (Bista and Bista 2005). It is also used to relieve bronchial asthma, common cold, pain and body aches, to purify blood, to improve eye sight. It is also used to control vomiting during pregnancy, and many other gynecological problems including menorrhegia and leucorrhoea (Kirtikar and Basu 1993), to relieve various types of skin diseases including eczema and scabies, to expel intestinal worms and treat jaundice. The stem of Chiretta in combination with

other drugs is prescribed in the treatment of snake-bite and scorpion stings but it is not considered an antidote to snake or scorpion venom (Kirtikar and Basu 1993; CSIR 1989).

Other uses

The plant extract is used for imparting bitter taste to liquors, in flavoring animal feeds, and extracting a yellow dye (Bhattarai 2001).

Pharmacological properties

Plant juice is said to have the liver-protection properties. Swerchirin, one of the constituents of Chiretta is said to lower the blood sugar level (Saxena *et al*. 1991). Its ether extract has been attributed to antibacterial and anti fungal properties (Devkota *et al*. 1999).

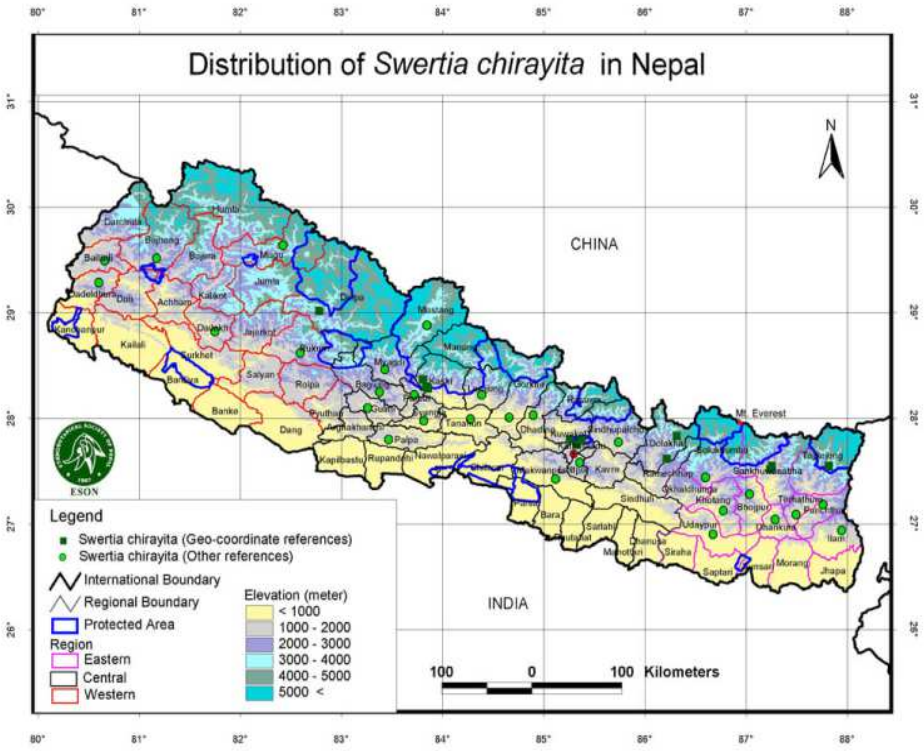
Ayurvedic drugs and preparations

The common Ayurvedic drugs containing Chiretta are Chandrapravavati, Sudarshan Churna, Rohitkyadic Churna, Kiratatiktaghanvati, Trisaptak Churnam, Pittaghavata, Panchabhadra Quath, Kiratadi Quath, Phalatrikadi Quath, etc.

4. Distribution

Chiretta is endemic to the Himalaya. It is distributed from Kashmir to Nepal, Bhutan and North-East India. It is usually found on hill slopes in sub-tropical to temperate zones throughout Nepal between altitudes of 1200-3000m (Baral and Kurmi, 2006). It has been

reported from 40 districts, 14 zones and 5 development regions of the country. It has also been widely known to occur in cultivated field margins as well in many parts of the country (Bhattarai and Acharya 1998).



