

HANDBOOK OF PHARMACOGNOSY

(Medicinal Plants in Nepal)

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Thapathali, Kathmandu, Nepal
2018

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Thapathali, Kathmandu, Nepal

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ISBN: 978-9937-0-4163-8

Front cover photo: From top left in clock wise direction.

Dactyloriza hatagirea (R. Tamang)
Leaf anatomy of *Azadirachta indica* (C. Khanal)
Dry stem of *Ephedra gerardiana* (C. Khanal)
Spiral vessel in powder microscopy of *Curculigo orchioides* (C. Khanal)

Back cover photo: Compound microscope (C. Khanal)

Published By:

Natural Product Research Laboratory
Thapathali, Kathmandu, Nepal

Foreword

Department of Plant Resources (DPR) has been facilitating in identification of plant samples through National Herbarium and Plant Laboratories (NHPL) Godavari, and Pharmacognosy section of Natural Product Research Laboratory (NPRL) since its establishment.

This hand book of pharmacognosy is an initiative to enhance the field of pharmacognostical research of medicinal plants of Nepal. It has covered taxonomical description, anatomical study, organoleptic characters and powder microscopy of commercially used parts of 30 medicinal plants of Nepal. This book is stepping stone towards development of quality standards of medicinal plants of Nepal.

This book has played a pioneer role in initiating pharmacognostical study of medicinal plants of Nepal. This book is mainly focused on the qualitative characters. Never-the-less, pharmacognostical studies should also encompass quantitative field since both qualitative and quantitative data of a particular plant part are essential for identification and authentication of substituents or adulterants. This, in turn, will help in development of quality standards of medicinal plants and ultimately support in trade. I hope that, in future, apart from updating of the informations present in this edition, our research team will expand the boundaries of this book to include more qualitative/quantitative parameters and also other economically significant medicinal plants in trade.

I am grateful to Ms. Chetana Khanal (Assistant Research Officer, NPRL), Ms. Sangeeta Swar (Planning Officer, DPR) and Ms. Usha Tandukar (Scientific Officer, DPR) for their efforts in manuscript preparation. I would like to congratulate Natural Product Research Laboratory and its whole team for this publication. I would also like to thank Ms. Jyoti Joshi Bhatta, Deputy Director General, Department of Plant Resources and Mr. Devi Prasad Bhandari, Chief of Natural Product Research Laboratory for their support to authors. Finally, I would like to thank all team members for their tireless effort to generate this book and hope that such endeavours will continue in future.



Sanjeev Kumar Rai
Director General
Department of Plant Resources

Acknowledgement

We would like to express our gratitude to Mr. Sanjeev Kumar Rai (Director General , Department of Plant Resources), Ms. Jyoti Joshi Bhatta (Deputy Director General, Department of Plant Resources), Mr. Devi Prasad Bhandari (Chief, Natural Product Research Laboratory) for their kind support, valuable suggestions and encouragement .

We would also like to acknowledge Ms. Sreejana Maharjan (Former: Assistant Research officer) for her contribution on microscopic analysis of some plants, Mr. Rajeshwor Ranjitkar(Assistant Research Officer), Pradipika Acharya (Assistant Research officer) for their kind support . We are also thankful to Mr. Hem Raj Poudel, Mr. Ganga Datta Bhatta, Mr. Tirtha Raj Pandey and Ms. Rita Chhetri (Assistant Research Officers,NHPL) for identification of some plants.

We would also like to thanks Mr.Sanjeev Kumar Rai (DG, DPR) Mr. Rajesh Tamang, Mr. Chandra mohan Gurmachhan, Ms Kalpana Sharma and Mr. Dammar Saud for providing some habit photos.

We are equally thankful to Mr. Govinda Gautam, Ms. Ganga Rijal and Ms. Sarita Yadhav (Pharmacognosy unit, Natural Product Research Laboratory) for assisting during lab analysis.

We would also like to thank Mr. Nanda lal Maharjan , Sunita Chaudhari, Rupa Luitel and Menuka Bhandari for their help in drying plant materials and making powder.

Finally we extend our gratitude to all the staff of Natural Product Research Laboratory and all those who were directly or indirectly involved in our work.

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Abbreviation

DDG	-	Deputy Director General
DG	-	Director General
DPR	-	Department of Plant Resources
NHPL	-	National Herbarium and Plant Laboratory
NPRL	-	Natural Product Research Laboratory
TS	-	Transverse Section
VS	-	Vertical Section

Introduction to Pharmacognosy:

In the nineteenth century, the term "Materia Medica" was used for the subject now known as "Pharmacognosy". A German scientist, C.A. Seydler while studying Sarsaparilla coined the term "Pharmacognosy" in 1815 in the title of his work "Analecta Pharmacognostica". He was referred to as the father of pharmacognosy. *Materia Medica* is a book with a records of about 600 kinds of crude drugs written by Dioscorides, a Greek doctor in about 77 AD. The book had played an important role in pharmacology and botany.

Work of Galen (131-200 A.D): Galen was Greek pharmacist he worked on the extraction of chemical constituent from the plants. He developed various methods of extraction therefore the branch of pharmacy which deals with extraction of chemical constituent from plants and animals is called as *Galenical Pharmacy*. Hippocrates (460-360 B.C). He was Greek scientist worked on human anatomy and Physiology particularly on circulatory system and nervous system. He prepared famous oath for physicians, which is still taken by the physicians. He is known as father of medicine.

In the suktas of Rigveda and Atharwa veda, about 5500 years old decribed medicinal property of plant. The old Ayurveda Books, Charak samhita and Sushrut samhita described many medicinal plants.

Pharmacognosy term is comes from two Greek words "pharmakon mening drug or medicine, and gnosis" meaning knowledge.

Pharmacognosy is "the study of physical, chemical, biochemical and biological properties of drugs, drug substances or potential drugs or drug substances of natural origin as well as the search for new drugs from natural sources".

Pharmacognosy is the study of medicinal uses of various naturally occurring drugs and its history, sources, distributions, method of cultivation, active constituents and adulterants.

Plant preparations are said to be medicinal or herbal when they are used to promote health beyond basic nutrition. The study of drugs from plants includes the subjects of botany, chemistry and pharmacology. Botany includes the identification (taxonomy), genetics and cultivation of plants. Chemical characterization includes the isolation, identification and quantification of constituents in the plant materials. Pharmacology is the study of the biological effects that the chemicals in medicinal plants have on cell cultures, animals and humans practical perspectives as follows: Quality control (identify, purity, consistency), Efficacy (therapeutic indications, pharmacological investigations), Safety (adverse reactions, drug interactions, contraindications, precautions)

Drug discovery from natural products have played and continue to play an invaluable role as sources of drugs or lead compounds in the prophylaxis and treatment of diseases.

Scope of Pharmacognosy:

Pharmacognosy as an applied science has played a crucial role in the development of different disciplines of science.

Pharmacognosy gives a sound knowledge of the vegetable drugs under botany and mineral drugs under zoology. It also includes plant taxonomy, plant breeding, plant pathology, plant genetics and by this knowledge one can improve the cultivation methods for both medicinal and aromatic plants. Plant chemistry (Phytochemistry) has undergone significant development in recent years as a distinct discipline. This includes a variety of substances that are accumulated by plants and synthesized by plants. The technology involving extraction, purification, and characterization of pharmaceuticals from natural sources is a significant contribution to the advancement of natural and physical sciences. The knowledge of chemotaxonomy, biogenetic pathways for formation of medicinally active primary and secondary metabolites, plant tissue culture and other related fields is essential for complete understanding of pharmacognosy. The basic knowledge of biochemistry and chemical engineering is essential for development of collection, processing and storage technology of crude drugs.

Pharmacognosy is an important link between Pharmacology and Medicinal Chemistry. The knowledge of Pharmacology is essential for understanding action of drugs on animals and the human system. Pharmacognosy is the infrastructure on which depends evolution of novel medicines, as it is seen that several crude drugs are utilized for preparation of galenicals or as sources of therapeutically significant substance that cannot be synthesized economically. Further, the crude drugs also provide essential intermediates for final synthesis of active compounds. Phytopharmaceuticals or synthetic drugs derived from phytochemicals have to be ultimately incorporated in suitable dosage form which involves the knowledge of dispensing and preparative pharmacy, pharmaceutical technology and analysis.

In a nutshell, Pharmacognosy is an important bridge between the pharmaceutical and basic sciences. Pharmacognosy is a vital link between ayurvedic and allopathic systems of medicines. It provides a system where in the active principles of crude drugs derived from natural origin can be dispensed, formulated and manufactured in dosage forms acceptable to allopathic system of medicine.

Note: Microscopic photos included in this book are taken in different magnification power.

अपमार्ग (Apamaarga), उल्केकुरो (Ultekuro)

Scientific name : *Achyranthes aspera* Linn.

Family : Amaranthaceae

Other names : Prickly chafflower plant (Eng), Chirchita (Hind), Apamarga (Sans)

Description of plant:

A herb with 30 – 90 cm tall, quadrangular branches thickened just above the node. Leaves simple, short petioled, opposite, velvety tomentose, 10 – 12 cm long and 7.5 cm wide, rounded at the apex, elliptic, ovate or orbicular. Inflorescence axillary or terminal spike. Flowers small, greenish white. Fruits capsule, orange to reddish purple or brown. Plant is pungent (Medicinal plants of Nepal, 2016).



Plate 1: Habit photo
(photo ©: R. Tamang)

Flowering and fruiting : June - July

Parts used : Whole plant

Uses:

Plant is pungent, purgative, diuretic, and used in dropsy, piles, boils, skin eruptions, colic, and snake bite. Infusion of roots is astringent (Medicinal plants of Nepal, 2016).

Chemical constituents:

Root contains ecdysterone and oleanoleic acid. Seeds yield saponins- saponin A dimethyl ester and saponin B methyl ester and oleanoleic acid and its ester (Husain *et al.*, 1992). Plant yields an alkaloid- achyranthin. 4-methylheptatriacont-1-en-10-ol, 2-tetracontanol and 27cyclohexylheptacosan-7-ol are also reported from this plant (Watanabe *et al.*, 2005).

Distribution in Nepal: East to West, 600 to 1800 m.

Macroscopic characters:

Leaf and stem:

Stems are cylindrical, branched, solid, hairy and yellowish-brown in color. Leaves are of opposite, petiolate, decussate, elliptic-obovate, acute with decurrent base. Dried leaves are yellowish green above and pale green below, midrib is raised below and flat above. Petiole is cylindrical. The adaxial surface is smooth and slippery unlike the abaxial side (Plate 2).



Plate 2: Dried stems and leaves

Organoleptic characteristics:

Powder is greenish in color, slight characteristic odor and does not have any characteristic taste.

Microscopic characters:**Anatomy of stem:**

Stem is cylindrical, 5-10 prominent ridges. Epidermis is single layered, covered by thick cuticle having uni-seriate, 2-3 celled trichomes. Cortex 4-8 layered, composed of parenchymatous cells, most of them containing calcium oxalate crystals (Plate 3a and b).

Pericycle is a discontinuous ring of lignified fibers. The cortical zone is wide with uniform width, vascular tissues show anomalous secondary growth having incomplete ring of xylem and phloem, cambial strip present between secondary xylem and phloem, vessels scalariform, spiral and pitted. The pith is wide having oval to polygonal parenchymatous cells (Quality Standards of Indian Medicinal Plants, 2013, Vol.11).

Powder microscopy:

Powder contains acicular fibers, collenchymatous cells, rosette shaped calcium oxalate crystals, scalariform and spiral vessels (Figure 3 a,b,c,d,e and f). Uniseriate, multicellular trichomes, thin walled cork cells and many starch grains are also found.

Photo plates

Anatomy

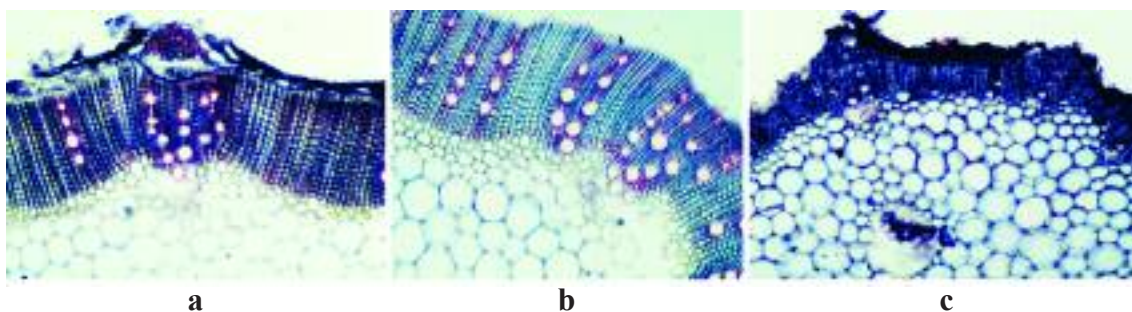


Plate 3: TS of Stem of *Achyranthes aspera* a) and b) Section showing outer region c) Section showing vascular bundle.

Powder analysis

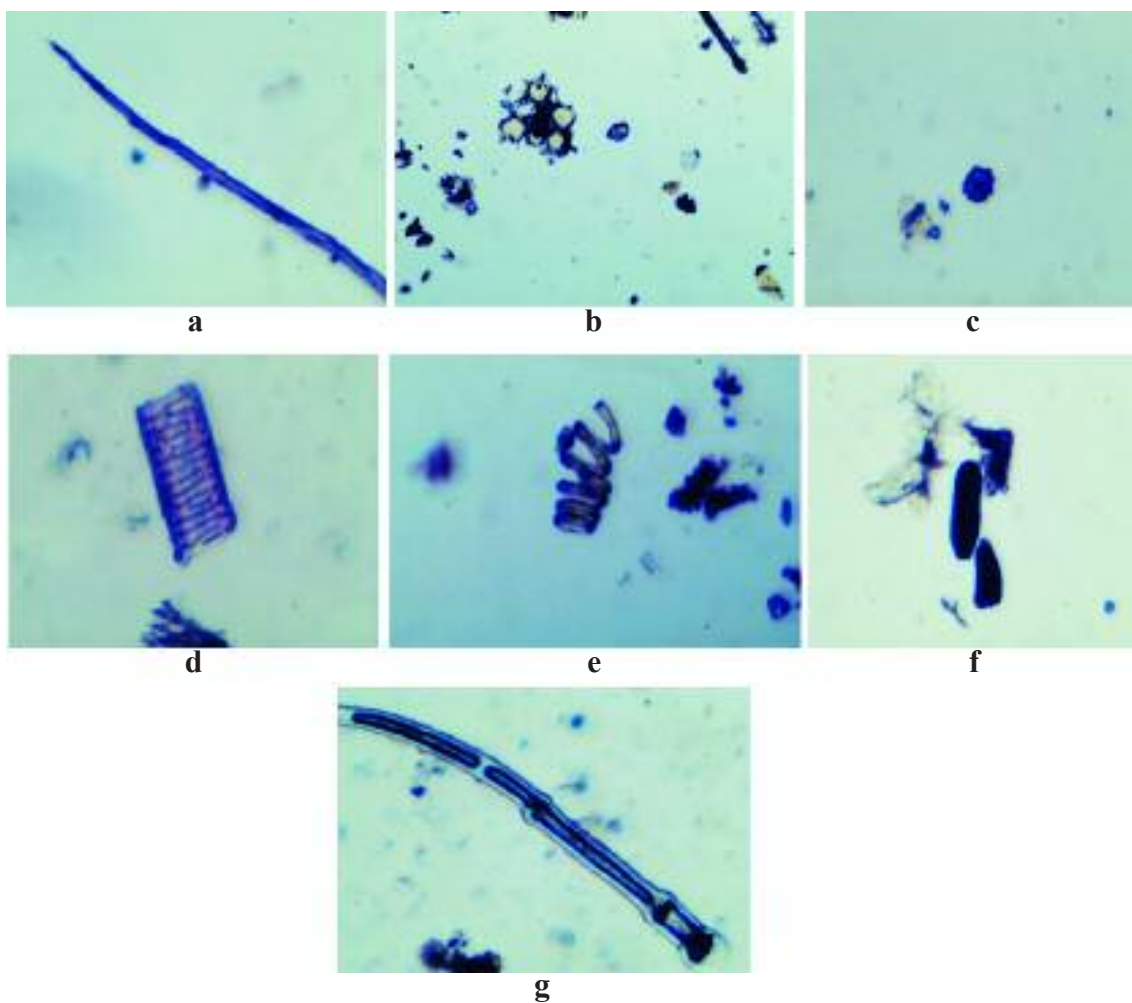


Plate 4: Powder characteristics of *Achyranthes aspera*. a) Acicular fiber b) Collenchymatous cells c) Rosette crystal d) Scalariform vessel e) Spiral vessel f) Starch grains g) Trichome.