Map 1. Distribution of *Zanthoxylum armatum* in Nepal (ESON 2009)

4.1 Ecological Characteristics

In nature, Chiretta mostly occurs in open places and hill slopes under *Rhododendron* and *Quercus* forests (Phoboo *et al*. 2008). Its occurrence depends on altitude, gradient, moisture and humus content of its habitat. It prefers north facing slopes descending to 1500m at places. However, it grows on south facing slopes as well

between 1500m and 3000m altitudes. In general, 2000m altitude is the most preferred range of its distribution (Bhattarai and Shrestha, 1996). Associated species of the plant are *Anaphalis* spp., *Bidens* spp., *Eupatorium grandiflorum, Centella asiatica, Viola* spp., *Polygonum amplexicaule, Rhododendron arboreum, Quercus* spp. *and Acer* spp. (Phoboo *et. al.* 2008).

4.2 Major Production Areas

Considerable production in the wild has been reported to occur in about 40 districts of Nepal which has been fulfilling the regional and international demands. The major Chiretta producing districts are Sankhuwasabha, Terathum, Dhankuta, Ilam, Taplejung, and Panchthar in east Nepal, where as in central Nepal they are Rasuwa, Ramechhap, Dolakha, Sindhupalchok, Gorkha, Sindhuli, and Makwanpur, while Rolpa, Dolpa, Salyan, Achham, Dadeldhura, Doti and Achham are the major producing districts in western Nepal (Phoobo and Jha 2010).

5. Characteristics of the Plant

5.1 Morphological Characteristics

The plant is an erect biannual herb, about 60-125cm tall with robust branching in later stage. In the first year, the plant develops as rosette form and in the second year develops elongated flowering and fruiting branches in course of its growth-cycle. Root somewhat twisted, 5-10cm long, 1-2 cm in diameter, gradually tapering

downwards, solid, light brown to purple brown in color. Leaves simple in opposite pairs, united at base by a transverse stipular line, sessile or sub-sessile, ovate, elliptic, 3-5 nerved, 2-3x1.3-2.5cm, radical leaves larger than the cauline. Flower small, bisexual, 0.5cm across, pale green tinged purple in large panicles, numerous in dense corymbose cyme, pedicels 2.5-13mm long, bracts fallacious, lanceolate, 3-nerved, calyx 8mm long, tube about 1.25mm long, lobes lanceolate, acute with a strong mid vein, petals 4, white, each petal lobe broadly ovate, shortly acuminate with a pair of elongated fringed green glands. Fruit a capsule ca. 0.6cm, ovoid. Seeds are small, numerous (Bhattarai and Ghimire 2006; DPR 2007).

Flowering season: July - September.
Fruiting season: October - November.

6. Characteristics of the Drug Material

6.1 Diagnostic Feature of the Crude Drug

Macroscopic

The stem with root forms the major portion of the drug. In the market, the dry stems, about 90cm long, come in bundles of about 5 kg each. The diameter of the stem is about 0.8-1.5cm, brown or purplish brown with continuous, easily separable dark colored pith. The drug is odorless but has a strong bitter taste. The whole plant is medicinal but the root is said to be the most effective part. The root is pale brown, somewhat twisted in the upper part and tapered

downwards. The dark colored stem with large continuous pith and intensely bitter taste has been the characteristic feature of the raw material.

Microscopic

Root: Cork 2-4 layered, secondary cortex 4- 12 layers of thick walled parenchymatous cells, secondary xylem, lignified, and thick walled vessel and tracheids with scalariform thickenings and bordered pits. Minute acicular crystals in secondary cortex and phloem. Stem: Endodermis distinct showing anticlinal or periclinal walls. Stele: amphiphloic, siphonstele, xylem tracheids and fibers with few vessels, mostly single or rarely in groups of two; medullary rays absent, prominent intercellular space in pith.

Leaf: Anisocytic type of stomata present on the lower epidermis. Palisade tissue single layered. Spongy mesophyll 4-1 layers of loosely arranged elongated cells. Mucilage present in epidermal and mesophyll cells. Minute acicular crystals found abundantly in mesophyll cells.