अतीस (Atees)

Scientific name : *Aconitum heterophyllum* Wall. ex Royle

Aconitum cordatum Royle

Family : Ranunculaceae

Other names : Atis root (Eng), Atis (Hind), Atibisha (Sans)

Description:

A herb 1 m tall with tuberous roots. Roots biennial, paired, cylindrical, oblong. Leaves 5 – 10 cm long, acute or obtuse, cauline leaves sharply toothed, lowest long petioled, lanceolate. Inflorescence raceme, flower is more than 2.5 cm long, bright blue to greenish blue with purple veins (Medicinal plants of Nepal, 2016).



Plate 5: Habit photo
(photo ©: S. K. Rai)

Flowering and fruiting : July - August

Parts used : Root

Uses:

Roots are antiperiodic, aphrodisiac, astringent, tonic, and useful in diarrhea, dyspepsia, and cough (Medicinal plants of Nepal, 2016).

Chemical constituents:

Roots give alkaloids- heterophyllisine, heterophylline, heterophyllidine, atidine, benzoylheteratisine, heteratisine, atisine and hetisine (Husain et al., 1992). heterophyllinine-A, heterophyllinine-B, dihydroatisine and lycoctonine (Nisar et al., 2009)

Distribution in Nepal: West and Central, 2800 – 3700 m.

Pharmaceutical notes:

It is available in powder and tablet form. Some of the formulations available in the market are Amritarista vatsayadi, Atibisadi churna, Balachaturbhadra Churna, Chandanadi Churna, Chandraprabha Vati, Pushyanuga Churna and Rohitakadi Churna (<http://eson.org.np/database/index.php>).

Conservation status:

It is endangered species according to IUCN category. (<http://www.iucnredlist.org/search>)



Plate 6: Dried roots

Note: It is also included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

Dried tuberous root is conical, fusi form or cylindrical, smooth and longitudinally wrinkled. Tubers are marked with few whitish scars of rootlets. Externally it is yellowish to grayish in color and fracture short and starchy (Plate 6).

Organoleptic characteristics:

Powder is grayish brown in color, odorless and taste is slightly bitter.

Microscopic characters:

Anatomy of Root:

Transverse section of root shows the outermost cork consisting of one to three layers of suberized thick-walled cells (Plate 7a). In the mature root often getting detached partially and completely. Underneath this lies five to ten rows of parenchymatous cells of the cortex (Plate 7a). A layer of endodermis encircles the wide secondary phloem, which is embedded with scattered groups of sieve tissues.

A ring of four to nine concentric vascular bundles are embedded in the inner ground tissues of the phloem, consisting of primary xylem elements in the center flanked by radiating rows of secondary xylem elements forming somewhat v-shaped structure, enclosing xylem parenchyma and is surrounded by a ring of three to four rows of cambium and phloem tissues (Indian Council of Medical Research 2010, Vol 4). Small parenchymatous pith lies in the centre (Plate 7c). Abundant simple and compound starch grains of various sizes are present throughout the parenchymatous cells of the section.

Powder microscopy:

Shows abundant simple and compound, spherical starch grains scattered as such or embedded in the parenchymatous cells (Plate 8e). Fragments of longitudinally cut reticulate xylem vessels (Plate 8c and d), suberised cells of the cork in surface view and rosette of crystals (Plate 8a and b).

Photo plates

Anatomy

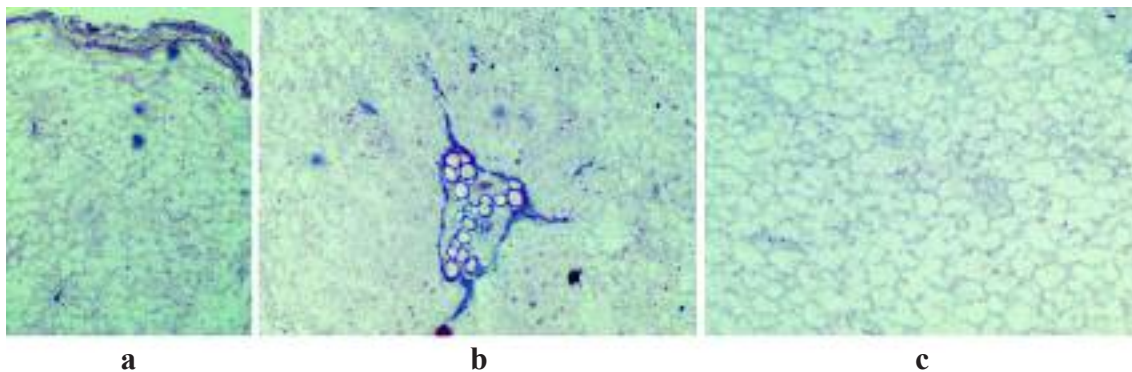


Plate 7: TS of root of *Aconitum heterophyllum* a) Section showing cork and cortex b) Section showing vascular bundle c) Section showing pith region.

Powder analysis

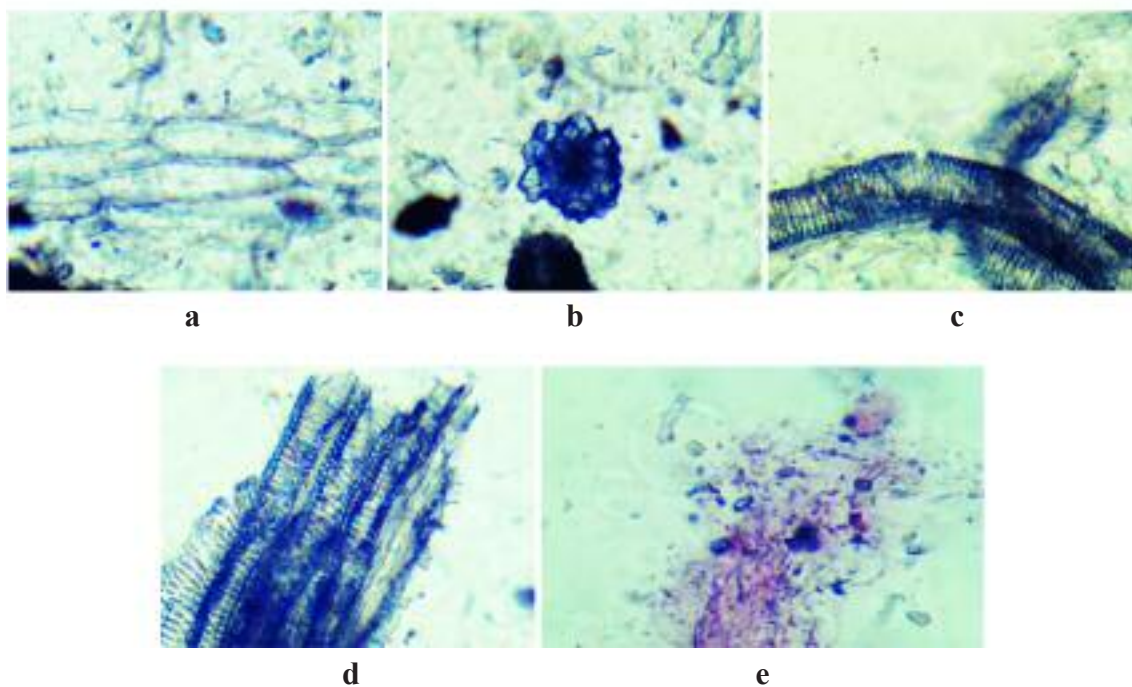


Plate 8: Powder characteristics of root of *Aconitum heterophyllum*. a) Cork cells b) Crystal c) and d) Vessels e) Starch grains

बोझो (Bhojo)

Scientific name : *Acorus calamus* L.

Acorus verus (L.) Raf..

Family : Acoraceae

Other names : Sweet flag (Eng), Bach, Ghorbach (Hind), Vacha, Ugragandha (Sans)

Description:

A rhizomatous herb growing on marshy places. Rhizomes sub-cylindrical, 2-10 cm long, 0.5-2 cm broad, dark brown, surrounding with zig-zag root scars, leaf scars and hair like fibres. Leaves bright green, 15-25 cm long and 0.2-0.5 cm broad, ensiform with distinct midrib. Inflorescence cylindrical spadix, flowers small, yellowish green in color (Medicinal plants of Nepal, 2016).



Plate 9: Habit photo (photo ©: R. Tamang)

Flowering and fruiting : June-July

Parts used : Rhizome

Uses:

The rhizome is aromatic, carminative, emetic, anthelmintic, expectorant, antispasmodic and nerve tonic. It is used in dyspepsia, colic, remittent fevers, diarrhoea, dysentery, bronchial and chest affections (Medicinal plants of Nepal, 2016).

Chemical constituents:

Rhizome and root afford an essential containing β -asarone as major constituent and calamene, calamol, asarone, camphene, α -pinene and asaronaldehyde as other constituents (Srivastava et al., 2006). β -caryophyllene, tatarine A and C also reported from the rhizome (Watanabe et al., 2005).

Distribution in Nepal: East to West, 500-2300 m.

Pharmaceutical notes:

It is available in the powder, liquid, tablet and decoction form. Some available preparations are Sarswat churna, Ashwagandharista, Sanjivani Vati, Chandraprabha Vati and Saraswati Churna (<http://eson.org.np/database/index.php>).

Conservation status:

It is least concern species according to IUCN category (<http://www.iucnredlist.org/search>)

Note: It is also included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

Dried rhizome pieces are sub-cylindrical, occasionally bent at places, straight, slightly compressed, 5-15cm in length and 1-2cm in thickness, covered with thin corky skin and adherent triangular shriveled scaly withered leaf bases visible clearly, encircle the upper surface. Lower surface shows irregularly placed elevated circular tubercular root scars, fracture short, fractured surface somewhat spongy, minutely porous and light buff in color (Plate 10).



Plate 10: Dried rhizomes

Organoleptic characteristics:

Powder is pale brown in color, odor aromatic, taste is slightly acrid to pungent and bitter.

Microscopic characters:

Anatomy of Rhizome:

Transverse section of rhizome shows an outer layer of epidermis covered with thin cuticle (Plate 11a). Few thin-walled cells of cork developed underneath it, followed by 3 to 4 rows of collenchymatous hypodermis. A wider zone of parenchymatous cortex embedded with starch grains, isolated oleo-resin cells and concentric vascular bundles which are very few in number towards the peripheral region.

Vascular bundles are oval to spherical in shape, showing centrally located phloem encircled by a ring of xylem vessels and pericyclic fibers (Plate 11c). A layer of endodermis is separating the cortex and stellar region (Plate 11b). Parenchymatous ground tissue of the stellar region is very wide and embedded with similar type of vascular bundles but those lying underneath the endodermis are smaller in size and are devoid of fibers. Parenchymatous cells of the stellar tissue are also embedded with oleo-resin cells and starch grains (Quality Standards of Indian Medicinal Plants, 2012, Vol.10).

Powder microscopy:

Shows transversely cut fragments of cortical parenchymatous tissue embedded with oleo-resin cells (Quality Standards of Indian Medicinal Plants, 2012, Vol.10). Many small sized starch grains, longitudinally cut thin walled fibers, parenchymatous cells, reticulate vessels (Plate 12a to e).

Photo plates

Anatomy

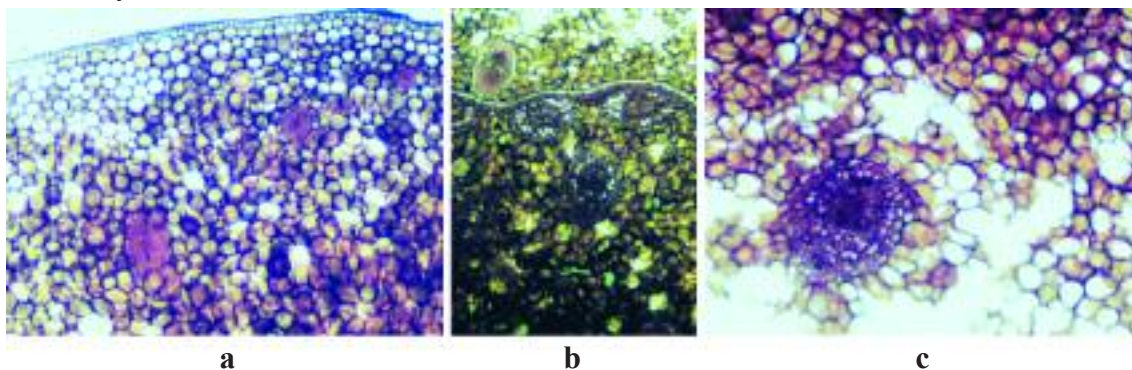


Plate 11: TS of rhizome of *Acorus calamus* a) Section showing epidermis and cortex b) Section showing endodermis and vascular bundle c) Section showing vascular bundle in stellar region.

Powder analysis

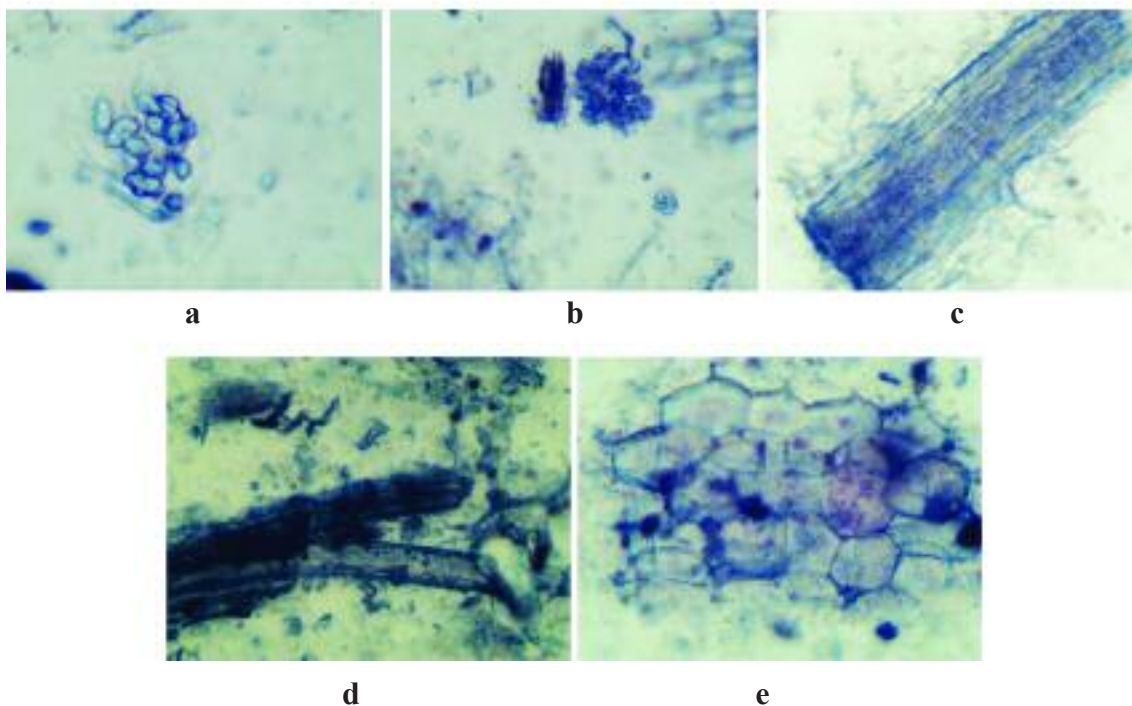


Plate 12: Powder characteristics of rhizome of *Acorus calamus*. a) and b) Starch grains c) Fiber d) Vessels e) Parenchymatous cells.

छतिवन (Chhatiwan)

Scientific name : *Alstonia scholaris* (Linn.) R. Br.

Family : Apocynaceae

Other names : Devil's tree, Ditta bark tree (Eng), Chhatiwan (Hind), Saptaparna (Sans)

Description:

A large evergreen tree is up to 25 m tall with milky latex. Leaves simple, nearly sessile, 4 – 7 in whorls, 10-20 cm long, leathery, elliptic-oblong, coriaceous. Inflorescence is umbellate panicles, flowers small, greenish white, strongly scented. Fruit is 30 – 60 cm long, narrow, slender, hanging in pairs and forming a dense cluster, follicle (Medicinal plants of Nepal, 2016).



Plate 13: Habit photo (photo ©: R. Tamang)

Flowering and fruiting : March – April

Parts used : Bark, leaves and milky exudates.

Uses:

The bark is useful in fever, malarial fever, diarrhoea, dysentery, leprosy, skin diseases. The poultice of tender leaves is useful in ulcers with a foul discharge. The milky exudate is good for ulcers (Medicinal plants of Nepal, 2016).

Chemical constituents:

The plant gives alkaloids - echitamine, Nb-demethylechitamine, akummicine, its Nb-oxide and Nb-methiodide, echitamidine, tubotaiwine, pseudoakuammigine, picrinine, strictamine, akuammidine, tetrahydroalstonine, narelone, ditamine and picralinal. Leaves give betuline, ursolic acid and β -sitosterol. Bark contains lupeol acetate and amyryl (Husain *et al.*, 1992). Dichloromethane leaves extract of *Alstonia scholaris* (L.) R. Br. yield erythrodiol, uvaol, erythrodiol, betulin, oleanolic acid, ursolic acid, $\hat{\alpha}$ - amyryl acetate, $\hat{\alpha}$ -amyryl acetate, $\hat{\alpha}$ -sitosterol, stigmaterol, squalene, $\hat{\alpha}$ -sitosteryl-3 $\hat{\alpha}$ -glucopyranoside-6'-> O-fatty acid esters, chlorophyll a (Consolacion, *et al.*, 2016).



Plate 14: Dried barks

Distribution in Nepal: East to Central, 100 – 300 m.

Macroscopic characters:

Young bark curved, channeled or occasionally quill or double quill, externally very rough, longitudinally and transversely fissured, rusty gray, marked with transversely elongated white lenticels, thick cork often getting exfoliated with an exposer of cream colored cortex (Plate13).

Organoleptic characteristics:

Powder is brown color, odor mild and pleasant, taste is persistently bitter and gritty.

Microscopic characters:**Anatomy of Bark:**

Transverse section of matured bark shows multilayered, 80 to 150 rows of stratified cork (Plate15a) consisting of rectangular, suberized cells alternating with many layered squarish, lignified, pitted, radially arranged thick walled cells containing prismatic crystals of calcium oxalate.

Cork cambium is 1 to 2 layered, secondary cortex made up of parenchymatous tissue containing abundant simple starch grains and prismatic crystals of calcium oxalate, and laticiferous canal (Plate15b) and stone cells (Plate15d) of various size, shape and thickness forming groups of 2 to 20. Occasionally stone cells is running in the form of bands, associated with idioblast containing prismatic crystals, non-lignified fibers isolated or in groups of 2 or rarely 3 to 5 traversed throughout the cortex (Quality Standards of Indian Medicinal Plants, 2005, Vol.3).

Powder microscopy:

Shows fragments of stratified cork cell, occasionally containing prismatic crystals of calcium oxalate, stone cells oval to spherical found isolated or in group. Pitted parenchymatous cells, abundant starch grains, rhombic crystals, latex canal cells and medullary rays are also seen (Plate 16).

Photo plates

Anatomy

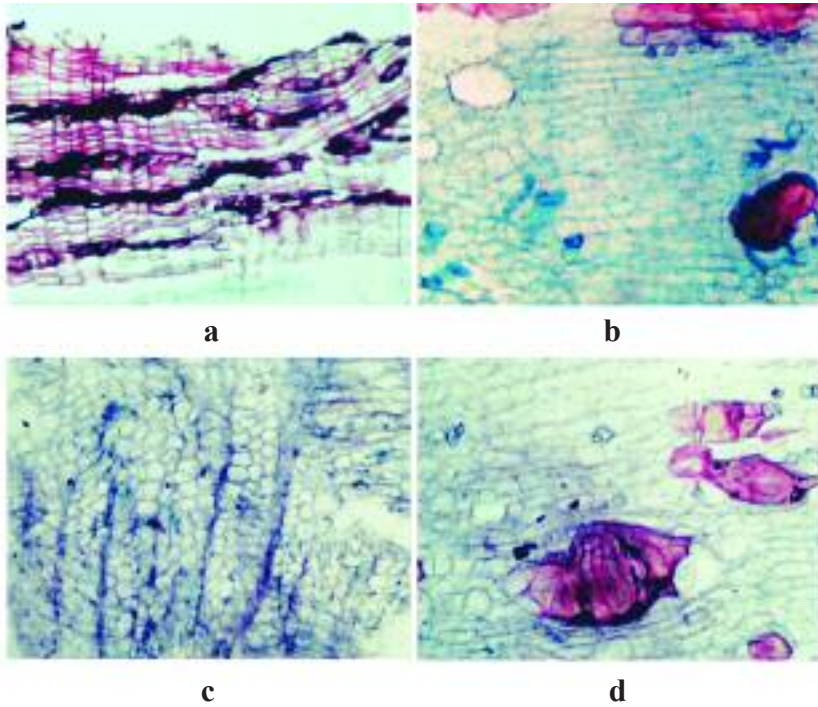


Plate 15: TS of bark of *Alstonia scholaris* a) Section showing Cork cells b) Section showing Cortex with latex canal c) Section showing Phloem region with medullary rays d) Section showing cells with stone cells.

Powder analysis

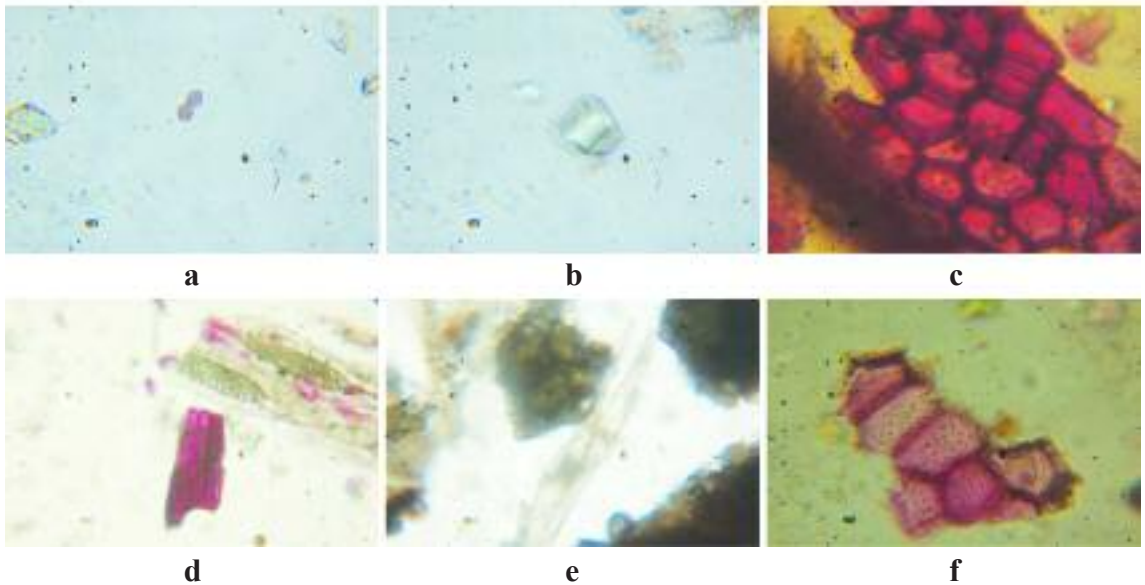


Plate 16: Powder characteristics of bark of *Alstonia scholaris* a) Starch grains b) Rhombic crystals, c) Cork cells d) Medullary rays and stone cells e) Latex canal cells f) Pitted parenchyma.

सतावर (Sataawar), बनकुरिला (Bankurilo)

Botanical name : *Asparagus racemosus* Willd.

Family : Asparagaceae

Other names : Wild asparagus (Eng), Stavar, Satmula (Hind), Satawari, Abhiru (Sans)

Description of plant:

A tall woody much branched, climber with straight or curved spines. Leaves with slender pointed often-curved cladodes, curved in clusters of 2-6, mostly 1-2cm long. Inflorescences are axillary racemes. Flowers are small, white and fragrant. Fruits are globular berries, 4-7mm (Medicinal plants of Nepal, 2016).

Flowering and Fruiting : June-August

Distribution in Nepal : East to West, 100-2100m,

Parts used : Tuber

Uses:

Tubers are diuretic, aphrodisiac, tonic, appetizer, caminative, antispasmodic, galactagogue and astringent. They are also used in tuberculosis, cough, bronchities, diarrhoea, dysentery and general debility (Medicinal plants of Nepal, 2016).

Pharmaceutical notes:

It is available in powder and liquid dosage forms. Some of available preparations are satavari churna, satavari ghrith, narayan tel (Rajbhandari & Ranjitkar, 2006).

Note: It is included in 33 prioritized plants for economic development of Nepal.

Chemical constituents:

Steroidal glycoside satavarin I-IV, a polycyclic alkaloid and 9, 10-dihydrophenanthrene derivative- resimosol are reported as major components from rhizome (Gupta et al, 2003) Flowers contain quercetin, hyperoside and rutin and fruit contains glycosides of these. Fully ripe fruit contain cyanidin-3galactoside and cyaniding-3-glucorhamnoside. Leaves contain rutin, diosgenin and a flavoneoid glycoside- quercetin-3-glucoronide (Husain et al, 1992). The



Plate 17: Habit photo
(photo ©: R. Tamang)



Plate 18: Dried tubers

major active constituents of *Asparagus racemosus* are steroidal saponins. Isoflavones, asparagamine, racemosol, polysaccharides, mucilage, vitamins A, B1, B2, C, E, Mg, P, Ca, Fe, and folic acid present in roots. Other primary chemical constituents of *Asparagus* are essential oils, asparagine, arginine, tyrosine, flavonoids (kaempferol, quercetin, and rutin), resin, and tannin (Joshi, 2016)

Macroscopic characters:

Roots are perennial, fascicled, succulent, tuberous, arising from a short rootstock adventitiously. Tubers are 30 to 100cm long, fairly smooth except for the presence of a few rootlets, tapering towards the basal and distal end, color varies from creamish - white to light yellow (Plate 18).

Organoleptic characteristics:

Powder is Creamish-yellow in color with characteristic odor. Taste is sweet at first later it becomes bitter.

Anatomy of Tuber:

Transverse section of root reveals compactly arranged, uniseriate, polygonal to radially elongated, thick-walled cells represent the outermost epidermal layer. Immediately lying below the epidermis is extensively developed, several layers of thick cortex made up parenchymatous cells. The cortex is clearly distinguished into outer lignified cortex and inner parenchymatous cortex. The cortical cells contain raphide bundles. The innermost one or two layers of cortex immediately outside the endodermis comprise thick walled cells, with numerous circular or oval pits on their walls (Quality Standards of Indian Medicinal Plants, 2003, Vol.1).

Endodermis is composed of a single layer of compactly arranged, barrel-shaped parenchymatous cells. Inner to endodermis, a single layer of thin walled parenchymatous cells constituting the pericycle in the form of a ring which surrounds a central stele (Plate 19c).

Phloem and xylem groups, many in number are arranged on alternate radii and form a ring. Phloem is mostly undifferentiated and consists of thin walled polygonal cells. Vessel elements possess spiral, scalariform and pitted thickening. Pith wide, composed of thin-walled rounded or angular cells (Plate 19c).

Powder microscopy:

Important structures visible are vessels with pitted thickenings, raphides, fibers and stone cells (Plate 20). Starch grains and reticulate vessels are also seen (Quality Standards of Indian Medicinal Plants, 2003, Vol.1).