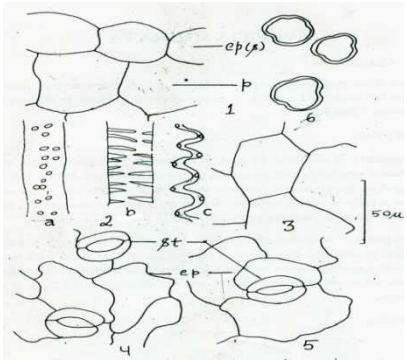


Fig 1. Microscopic features of powdered drug
1. Epidermal cell of stem with parenchyma; 2. Vessels ; 3. Upper epidermal cell of leaf; 4. Fragment of lower leaf showing anomocytic stomata; 5. Fragment of lower epidermis showing anisocytic stomata; 6. Pollen; a. pitted; b. reticulate; c. spiral; ep. Epidermal cells of leaf; ep(s). epidermal cell of stem; p. parenchyma; st. stomata.

Powdered drug Dark brown, vessels with bordered pits, reticulate and spiral thickenings, fragments of

epidermal cells of stem with parenchyma, dorsiventral leaf, upper epidermis with straight anticlinal walls, lower epidermis with wavy anticlinical walls, stomata anomocytic and anisocytic, pollen 25 µ in diameter, spherical 3 prores (Rajbhandary *et al*. 1995)

7. Preferred Growing Conditions

Soil/Climatic Conditions

In the wild, Chiretta prefers moist and fertile soil on the north and west facing slopes rather than south facing slopes which is true in case of its cultivation as well. Chiretta grows well in black sandy soil rich in organic matters and acidic with pH 4.5-5.5 and adequate soil moisture. Water-logging has been observed harmful.

8. Methods of Cultivation

8.1 Vegetative propagation

It has been reported that Chiretta can be propagated from tender leaves, stem cuttings as well as root cuttings treated with root growth hermone like 'rootex'. The cuttings under suitable climatic and edaphic factors initiate rooting after about two weeks. However, the usual method of propagation has been from the seeds. Transplantation of small plants from wild are also practiced.

8.2 Propagation by seeds

Although seeds can also be spread directly in the field for propagation, field experiences have revealed that the seedlings

produced this way are not uniformly distributed and needs excessive transplantation and management. Also, the growth pattern and maturation period of the plants are not uniform under this technique. Hence, propagation from seedlings developed in nursery is considered better as well as economical.

Seed collection The flowers are pollinated by bees (Khoshoo and Tandon 1963). The fruits mature in October-November. Seeds collected during this period are found to germinate well showing up to 90% germination. The germination percentage will be lower in seeds collected before or after this period. Also, the viability of seeds decreases with time and are useless after one year of collection. Seeds are collected from fully matured plants by uprooting the whole plants and by drying them on clean paper or cloth. Plants are shook 2-3 times. Then seeds are strained from appropriate mess. Such seeds again dried for 24 hours in 25-35° c and stored in airy muslin pouch.

Nursery The seedlings should be raised in propagators or in nursery beds. March-April has been found the most suitable season for seed sowing and the most favorable season for its germination are the months of May and June (Barakoti 2000; Bhattarai and Basnet 2000).

Seeds soaked in water for 12-24 hours are found to reduce germination period considerably and the optimum temperature of 24

° C has been found to be most suitable for its germination (Bhattarai and Ghimire, 2006; Ghimire *et al*. 2008).

The nursery beds, 1m wide with appropriate length, should be raised 50cm above ground. Then, a 5cm thick layer of soil is added to the bed prepared by mixing finely sieved soil, sand and cow-dung or compost in equal proportions. For uniform dispersal, the seeds should be mixed with fine sand in a ratio of 1:100 by volume. Generally, 1gm of the seeds contains about 40000 seeds which are adequate for 2 square meters of the nursery bed. After sowing the seeds, the nursery bed should be thinly covered with straw and sprinkled with water. The bed should be protected from sun or rain with thatch or polythene shed. Germination initiates after 2 weeks that continues for 6 week (Ghimire *et al*. 2008). Transplanting the seedlings in polythene bags should be done at four leaved stage, or after 2-3 weeks of germination, i.e. when the seedlings are 3-4 cm tall. Six to eight-leaved stage or about 8-10 cm tall seedlings are suitable for transplantation in the field. It is suggested to keep the small seedlings in the nursery bed or polythene bags for the next season (Bhattarai and Ghimire 2006; Kunwar 2006)

8.3 Land Preparation

As Chiretta grows better in the altitude range of 1800-2700m, the selection of land for cultivation should be within this range. To avoid water logging, slightly sloppy land should be preferred to flat land with no outlet. North and west facing slopes are preferred for their comparatively moist and humid environment. The plantation

site should be far from areas with a hazardous condition like contaminated with heavy metal, chemical agent and other industrial waste (WHO 2003).