Photo plates

Anatomy

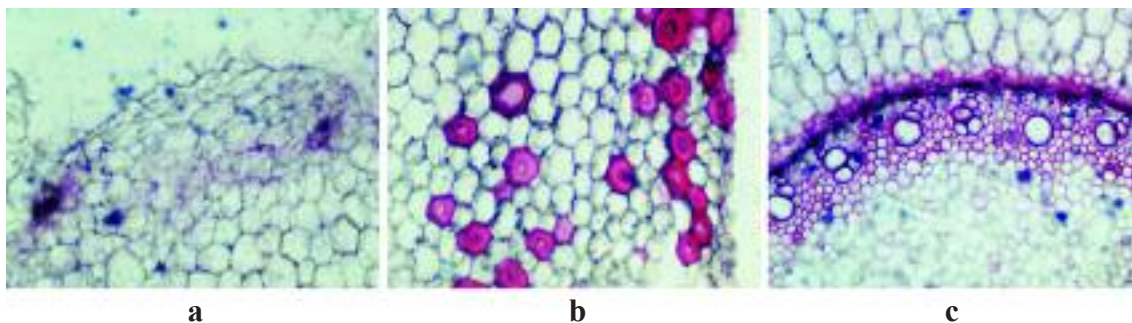


Plate 19: TS of tuber of *Asparagus racemosus* a) Section showing epidermis b) Section showing cortex and stone cells c) Section showing vascular bundles.

Powder analysis

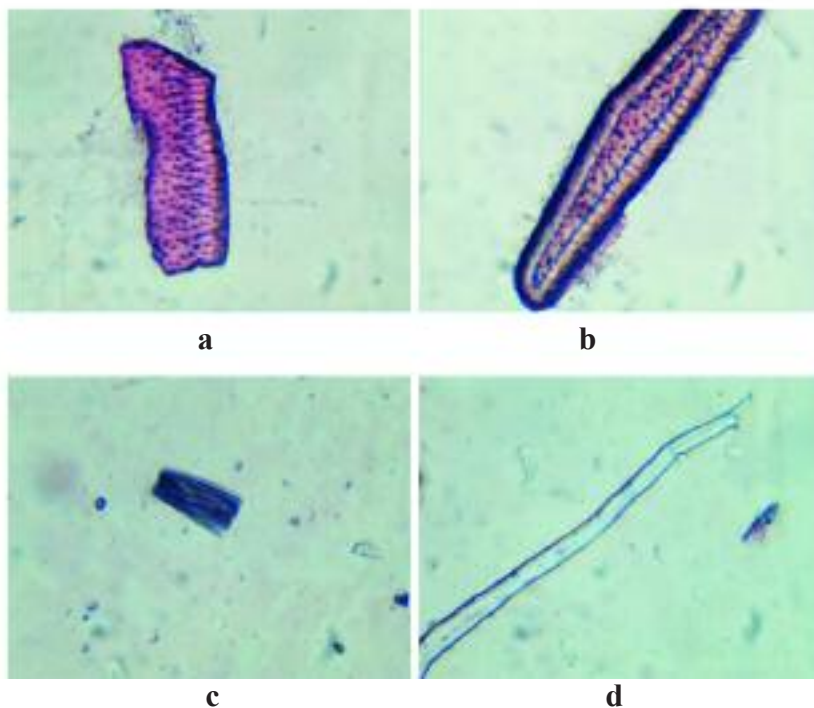


Plate 20: Powder characteristics of tuber of *Asparagus racemosus* a) Pitted vessel b) Stone cell c) Raphides d) Fiber.

निम (Neem)

Scientific name : *Azadirachta indica* A. Juss.

Family : Meliaceae

Other names : Indian lilac, Margosa tree, Neem tree (Eng), Neem (Hind), Nimbah, Prabhadrach (Sans)

Description:

A tree with 15-20 m tall, leaves compound, imparipinnate, leaflets 13–17 leaflet, 7 cm long, lanceolate, glabrous, serrate, very oblique at the base, petiole 5-10cm long. Inflorescence axillary panicles, flowers small, white, sweet scented, in loose clusters. Fruits one seeded drupe, greenish yellow when ripe (Medicinal plants of Nepal, 2016).



Plate 21: Habit photo (photo ©: C. Khanal)

Flowering and fruiting : March–April

Parts used : Bark, leaf, flower and seed

Uses:

Leaves are useful in skin diseases, intestinal worms, ulcers, malarial and intermittent fever, liver complaint and diabetes. The bark also is used as in the same way as leaves. Leaves are used as insecticide. Fruits are highly recommended for urinary diseases, piles, intestinal worms and leprosy. Seeds are useful in tumors, leprosy, skin diseases, intestinal worms, pulmonary tuberculosis, wounds, ulcers, and diabetes. Oil is used in skin diseases, indolent ulcers, ring worm, scabies, and malarial fevers (Medicinal plants of Nepal, 2016)

Chemical constituents:

More than 100 compounds are reported from various parts of this plant including sterols, terpenoids, fatty acids, amino acids, etc in which azadirachtin, nimbin, nimbinin and fatty acids- oleic, palmitic, stearic, linoleic, and arachidic acids are the major compounds. (Siddiqui et al,1993) and (Husain et al., 1992). Mahmoodin , a new limonoid, has been isolated from *Azadirachta indica* (neem) oil, along with seven known tetranortriterpenoids, azadirone, epoxyazadiradione, nimbin, gedunin, azadiradione, deacetylnimbin, and 17-hydroxyazadiradione. A new protolimonoid, naheedine has been obtained from the neem fruits along with azadirachtol (Siddiqui, et al., 1992)

Distribution in Nepal: Cultivated.

Pharmaceutical notes:

It is available in powder, tablet and liquid dosage form. Some of the formulations available in the market are Pitghana bati, Nimbadi churna, Pilarin tablet, Mahamarichyadi tel (Rajbhandari and Ranjitkar, 2006). It is also used in different toiletry product like neem soap, shampoo etc.

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

Leaves alternate, ex-stipulate, imparipinnate, 14 to 13 cm in length, leaflets 7 to 15, opposite or alternate, lanceolate, acuminate, oblique, serrate, glabrous, shortly petioled, reticulate, midrib prominent. Fresh leaves flexible, dark green and shiny above, dry leaves brittle, pale yellow (Plate 22).



Plate 22: Dried leaves

Organoleptic characteristics:

Powder is greenish in color, characteristic odor and bitter in taste.

Microscopic characters:

Anatomy of Leaf:

Vertical section of leaf shows upper and lower epidermis bearing trichomes at places and covered with cuticle (Plate 23a and b). Upper epidermis is followed by palisade layer of single cell, remaining tissue is composed of narrow mesophyll (Plate 23c). Midrib is composed of a broad arc of centrally located meristele of ten to thirteen rows of vertically running xylem vessels (Plate 23a).

Above the arc lies few rudimentary vascular strands, phloem tissues is embedded with plenty of rosette and cluster of crystals of calcium oxalates, an arc of pericycle (Plate 23a) is distinct and collenchymatous. The remaining ground tissue is parenchymatous except underneath the upper and lower epidermis where lies collenchymatous cells.

Powder microscopy:

Shows upper epidermis devoid of stomata and lower epidermis with anomocytic stomata (Plate 24c) at places. Exhibit palisade cells lying underneath it embedded with rosette crystals of calcium oxalate (Plate 24e). Powder consists of fragments of fiber (Plate 24d), simple and stellate trichomes (Plate 24a and b) and vessels (Plate 24f).

Photo plates

Anatomy

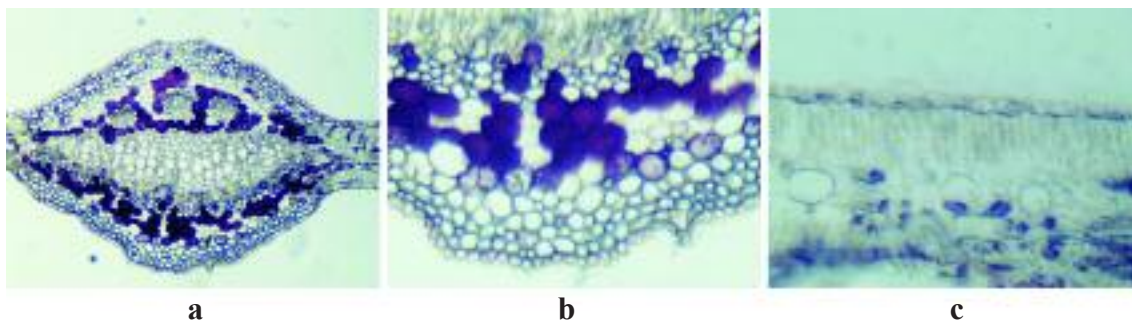


Plate 23: VS of leaf of *Azadirachta indica* a) Section showing upper epidermis, pericycle and vascular region b) Section showing lower epidermis and pericycle d) Section showing palisade and oil globule.

Powder analysis

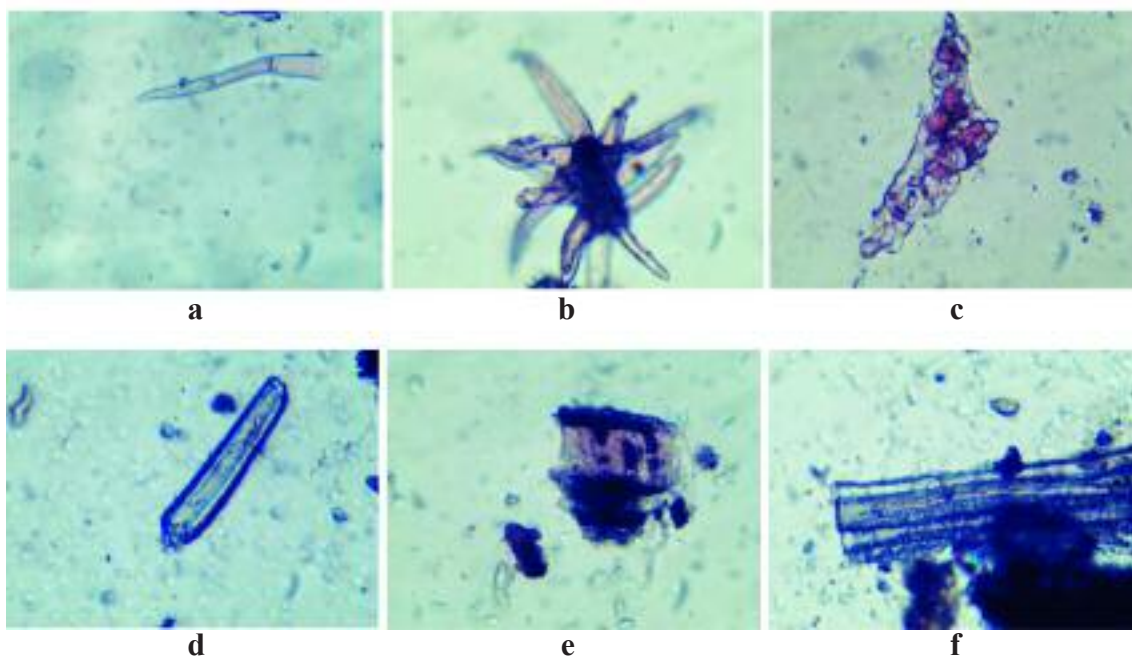


Plate 24: Powder characteristics of leaf of *Azadirachta indica* a) Simple trichome b) Stellate trichome c) Epidermal cells with stomata d) Fiber e) Palisade f) Vessels.

पाषाणमेद (Paasaanved)

Scientific name : *Bergenia ciliata* (Haw.) Sternb

Family : Saxifragaceae

Other names : Rockfoil (Eng), Pashanved (Hind) Pasanved (Sans)

Description:

A perennial rhizomatous creeping herb on rocks ledges with stout rootstock. Leaves are simple, short petiolated, large with ovate or rounded blade, 5 - 15 cm long but enlarging up to 30 cm or more. Leaves turn bright red in autumn fringed with long bristle like hairs. Inflorescence cyme or paniculate, flowers are white, pinkish or purple. Fruits capsule, 2 mm long (Medicinal plants of Nepal, 2016).



Plate 25: Habit photo (photo ©: R. Tamang)

Flowering and fruiting : March - April

Part used : Rootstock

Uses:

The root is cooling and useful in piles, tumors, urinary discharges, heart diseases, diseases of the bladder and lungs. It is also used as tonic in fever, diarrhea, cough and dysentery (Medicinal plants of Nepal, 2016).

Chemical constituents:

It contains bergenin, afzelechin, saxin, catechin-3-gallate (Watanabe et al., 2005). Rhizomes are reported to contain berganin and its glycosides, β -sitosterol, gallic acid, catechin-3-gallate and (-) afzelechin as major constituents (Gupta et al., 2003). Leucocyanidin is also reported (Medicinal Plant of Nepal, 2016).

Distribution in Nepal : East to West, 1000 - 3200 m.

Pharmaceutical notes:

It is available in powder form. Some of the available formulations are Pashanvedadi churna, pushyanug churna (Rajbhandari and Ranjitkar, 2006).

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

The rhizome is available in more or less cylindrical or halved cut pieces. Outer surface wrinkled, after removal of bark, exposed surface is smooth. Fracture short, longitudinal as

well as transverse, outer surface with root-scars, dark brown in color and lighter inside (Plate 26).

Organoleptic characteristics:

Powder is brown in color, aromatic odor and slightly bitter in taste.

Anatomy of Rhizome:

Transverse section of rhizome shows cork divided into two zones. The outer region consisting of a few compressed cells filled with brown contents. The inner multilayered zone composed of thin-walled, tangentially elongated colorless cells followed by a single layer of cork cambium and few layers of secondary cortex (Plate 27a).

Some cells of secondary cortex contain cluster and large rosette crystals and starch grains. Cortex is composed of parenchymatous cells (Plate 27b). Most of the cortical cells contain rosettes. Endodermis and pericycle are not seen.

Vascular bundles are arranged in a ring. They are conjoint, collateral and open (Plate 27d). Phloem tissue is composed of sieve elements and parenchyma. Two to three layered of cambium is present. Xylem consists of tracheids, vessel elements, xylem parenchyma and xylem fibers. Pith is composed of rounded or oval parenchymatous cells. Tanniferous cells are seen abundantly both in the cortical and pith region.

Powder microscopy:

Shows large rosette crystals (Plate 28a), cork cells (Plate 28b), starch grains (Plate 28c), vessels element with scalariform thickenings (Plate 28d), parenchymatous cells (Plate 28e).



Plate 26: Dried rhizomes

Photoplates

Anatomy

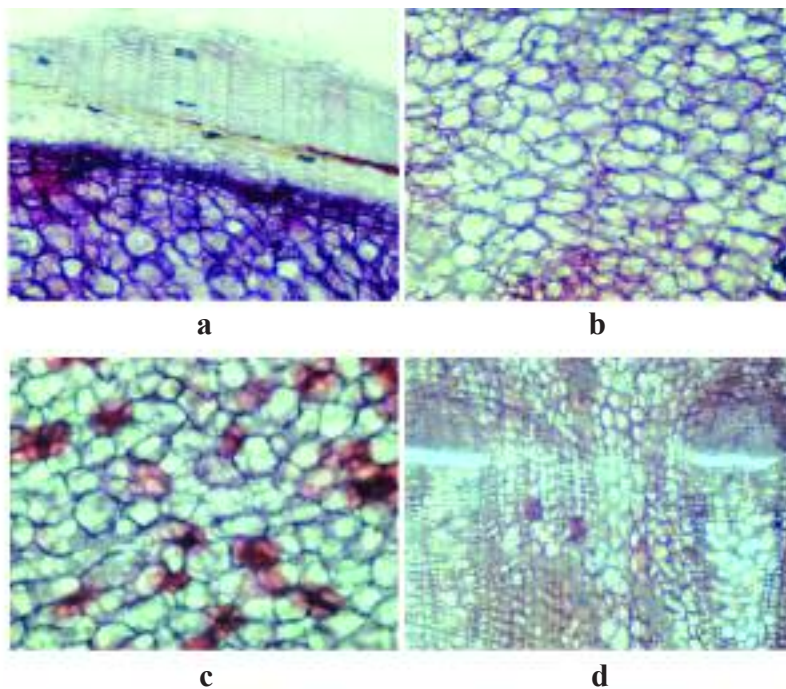


Plate 27: TS of Rhizome of *Berginia ciliata* a) Section showing cork and cortex b) Section showing cortex region c) Section showing pith region d) Section showing vascular bundles.