The plantation site should be tilted well. In case of barren land, weeds and other plants are slashed and burned and then made into ridge and furrows, alternatively. The land should be well drained and irrigated. If the land is steep, 10-15cm deep furrows should be prepared for transplanting the seedling. After this, well prepared compost/cow-dung (250gm/plant) should be applied during plantation supplemented by additional 250 gm/plant in the next year.

8.4 Plantation

Fertilizer and manure should be mixed thoroughly with the soil and irrigated well before planting the seedlings. The seedlings should be planted in rows with a distance of 30-40cm between two plants and 40-50cms between two rows. Soil around the plant should be gently pressed to fix the plant. One hectare of land needs about 80,000-100,000 seedlings (4000-5000 plants/ ropani).

8.5 Direct Seed Sowing in the Field

On flat land For the uniform sowing, seeds should be mixed with sand or fine soil and sown in the well prepared cultivation site directly in a linear fashion or uniformly spread all over the land. Due to very small size of the seeds, this method has been found better in terms of germination than sowing in lines.

On slopes Horizontal furrows of 1.5 cm depth should be prepared on the slopes across the land. The distance between two furrows should be about 45cm. Seeds mixed with enough quantity of fine sand should be sown in these furrows. Then mulching with straw should be done to provide shade and retain the moisture. Seeds may germinate on the land between furrows as a result of dispersal. In such case, thinning should be done during the rainy season when the plants will be at 5-6 leaved stage and transplanted on furrows having sparse population.

By coating on the slopes Seeds can be coated on wall of terrace field. After proper weeding and scrapping other plants, a dilute mixture of adequate quantity of the seeds, cow-dung and water should be coated over the slope or sprayed with a sprayer and covered with straw till seedlings come out. Thinning should be done at 4-6 leaved stage (when the plant is 7-10cm tall) and transplanted in other appropriate site.

9. Management

9.1 Irrigation

As Chiretta cannot grow well in dry habitat, the cultivated field should be frequently irrigated during dry months (November-April) depending upon the dryness of the soil. Controlled irrigation during cold months (December, January) may also be needed. Water for

irrigation should be devoid of contaminants from domestic animals and human wastes (WHO 2003).

9.2 Thinning and Weeding

Weeding will be needed at an interval of 3-4 weeks during wet or rainy season and the interval may be increased considerably during the dry or winter season. Weeding and hoeing to loosen the soil for better aeration should be done alternately. The crop may need 10-12 times weeding and hoeing in course of its two year life cycle. The crop will be ready for harvest after 20-24 months of plantation.

9.3 Manuring

Two doses of 250gm of fully rotten compost/cow-dung compost per plant or 25 ton / hectare should be applied -the first dose during land preparation and second dose during hoeing in May-June of the second year (Bhattarai and Ghimire 2006).

9.4 Disease and Pest Control

The common diseases found in Chiretta are *Cercospora* leaf spot, *Fusarium* wilt, etc. Infection by stem borer is reported in eastern region. To minimize damages due to these diseases, healthy seeds and seedlings should be used with proper weeding and irrigating with clean water should be done. Organic pesticide and herbicides should be used if necessary.

10 Harvesting and Post-harvest Procedures

Harvesting is done normally after 2 years of plantation. The mature plants are harvested with 2-years rotation cycle from different blocks of its habitat for sustainability. The ideal time to harvest Chiretta for medicinal and commercial purposes is just before fruit initiation which is mostly during October-November. During this period, the active principle content in the plant is high. The highest percentage of bitter principle was found in the inflorescence part followed by the leaves and the roots (Joshi 2003). Morning time is ideal for harvesting. The whole plant is uprooted to harvest the roots as well. It has been reported that the roots also contain high proportion of medicinal ingredients. Harvested crop should be unpacked as soon as possible. It should not be allowed to stand for extended period and on direct sunlight. Harvesting tools should be clean and well maintained. Damaged and spoiled crop material should be sorted and discarded. After harvest, the roots should be freed of soil, and the plants are covered with a thin cloth or plastic sheet for drying. The dried plants with intact leaves fetch high price, hence attempts to retain leaves as much as possible should be done. The dried crop should be tied in bundles and stored in dry and well-ventilated storehouse. Plastic sack should not be used as container for storing. Only jute sacks should be used. Sacks should not be over filled to prevent from composting the material (Bhattarai and Ghimire 2006). After complete drying, the material should be stored in dry and well ventilated room with minimum risk of contaminants (WHO 2003).