Powder analysis

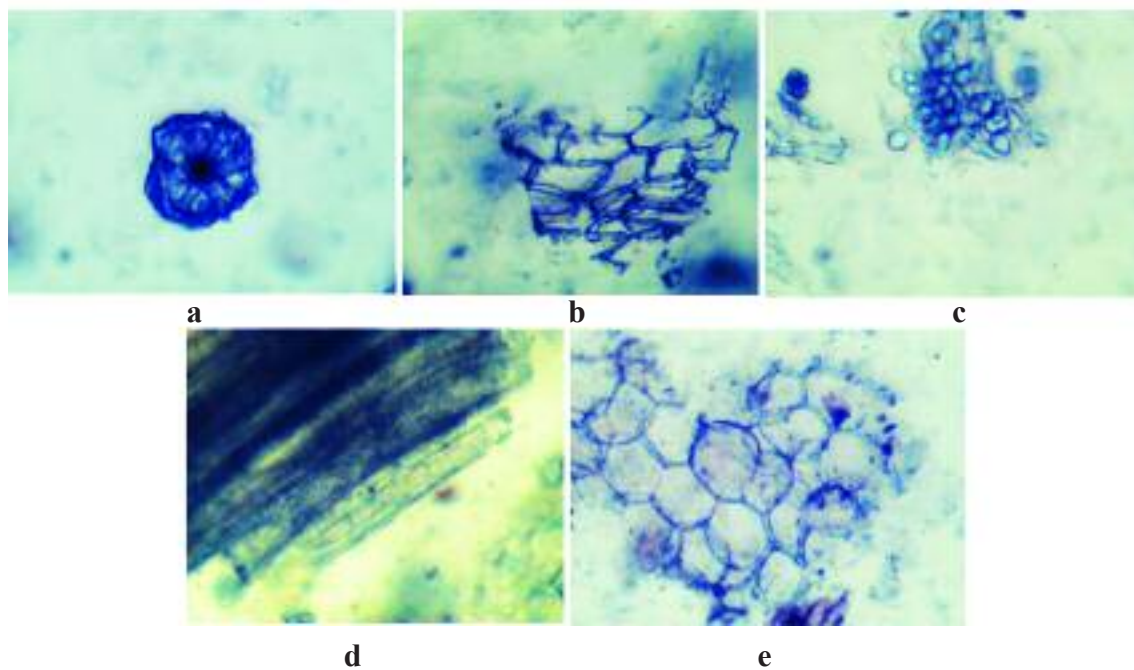


Plate 28: Powder characteristics of rhizome of *Berginia ciliata* a) Rosette crystal b) Cork cells c) Starch grains d) Vessels e) Parenchymatous cells.

भाङ्ग (Bhang), गाजा (Ganja)

Scientific name : *Cannabis sativa* L.

Family : Cannabaceae

Other names : Indian hemp (Eng), Bhang, Ganja, Charas (Hind), Bhanga (Sans)

Description:

An erect, aromatic, resinous, annual herb with angular stem, 1.2–4.8 m tall. The female plant is usually taller than the male. Leaves alternate, stalked, palmately compound, lower leaves with 5–11 leaflets and upper leaves with 1–3 leaflets. Leaflets are variable in size, 3–10 cm long, linear-lanceolate, long pointed, coarsely toothed. Flowers are unisexual. Male inflorescence short drooping panicles, female inflorescence short axillary crowded spikes. Fruits 4 mm, glandular hairy. Seeds white, globose, 1-3mm diameter, glabrous (Medicinal plants of Nepal, 2016).



Plate 29: Habit photo
(photo ©: R. Tamang)

Flowering and fruiting : June-September

Parts used : Leaf and flowering shoot

Uses:

Plant is narcotic inebriant. The intoxicating drugs ‘**Ganja**’ or **Charas** are obtained from the resinous exudations of the stem, young leaves and flower buds. Charas also called as Hashish is a valuable narcotic used in malarial and periodical headaches, migraine, acute mania, insanity, whooping cough, asthma, diarrhea and dysentery etc. It is an appetizer and an anodyne neuralgia and severe pains (Medicinal plants of Nepal, 2016).

Chemical constituents:

Leaves contain flavonoid glycosides. Plant contains β -lectin, cannabidiol, cannabidiolic acid and cannabigerol. Seeds contain Δ^9 -tetrahydrocannabinol. Herbs afforded essential oil containing cannabinoids (Medicinal plants of Nepal, 2016 Eds Second). Resin contains volatile oil, cannabinoids, cannabipirans and alkaloids (Watanabe et al., 2005).

Distribution in Nepal: East to West, naturalized upto 3000m.

Macroscopic characters:

Lower leaves are opposite 5 to 11 foliate, with long rachis and upper leaves are alternate 3 to 5 foliate, leaflet 5 to 10cm in length and 0.8 to 1.5cm in width. Leaves are serrate, acute, and pubescent (Plate 30).

Organoleptic characteristics:

Powder is light green in color, strong characteristic odor and taste slightly acrid.



Plate 30: Dried twigs

Anatomy of leaf:

Vertical section shows a layer of upper epidermis covered with thin striated cuticle, the cell being devoid of stomata, polygonal and straight walled in surface view. It bears both simple and glandular trichomes (Plate3 1a). Simple trichomes are conical, short, occasionally bent with enlarged basal cell. The glandular trichomes are sessile with 8 to 12 radiating club shaped cells and others being with multicellular, multi-seriate stalk with multi-cellular head. The lower epidermis is composed of smaller sized cells with numerous anomocytic stomata. Trichomes are numerous, both simple and glandular. Mesophyll consists of layer of palisade, rarely of two, discontinuous over the midrib, and 2 to 4 rows of spongy parenchyma (Plate31a and b). A small patch of 4 to 5 celled collenchymatous tissue lies underneath the elevation of the upper epidermis of the midrib and 2 to 3 rows at its lower side.

Meristele is conjoint, collateral consisting of radially arranged xylem vessel in rows. Narrow arc of phloem, embedded in parenchymatous cells filled with brown colored resinous material is seen. The ground tissue is parenchymatous, traversed with cluster crystals of calcium oxalate (Quality Standards of Indian Medicinal Plants, 2010, Vol.4).

Powder microscopy:

Shows presence of vascular strands from the midrib showing vessels with pitted and spiral thickening (Plate 32e and f). The upper epidermal cells in surface view are devoid of stomata and exhibiting faint striated cuticle, lower epidermal cells in surface view with numerous stomata (Plate 32c and d). Various types of simple and glandular trichomes are also present (Plate 32a and b).

Photoplates

Anatomy

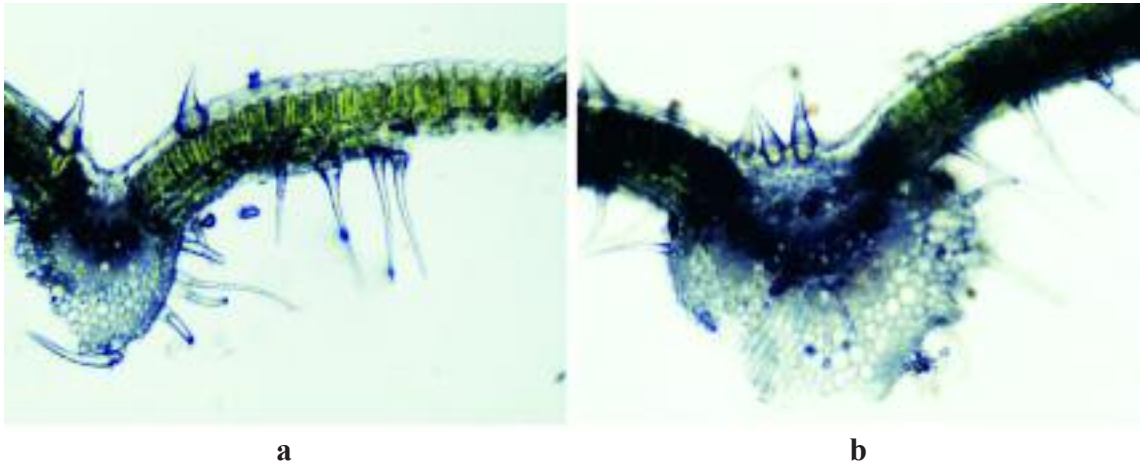


Plate 31: VS of leaf of *Cannabis sativa* a) Section showing trichomes, epidermis and mesophyll tissues b) Section showing vascular tissue.

Powder analysis

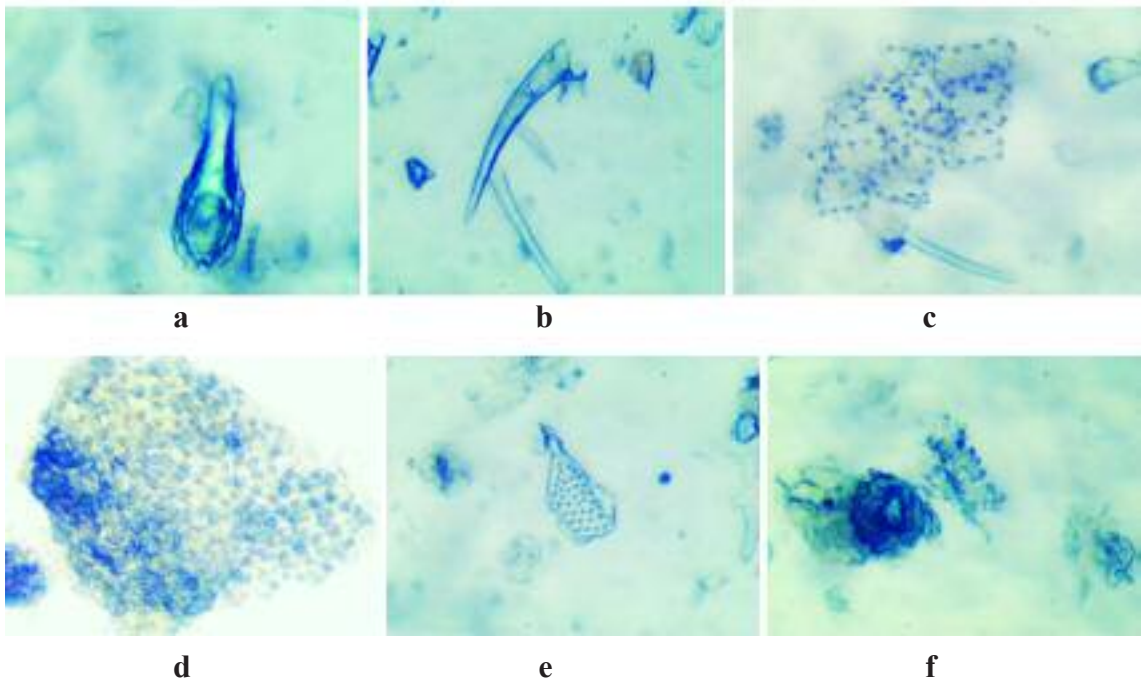


Plate 32: Powder characteristics of aerial part of *Cannabis sativa* a) Glandular trichome b) Simple trichome c) Upper epidermis d) Lower epidermis e) Pitted vessel f) Spiral vessel.

बेतलौरी (Betlauree), कुस्त (Kusta)

Scientific name : *Cheilocostus speciosus* (J. Konig) C. Specht

Family : Zingiberaceae

Other names : Spiral ginger (Eng)

Description:

A rhizomatous perennial herb about 1.5 m tall. Leaves simple, sessile with broad leaf sheath, spirally arranged, oblong-oblongate, 6 – 28 cm long and 2 – 7 cm broad, acute, entire. Inflorescence is terminal spike, flowers are large, white, bracts bright red (Medicinal plants of Nepal, 2016).

Flowering and fruiting : June - July

Parts used : Roots and rhizome

Uses:

Rhizomes are astringent, purgative, depurative, stimulant, anthelmintic and used in snake bite (Medicinal plants of Nepal, 2016).

Chemical constituents:

Tubers and roots contain diosgenin, 5α -stigma-9(11)-en-3 β -ol, sitosterol, β -sitosterol- β -D-glucoside, dioscin, prosapgenins A and B of dioscin, gracillin and quinones. Seeds contain α -tocopherols (Medicinal Plants of Nepal, 2016).

Distribution in Nepal: East to West, 400- 700m.

Macroscopic characters:

The dried rhizome is curved or somewhat straight, cylindrical, branched piece. Upper surface is marked with circular nodal scars with remnant of leaf bases. Lower and lateral surface exhibit small circular scars of roots or few wiry rootlets, fracture fibrous and fractured surface is yellowish brown (Plate 34).

Organoleptic characteristics:

Powder is yellowish brown in color, do not contain characteristic odor and taste.



Plate 33: Habit photo
(photo ©:R. Tamang)



Plate 34: Dried rhizomes

Microscopic characters:**Anatomy of Rhizome:**

Transverse section shows a layer of epidermis bearing simple, unicellular, thick walled trichomes and few multi-cellular uni-seriate trichomes (Plate 35a). Cork cells are multilayered lie underneath epidermis. The outermost 2-3 layers of which are thick walled and remaining are thin walled cells. The cortex and the wide central ground stellar tissue are parenchymatous and scattered throughout with collateral vascular bundles. Vascular bundles are numerous towards the adjacent peripheral region of the endodermis. Those lying underneath it are of very small sized and devoid of fibers. Stellar vascular bundles (Plate 35c) are well developed and composed of isolated groups of 2-3 vessels associated with narrow phloem. Parenchymatous cells encircled the vascular bundles contain cluster and prismatic crystals. Simple oval to pear shaped starch grains and orange to dark brown colored oleoresin cells traversed throughout the ground tissue of the section (Quality Standards of Indian Medicinal Plants, 2008, Vol.7).

Powder microscopy:

Shows short uniseriate simple trichomes (Plate 36f). Large, simple, round, oval-ovoid or ellipsoidal starch grains (Plate 36a) are present. Fragments of vascular strands with spiral and scalariform vessels (Plate 36c and d), thin walled fibers (Plate 36e), few scattered prismatic (Plate 36b) and cluster crystals are also seen.