11 Regeneration

In addition to rotational harvesting to assure sustainability, the resource sites should be strictly protected from grazing, fire, flood, landslide, etc.

In nature, regeneration of the plant takes place by seeds. During the optimum harvesting period (October-November), the fruits may not be mature enough; hence the seeds might be of inferior quality. Therefore, in both wild and cultivated areas, some scattered plants should be left undisturbed in the field until December or even January when the fruits fully mature with good quality seeds. These may be collected for propagation in the farm or allowed to disperse in the wild. Generally only 70% of mature plants are harvested for sustainability.

12. Expected Yield

The yield of Chiretta is about 2000-3000 kg/ha (100-150kg/ropani) of plants that can be expected from cultivation as shown by field-based research done in Pakhribas Agricultural Research Centre, Dhankuta district (Barakoti 2004).

13. Quality standards

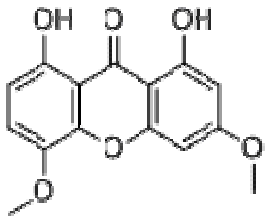
About 90% of the Chiretta collected and /or produced in Nepal are exported in crude forms. Information on quality standard of the raw material is the most vital tool to extend and strengthen market

linkages. Therefore, in order to make the best possible use of current market demands and the growing quality consciousness of the importers/users, Nepalese Chiretta must include information on different aspects of its quality in relation to the internationally accepted requirements.

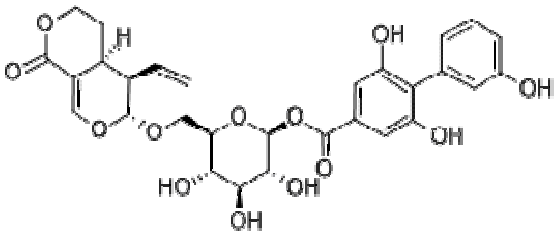
Chemical constituents

Plant contains amarogentin and amaroswerin as major component. Other constituents are amaroswerin, arechiratol, chiratanin, chiratin, chiratanin, chiratinol, chiratol decussatin, gentiopicrin, methyl bellidifolin 7-0-methylswertianin, magniferin, swerchirin, swertenol, swertianin, swertinin, sweetenol, swertiamarin, and alkaloids like enicoflavine and gentianine, and ophalic acid (DPR 2007).

Chemical structure of major bitter constituents



Swerchirin



Amarogentin

TLC identify test: Extract the powdered plant material with 50 ml methanol on a water bath at 80^0C for 4 hours. Filter, evaporate filtrate under vacuum. Dissolve residue in 50 ml water. Partition with hexane 50 ml two times each, then with chloroform 3x50 ml and butanol 3x50 ml, each time taking aqueous layer for next

partition. Evaporate butanol fraction under vacuum and dissolve the residue in 2 ml methanol (Anonymous, 2002).

Standard solution: Dissolve 1mg each of amarogentin and amaroswerin in 1 ml methanol.

Solvent system: ethyl acetate: methanol: Water (21.3: 2.2: 10.5)

Visualization of spots; spray the plate with fast Red salt reagent;

Evaluation: under day light : spots corresponding to amarogentin Rf 0.5 and amaroswerin Rf 0.44 are visible as dark red zones in both reference and test solution trickles. These spots are absent from adulterants, viz. *S. purpurescens, S. alata, S. cordata, and S. paniculata.*

Assay / Analytical Methods

HPLC: Column: µ Bondapak C_{18} (30 cm x 3.9 mm)

Mobile phase: methanol: water: 45: 55

Flow rate: 1.0 ml/min

Detection: UV at 235 nm.

Standard preparation: Prepare a solution containing known concentrate of amarogentin (conc. Range: 10 – 180 µg/ ml) in methanol.

Sample preparation: extract 3g of powdered plant material with 50ml methanol on water bath for 4 hrs. Filter and evaporate the filtrate under reduced pressure and dissolve the residue in 50ml distilled water. Extract water layer with hexane (2x50ml), then with

chloroform (3x50ml) followed by Butanol (3x50ml). Evaporate the combined butanol extract under reduced pressure and dissolve residue in 2ml methanol and make up the volume to 20 ml with methanol. Prepare further dilution as necessary (Anonymous, 2002).

Procedure: Subject known volume of (5µl) standard and sample preparations to HPLC and record the respective peak areas for amarogentine and amaroswerin in triplicate and accordingly calculate their percentage in extracts.

:

Quality Standard based on WHO - Quality control method for medicinal plant materials (Anonymous, 2002; GoI 1996; GoI 1989; Kapoor 2001).

- Foreign matter — less than 2 %
- Moisture content — less than 10 %
- Total ash — less than 4
- Acid insoluble ash — less than 2.5
- Water extractive value — greater than 10
- Alcohol extractive value — greater than 4.5
- Total crude fiber — less than 50
- Total crude fat — less than 3
- Total bitter principle — greater than 2

Features of quality crude Chiretta are as follows:

- Reddish brown not black in color;

- Extremely bitter in taste that differentiate it from other species and adulterants;
- Adequately dried material with high brittleness;
- Free of fungi, molds and their spores/mycelia.

14. Adulterants and Substitutes

Adulterants: *Swertia chirayita* being a commodity with high demand and price, the raw material in trade has been subjected to high degree of adulteration. The Chiretta samples collected from 27 trading centres of Nepal revealed that most samples happened to be a mixture of or adulterated with one or more of the 8 species of *Swertia* in varying proportions (Bhattarai and Acharya 1998). The common *Swertia* species used as adulterant were as follows:

1. *Swertia alata* (Royle ex D. Don) C.B. Clarke
2. *Swertia angustifolia* Buch.-Ham. ex D. Don
3. *Swertia ciliata* (D.Don ex G. Don) B.L. Burtt
4. *Swertia dilatata* C.B. Clarke
5. *Swertia multicaulis* D.Don
6. *Swertia nervosa* (G.Don) C.B. Clarke
7. *Swertia racemosa* (Griseb.) C.B. Clarke
8. *Swertia tetragona* Edgew.

Substitutes: Substitutes in Chiretta is mostly done in case of Chiretta-based medicinal preparations. Major substitutes are *S. angustifolia* Buch.-Ham. ex D. Don and *S. nervosa* (G. Don) C.B. Clarke. *Andrographis paniculata* (Burm.f.) wall. Ex Nees containing

the bitter principle andrographolide is largely considered as a substitute (Phoboo and Jha 2010).

15. Cultivation Calendar

• Seed collection	November-December
• Seed sowing for nursery	February-March
• Seed sowing in the field	March/April
• Transfer seedlings in polythene bags	6-8 leaved stage (Oct-Nov)
• Plantation in the field	May/June and July/August
•	Manuring During plantation and second year (April-Oct)
• Irrigation	As per required.
•	Weeding 2-3 months in winter, 3-4 weeks in summer/rainy season
•	Harvest October (after 20-24 months of plantation when the fruits are mature)

In compliance with recommendation of GACP, its collection, cultivation and management should be regularly monitored by producers and buyers' representatives with expertise in hygienic agricultural practices.

16.Economics of cultivation per hectare (modified from Barakoti 2004)

S. No.	Description	Unit	Quantity		Rate NRs	Budget in NRs.	
			1st year	2nd year		1st year	2nd year
1	Seedlings	No	100,000	20,000	2	200,000	40,000
2	Compost	Kg	25,000	20,000	2000	50000	40,000
3	Labourer						
	Site clearing	MD	75		300	22500	
	Land preparation	MD	200		300	60,000	
	Composting	MD	100		300	30,000	
	Plantation	MD	200	50	300	60,000	15,000
	Weeding	MD	150	100	300	45,000	30,000
	Harvesting /Post harvesting	MD		50	300		15,000
	Storage	MD		40	300		12000
4	Agricultural materials	Lump sum				15000	
	Total					482,500	152,000
	Grand Total						634,500
5	Production	KG		2500	300		7,50,000
	Profit						115500
	Contingency				5%		31725
	Net Profit						83,775

MD= Man days

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