Photo plates

Anatomy

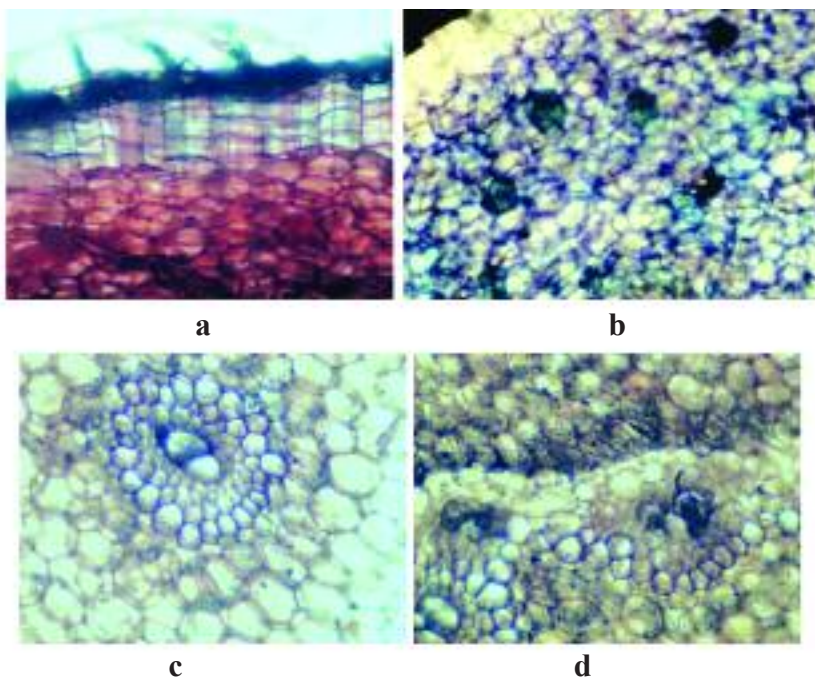


Plate 35: TS of rhizome of *Cheilocostus speciosus* a) Section showing cork and cortex b) Section showing cortex with crystals c) Section showing vascular bundle d) Section showing endodermis.

Powder analysis

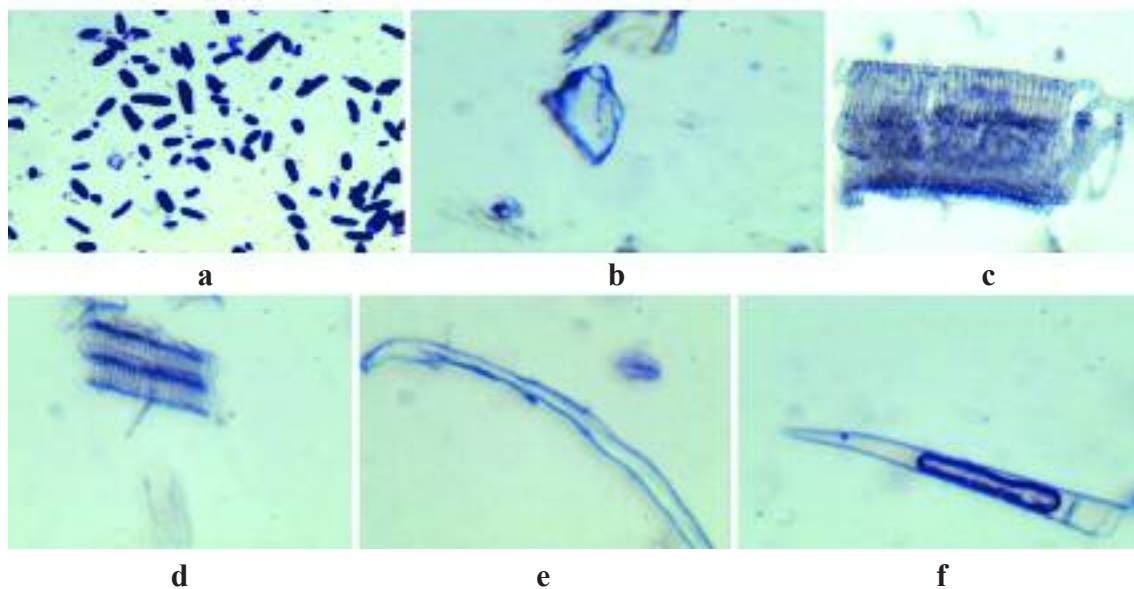


Plate 36: Powder characteristics of rhizome of *Cheilocostus speciosus* a) Starch grains b) Crystal c) Spiral thickening in vessel d) Vessel with scalariform thickening e) Fiber f) Trichome.

तेजपात (Tejpaat)

Scientific name : *Cinnamomum tamala* (Buch. – Ham.) Nees & Eberm

Cinnamomum albiflorum Nees

Family : Lauraceae

Other names : Indian cassia lignea (Eng), Tejpat (Hind), Tamalpatra (Sans).

Description:

A medium sized evergreen tree about 8 meter tall. Leaves simple, sub opposite, short stalked, leathery, ovate – lanceolate, long pointed 10-15 cm long with 3 conspicuous nearly parallel veins arising from near the base. Upper surface of leaves are shining and lower surface are pale and white. Leaves are bright pink when young in spring, aromatic when crushed. Inflorescences axillary or terminal panicles, flowers are pale yellow. Fruits are small ellipsoidal 1cm long, seated on enlarged fleshy cup-shaped perianth (Flora of Kathamandu Valley 1986; Medicinal plants of Nepal, 2016).



Plate 37: Habit photo (photo ©: R. Tamang)

Flowering and fruiting : March – April

Parts used : Leaves and bark.

Uses:

Leaves are carminative. Bark is useful in diarrhoea, flatulence, and nausea. Leaves and bark are used in spices (Medicinal plants of Nepal, 2016).

Chemical constituents:

Leaves and twigs afford essential oil containing cinnamaldehyde as major constituent; others include α - and β -pinene, limonene, β -phellandrene, p-cymene, ocimene, α -terpinene camphor, linalool, borneol, β -caryophellene, α -terpineol, benzyl cinnamate, benzaldehyde, eugenylacetate, eugenol and cinnamyl acetate (Husain *et al.*, 1992). The essential oil from leaves contains trans-caryophyllene, p-eugenol and myricetin (Watanabe *et al.*, 2005).

Distribution in Nepal: East to West , 450 – 2000 m.

Pharmaceutical notes:

It is available in powder, liquid, semi- solid and tablet form. Some of the available formulations are Avipattikara Churna, Chandraprabha Vati, Chitraka Haritaki and Chyavanaprasha Avaleha etc (<http://eson.org.np/database/index.php>).

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

Leaves are simple linear, lanceolate, 5-10cm long, 3-6cm broad, midrib prominent at the lower side, with three lateral veins arising from the base, converging towards the apex. Margin entire, apex acute – acuminate, base symmetrical. Leaves are dull-green in color with upper surface smooth shiny and lower surface slightly rough (Plate 38).



Plate 38: Dried leaves

Organoleptic characteristics:

Powder is light green in color, odor pleasant and aromatic, taste sweet and spicy.

Microscopic characters:

Anatomy of Leaf:

Vertical section passing through the mid rib shows convexly protrude on the lower side and obliquely on the upper side. Mid rib contains collenchymatous tissues above and below. Meristele consists of radially arranged central xylem and phloem, encircled by a ring of pericyclic fibres (Plate 39a and b).

Rows of palisade lie underneath the upper epidermis (Plate 39c). Lower epidermis contains paracytic stomata, simple unicellular, uniseriate multicellular trichomes and sessile as well as unicellular stalked glandular trichomes with unicellular head. Pearl gland and oil containing cells (Plate 39c) are also present. Circular to oval mucilage canals traversed throughout the lamina and midrib tissue with starch grains in mesophyll cells.

Powder microscopy:

Shows glandular trichomes in epidermal cells (Plate 40e), schizogenous mucilage canals (Plate 40c), stomata in lower epidermis (Plate 40a), fragments of vessels (Plate 40d) and fibers (Plate 40b and f).

Photo plates

Anatomy

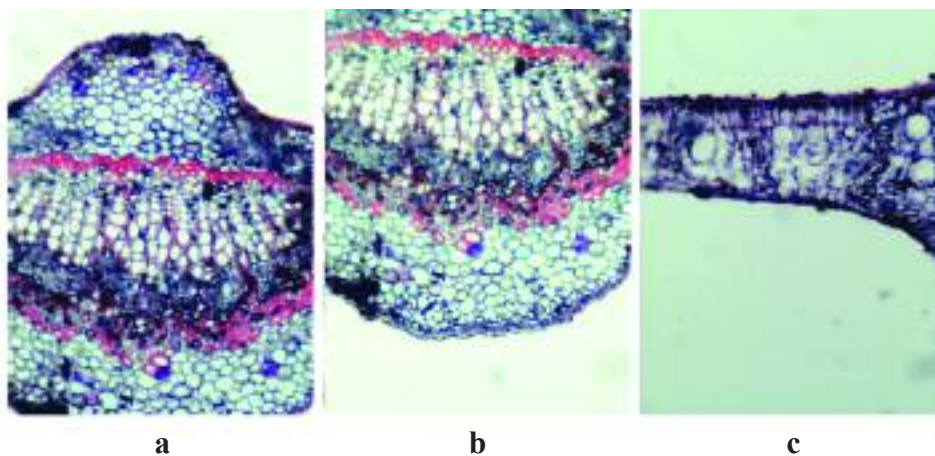


Plate 39: VS of leaf of *Cinnamomum tamala* a) Section showing upper epidermis, pericycle, xylem and phloem b) Section showing lower epidermis, pericycle, xylem and phloem c) Section showing palisade layer, spongy parenchyma and mucilage cells.

Powder analysis

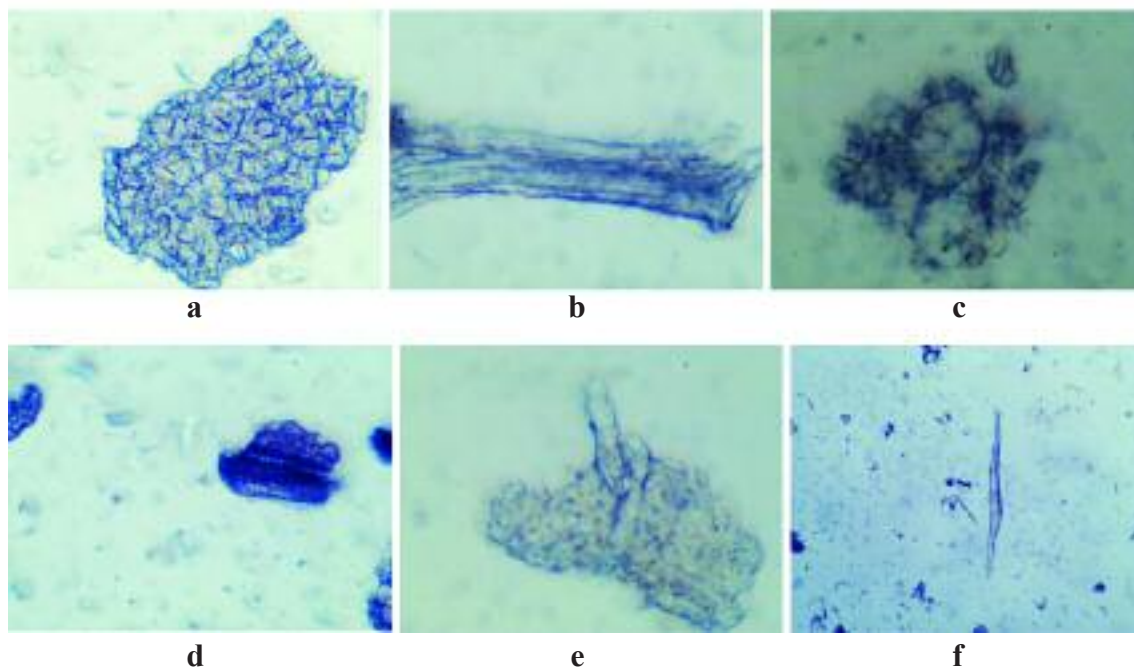


Plate 40: Powder characteristics leaf of *Cinnamomum tamala* a) Lower epidermis with stomata b) Fiber c) Schizogenous mucilage canal d) Vessel e) Epidermal cells with trichome f) Fiber.

कालो मुसली (Kaalo Musalee)

Scientific name : *Curculigo orchioides* Gaertn.

Family : Hypoxidaceae

Other names : Kalimusli, Musli (Hind), Musali (Sans)

Description:

A tuberous perennial herb with simple leaves, crowded on the short stem, sessile or short stalked, with sheathing leaf base, linear or linear lanceolate 15 – 45 cm long. Flowers bright yellow on the very short escape, lowermost flowers are bisexual and upper ones are male. Fruits capsules (Medicinal Plant of Nepal, 2016).



Plate 41: Habit photo
(photo ©: C. Khanal)

Flowering and fruiting : April - May

Part used : Rhizomes

Uses:

Rhizomes are demulcent, diuretic, tonic, aphrodisiac and are used in piles, jaundice, asthma, diarrhoea, and gonorrhoea. The poultice of rhizome is also used in itch and skin diseases (Medicinal Plant of Nepal, 2016).

Chemical constituents:

Rhizomes contain glycosides-5,7-dimethoxymyrctin-3-O- α -L-xylopyranosyl-4-O- β -D-glucopyranoside, curculigoside and corchioside A; sapogenin- yuccagenin; an alkaloid- lycorin, three aliphatic hydroxyketones- 27-hydroxytriacontan-6-one, 23-hydroxytriacontan-2-one and 21-hydroxytriacontan-20-one; a long chain fatty acid- 4-methylheptadecanoic acid (Medicinal Plants of Nepal, 2016).

Distribution in Nepal: East to Central, 500 - 1800 m.

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

Dried rhizomes are cylindrical, surface rough, marked with closely placed transverse wrinkles, few longitudinal striations and at places with short flattened, lateral rootlets, externally dark brown (Plate 42).



Plate 42: Dried rhizomes

Organoleptic characteristics:

Powder is brown in color, odor faint, taste disagreeable and slightly bitter.

Microscopic characters:**Anatomy of Rhizome:**

Transverse section shows outer 5 to 8 rows of corks with peripheral irregularly running dark brown cells of epidermis followed by 5 to 6 rows of thin walled tangentially running collenchymas (Plate 43a). Cortex consist of wide parenchymatous zone with compound starch grains and scattered idioblasts embedded with bundles of long acicular crystals of calcium oxalate. Very few prismatic crystals, mucilage cells and few amphivasal and collateral vascular bundles (Plate 43c) also present in cortical zone.

Endodermis is distinct. Parenchymatous stellar tissue is almost identical to the cortical zone but the vascular bundles are more in number and mucilage cells are very few, vascular bundles lying underneath the endodermis are arranged in rows and well developed (Quality Standards of Indian Medicinal Plants, 2012, Vol.10)

Powder microscopy:

Shows corks cell (Plate 44e) in surface view and transversely cut view, acicular crystals (Plate 44c) of calcium oxalate, plenty of compound starch grains (Plate 44d) and mucilage cells, annular (Plate 44f), spiral vessels (Plate 44a) and fiber (Plate 44b).

Photo plates

Anatomy

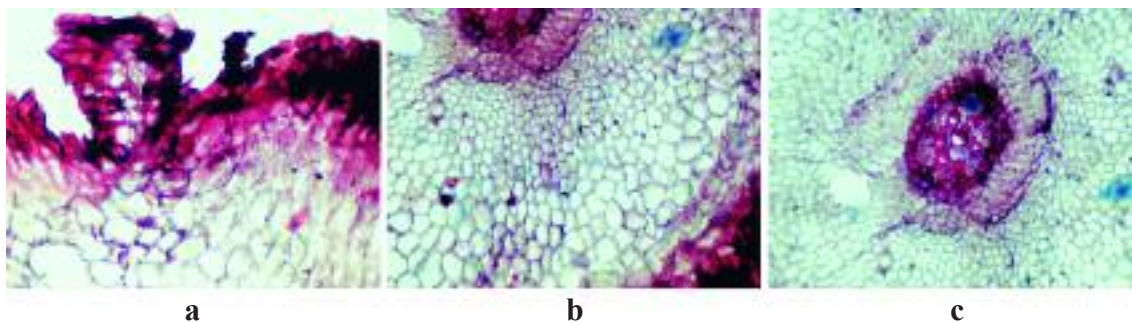


Plate 43: TS of rhizome of *Curculigo orchioides* a) Section showing cork b) Section showing cortex c) Section showing vascular bundle.

Powder analysis

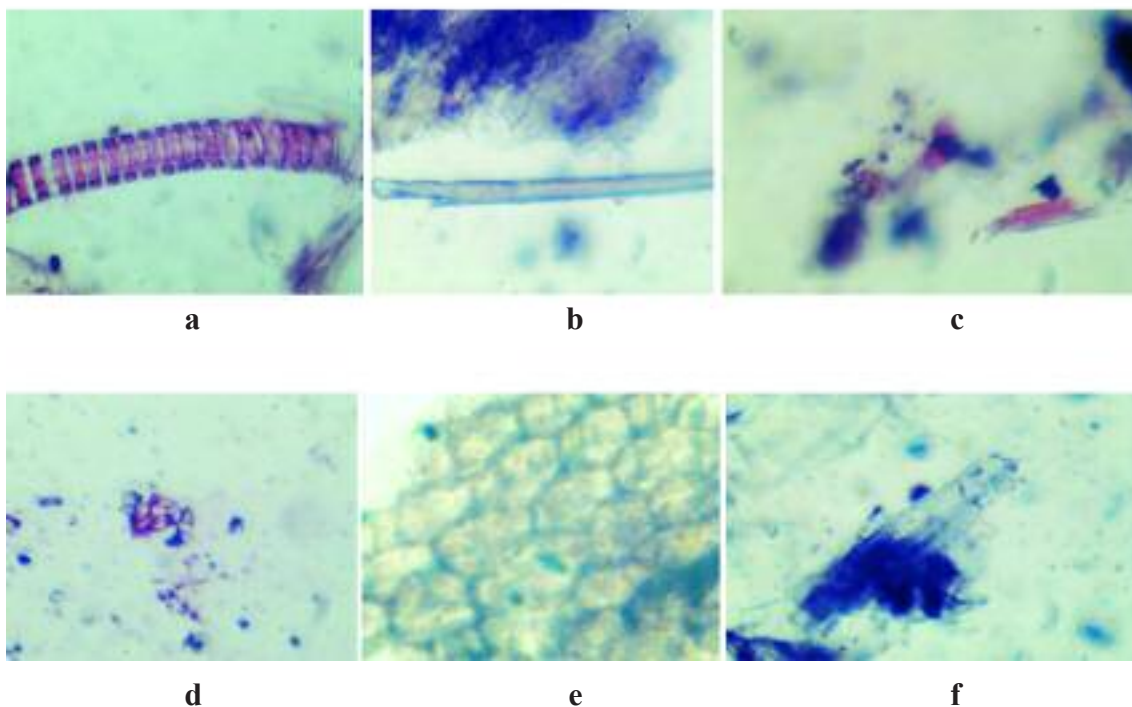


Plate 44: Powder characteristics of *Curculigo orchioides* a) spiral vessel b) Fiber c) Acicular crystals d) Starch grains e) Cork cells f) Annular vessel.

आकासेबेली (Aakasebelee)

Scientific name : *Cuscuta reflexa* Roxb.

Cuscuta verrucosa Sweet

Family : Convolvulaceae

Other names : Dodder (Eng), Akasbela, Amarbeli (Hind), Akasavalli, Asparsa (Sans)

Description:

A leafless parasitic plant is forming dense masses covering the host plant. Stem yellow or purplish, with fleshy bracts. Inflorescence raceme. Flowers stalkless, bell shaped, 6 - 8 mm long with short triangular reflexed lobes, very fragrant white to pink (Flora of Kathmandu valley 1986; Medicinal plants of Nepal, 2016).

Flowering and fruiting : August-October

Parts used : Entire plant

Uses:

The plant is astringent and used externally against itch, internally in protracted fever. Infusion of plant is used as a wash for sores and plant is used in bilious disorders or jaundice. Seeds are carminative, anthelmintic and alterative also used as anodyne.

Chemical constituents:

Seeds contain amberlin and kaempferol. Stem gives cuscutin, cuscutalin, β -sitosterol, lutein, berganin and kaempferol (Husain et al., 1992). Plant also contains kaempferol-3-O-rhamnoside, angustifolin and hydroxylupanine (Watanabe et al., 2005).

Distribution in Nepal: East to West, 600 - 3300 m.

Macroscopic characters:

Stem (Plate 16) is filiform, cylindrical with very long internodes, often branched and glabrous. It is closely twining, at places exhibiting membranous whitish papillose protrusions of the haustoria. It is pale green in color and faintly longitudinally furrowed.

Organoleptic characteristics:

Powder is reddish brown in color, do not have characteristic odor.



Plate 45: Habit photo (photo ©: R. Tamang)

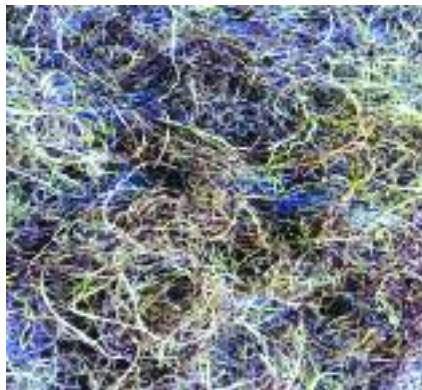


Plate 46: Dried stems

Microscopic characters:**Anatomy of Stem:**

Transverse section shows a layer of epidermis (Plate 47a) covered with thin cuticle, occasionally traversed with stomata, especially at the base of the notched margin. Underneath the epidermis lies hypodermis consisting of a row of parenchymatous cells traversed with resin ducts (Plate 47c).

The stellar region is composed of a ring of conjoint, bicollateral vascular bundles (Plate 47b) connected with intra-fascicular band of thin walled fibers. Xylem is composed of 2 to 10 vessels in each of the bundle. Phloem tissue is not always associated with xylem but at places seen above the fibrous band. Pith wide, parenchymatous. Cells located in the centre being bigger than surrounding cells and are arranged in the circular fashion (Quality Standards of Indian Medicinal Plants, 2008, Vol.5).

Powder microscopy:

Shows plenty of globular to irregular shaped resin masses and, elongated resin ducts filled with granular contents in surface view (Quality Standards of Indian Medicinal Plants 2008 Vol.5). Starch grains, epidermal cells of stem, fragments of a vessel and parenchymatous cells are also seen (Plate 48a to d).

Photo plates

Anatomy

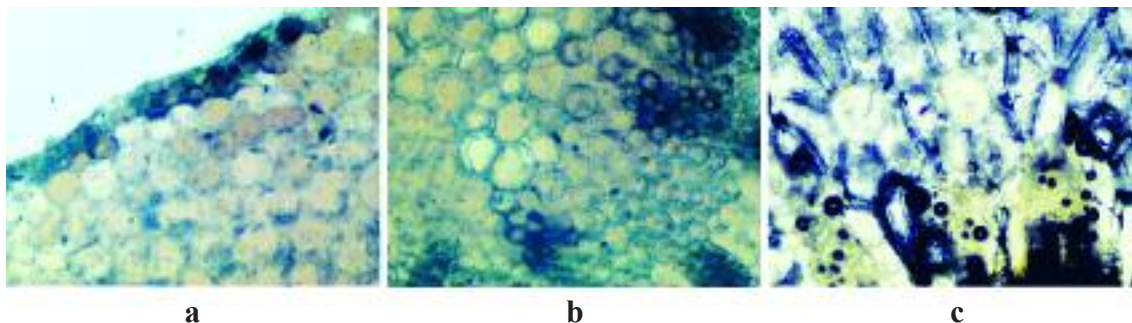


Plate 47: TS of stem of *Cuscuta reflexa* a) Section showing epidermis and cortex b) Section showing vascular region c) Section showing resin duct.

Powder analysis

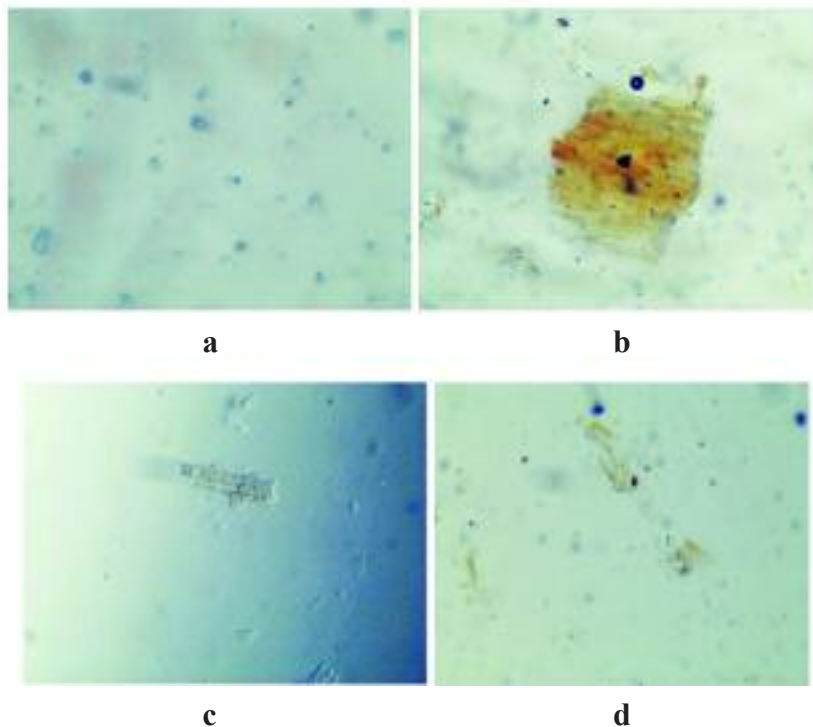


Plate 48: Powder characteristics stem of *Cuscuta reflexa* a) Starch grains b) Epidermal cells c) Vessel d) Parenchymatous cells.

पाँचऔले (Paachaule), हत्ताजडी (Hattajandee)

Scientific name : *Dactylorhiza hatagirea* (D. Don) Soo

Orchis hatagirea (D. Don)

Family : Orchidaceae

Other names : Salep, Marsh orchis (Eng), Salampanja (Hind), Bhunjatak (Sans)

Description:

A herb is 30-90 cm tall with robust leafy perennial and palmately lobed tubers. Leaves are simple, alternate, oblong lanceolate 10-15 cm long. Inflorescence is long cylindrical spike. Flower is 1.8 cm long including the stout curved cylindrical spur, spotted dark purple. Fruits are capsule (Medicinal plants of Nepal, 2016).

Flowering and fruiting : June-September

Parts used : Tuber

Uses:

Tubers are used as tonic. Tubers are expectorant, astringent, demulcent, and highly nutritious. Tubers are also used in urinary trouble (Medicinal plants of Nepal, 2016).

Chemical constituents:

Roots contain dactylose A, dactylose B, dactylorhins A, B, C, D and E, 4-(β -D-glucopyranosyloxy) benzyl alcohol, militarrin, lorglossin, (2R)-2-hydroxy-2-(2-methylpropyl) butanedioic acid, β -sitosterol, 4-hydroxybenzyl methyl ether,

4-hydroxybenzaldehyde, pyrocatechol, hydroquinone, 4-hydroxybenzyl alcohol and β -sitosterol-3-O- β -D-glucopyranoside (Kizu et al., 1999).

Distribution in Nepal: East to West, 2800-4000 m.

Conservation status:

Strictly protected by Government of Nepal (Ban on collection, utilization, and sale) and endangered.

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

Dried tubers are yellowish-white or grayish in color and



Plate 49: Habit photo
(photo ©: R. Tamang)



Plate 50: Dried tubers

rounded having somewhat wrinkled appearance and hard corny consistency. They are, to some extent, translucent, odorless and slightly bitter or tasteless.

Organoleptic characteristics:

Powder is yellowish-white or grayish in color, odorless having slightly bitter or tasteless taste.

Microscopic characters:

Anatomy of Tuber:

Transverse section shows epidermal cells made up of single layered compactly arranged barrel shaped cells without intercellular space. The epidermis is covered by a thick brown cuticle (Plate 51a). Epidermis is followed by multilayered parenchymatous zone known as ground tissue. There is no distinction of hypodermis, cortex, endodermis, pericycle and pith. Vascular bundles are scattered in the ground tissue. The parenchyma consist many starch grains, tannins, raphide bundles, albumin and mucilage.

Numerous mucilage canal cells (Plate 51b) are found to be scattered in the zone. Many exarch vascular bundles (Plate 51c) are seen scattered in the ground tissue. Xylem parenchyma is distinct but the phloem and cambium are not distinct.

Powder microscopy:

Many simple and compound starch grains (Plate 52a) are seen. Raphide bundles (Plate 52b), vessels (Plate 52c and d) and fibers (Plate 52e) are also seen.

Photo plates

Anatomy

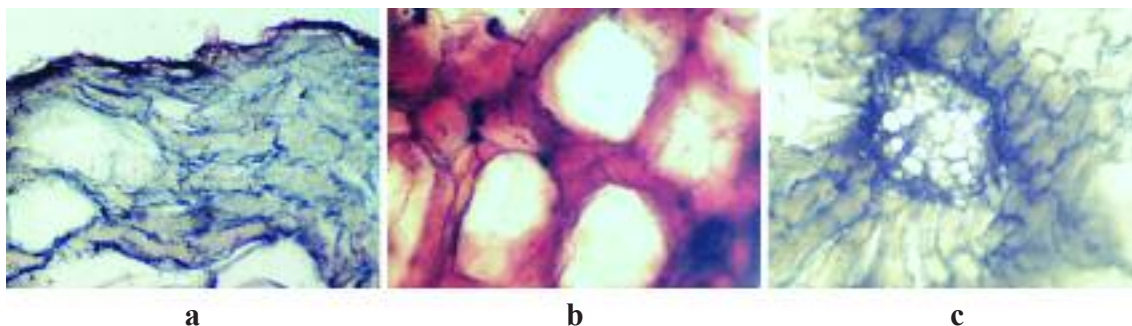


Plate 51: TS of tuberous root of *Dactylorhiza hatagirea* a) Section showing epidermis and cortex b) Section showing mucilage canal c) Section showing vascular bundle.

Powder analysis

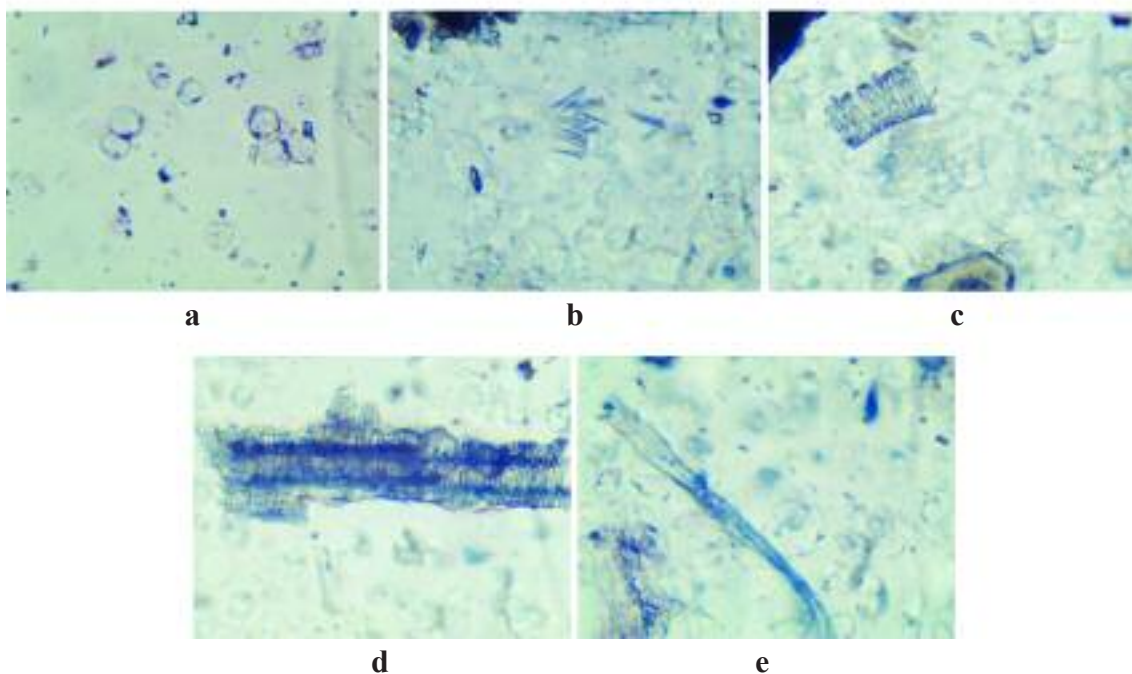


Plate 52: Powder characteristics of tuberous root of *Dactylorhiza hatagirea* a) Starch grains b) Raphids c) and d) Vessels e) Fiber.

सेतो घतुरो (Datura)

Scientific name : *Datura stramonium* Linn.

Family : Solanaceae

Other names : Stramonium (Eng), Datura (Hind), Dhatturah, Dhusturah (Sans)

Description:

An annual herb with green branches, 0.6 – 1.2 m tall. Leaves simple, alternate, stalked, ovate. Inflorescence is solitary axillary. Flowers white, stalked, funnel shaped. Fruits are sub-globose capsules, covered all over with numerous fleshy prickles. Seeds are numerous, smooth and yellowish brown (Medicinal plants of Nepal, 2016).

Flowering and fruiting : July - September

Part used : Leaves, flowers and fruits



Plate 53: Habit photo (photo ©: C. Khanal)

Uses:

Plant is antispasmodic, anodyne, and narcotic; inhalation of smoke of leaves is recommended for relieving attacks of asthma, and the drug is used to relieve the spasm of the bronchioles in asthma. Fruits are sedative and intoxicating. Leaves are applied to boils, sores and fish bites. Juice of flowers is used in earache. Juice of fruits is applied to scalp for curing dandruff and falling hair (Medicinal plants of Nepal, 2016).

Chemical constituents:

The major alkaloids are hyoscyamine, hyoscyne and atropine; other tropane alkaloids have been reported from the whole plant- skimmianine, apohyoscyne, apoatropine, tropine, α - and β -belladonine and 2, 6-dihydroxytropine (Husain et al., 1992). Twelve compounds isolated and identified from *Datura stramonium*, they are N-trans-feruloyl tryptamine, hyoscyamilactol, scopoletin, umckalin, daturaolone, daturadiol, N-trans-ferulicacyl-tyramine, cleomiscosin A, fraxetin, scopolamine, 1-Acetyl-7-hydroxy-beta-carbol-ine, 7-hydroxy-beta-carbolinel-propionic acid (Li, et al., 2012).



Plate 54: Dried leaves

Distribution in Nepal: Naturalized, East to West, 200 – 2200 m.

Macroscopic characters:

Leaf:

Fresh mature leaves are ovate, 8 to 20cm in length, 7 to 15cm in width. Margin is coarsely dentate, with 4 to 5 acute teeth on each side, occasionally with smaller teeth in between. Apex is acuminate, base asymmetrical, petiole stout, curved, venation reticulate, midrib raised, lateral veinlets 7 to 8, surface nearly glabrous, upper dark green. Dried leaves (Plate 54) are crumpled, shriveled and pale in color.

Organoleptic characteristics:

Powder is green in color, odor characteristic, unpleasant and taste is bitter.

Microscopic characters:

Anatomy of Leaf:

Vertical section shows upper and lower epidermis, covered with thin cuticle, embedded with stomata (Plate 55b), more on the lower side and bearing few simple and glandular trichomes are located more on the midrib region. Simple trichomes (Plate 55a) are uniseriate, multicellular, warty, straight or bent and with occasional collapsed cells, glandular trichomes are clavate and with spherical head, midrib shows 3 to 5 celled wide.

Collenchymatous band is present under the lower epidermis, it is 5 to 7 in rows in the elevated projection on the upper side, the ground tissue is parenchymatous embedded with microsphenoidal and few prismatic crystals of calcium oxalate and centrally located wide bicollateral meristele.

It consists of radially running xylem vessels alternating with uni to triseriate medullary rays, getting wider at the lower side and in continuation with dorsiventrally located phloem tissue. An arc of discontinuous rows of pericycle groups of fibers are present at its lower side. Mesophyll tissue of lamina consist of a layer of palisadenderneath the upper epidermis. 3 to 4 rows of spongy parenchyma traversed with obliquely cut vascular strands underneath the lower epidermis (Quality Standards of Indian Medicinal Plants, 2012, Vol.10).

Powder microscopy:

Shows fragments of upper and lower epidermis in surface view embedded with anisocytic stomata (Plate 56e), cluster and few prismatic crystals of calcium oxalate scattered as such throughout or embedded in the parenchymatous cells (Plate 56c). Trichomes and annular and spiral vessels are also seen (Plate 56d and b).

Photo plates

Anatomy

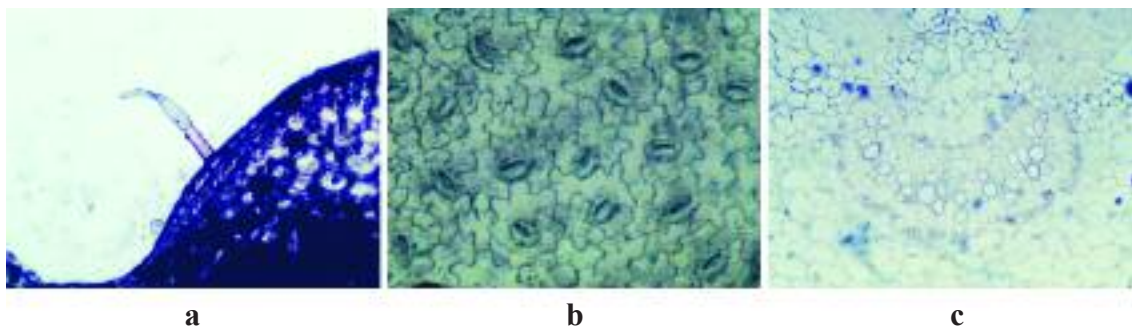


Plate 55: VS of Leaf of *Datura stramonium* a) Section showing epidermal cells with trichome b) Section showing epidermal cells with stomata c) Section showing vascular bundle region.

Powder analysis

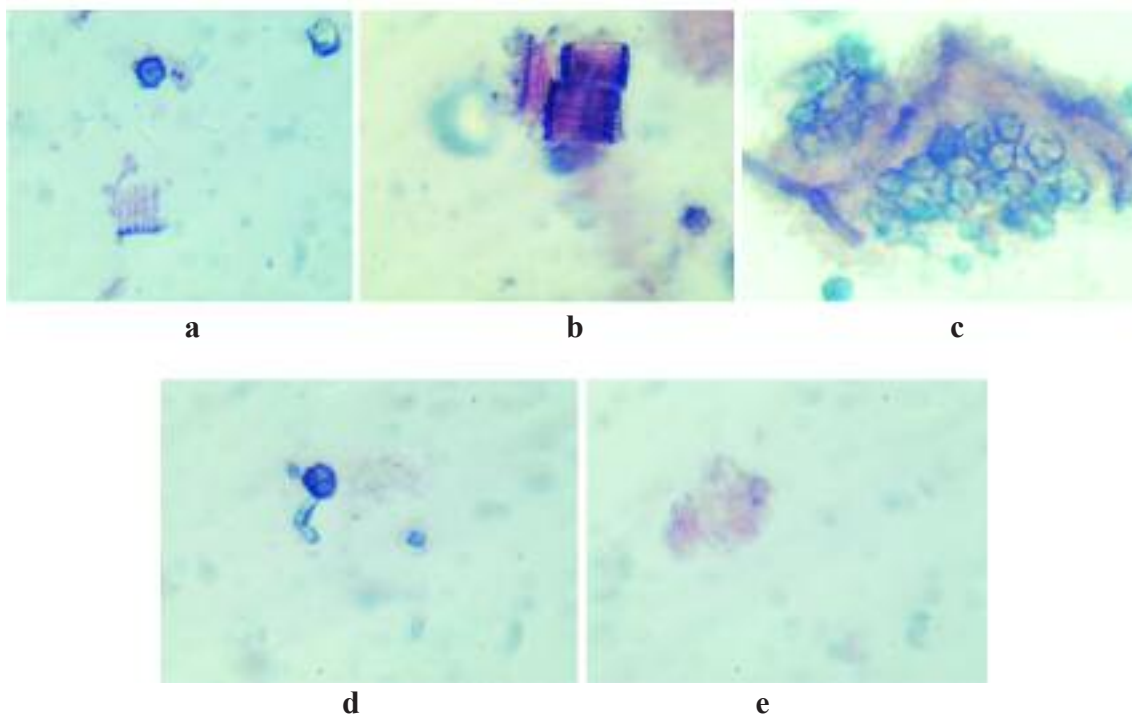


Plate 56: Powder characteristics of Leaf of *Datura stramonium* a) Crystals and vessel b) Vessel c) Cells with crystals d) Trichome e) Epidermal cells with stomata.

भ्याकुर (Bhyaakur)

Scientific name : *Dioscorea deltoidea* Wall. ex Griseb.

Dioscorea nepalensis Sweet ex Bernardi.

Family : Dioscoreaceae

Other names : Wild Yam (Eng)

Description:

A glabrous climber herb with stem unbranched. Leaves are simple, alternate, sub-deltoidly cordate, caudate acuminate, 7 - 9 nerved, membranous, petiole very slender and long. Inflorescence is spike. Flowers are unisexual, male spike is 10 - 20 cm long, female spikes 2-20 cm long. Capsule 4-6 on each matured spike and reddish straw colored when ripe. Seeds winged all round (Flora of Kathmandu 1986; Medicinal Plant of Nepal, 2016).



Plate 57: Habit photo (Photo©: K. Sharma)

Flowering and fruiting : May - June

Parts used : Rhizome

Uses:

It is used to extract diosgenin for the manufacture of steroid hormones and cortico steroids. Rhizomes are also used as fish poison, remove cattle lice and wash clothes in rural areas.

Chemical constituents:

Rhizomes are sources of diosgenin and its glycoside; smilagenin, epismilagenin, alkanes and diosgenin-3-0- β -D-glucopyranosyl(1'!3)-0-[β -D-glucopyranosyl(1'!4)]- β -D-glucopyranoside. Leaves contain a steroidal saponin detofolindiosgenin-3-0- α -L-rhamnopyranoside(1'!2)-(α -L-rhamnopyranosyl(1'!4)-4'-0- β -hydroxy- β -methylglutaryl)- β -D-glucopyranoside (Medicinal Plants of Nepal, 2016).

Distribution in Nepal: East to West , 450 – 3100 m.

Conservation status:

Listed in Appendix II of CITES.

Note: It is included in 33 prioritized plants for economic development of Nepal.



Plate 58: Dried rhizomes

Macroscopic characters:

Dried rhizome is hard, woody light in weight, subspherical, irregularly oblong often constricted at places, branched, dorsiventrally somewhat flattened. Surface rough, somewhat scaly, marked with numerous short, stiff root projections, protruding from circular depressions. It shows rounded elevation of stem scar, longitudinally irregularly striated, externally pale brown to buff internally yellowish white color and fracture tough (Quality standards of Indian Medicinal Plants, 2005, Vol.3).

Organoleptic characteristics:

Powder is light brown in color, odor indistinct, taste acrid and starchy.

Microscopic characters:**Anatomy of Rhizome:**

Transverse section shows cork (Plate 59a), the outermost tissue of the rhizome is composed of 4 to 5 rows of thick walled suberized radially arranged rows of cells often getting collapsed. Ground tissue comprises of an outer 4 to 6 layers of collenchymatous cells with idioblast cluster containing acicular crystals of calcium oxalate. Followed by thin walled simple or pitted parenchyma, containing clusters and prismatic crystals of calcium oxalate. Numerous simple elliptic to oval starch grains are present (Quality standards of Indian Medicinal Plants, 2005, Vol.3).

Vascular bundles (Plate 59c and d) are conjoint, collateral and closed. They are encircled by fibrous bundle sheath. Xylem is composed of pitted spiral and reticulate thickened vessels, tracheids, parenchyma and fibrous sclereids.

Powder microscopy:

It shows fragments of cork cells in surface view, abundant oval to elliptic starch grains (Plate 60a) acicular crystals of calcium oxalate (Plate 60b), fragments of xylem vessels with annular and pitted thickenings (Plate 60c and d) and fibers.

Photo plates

Anatomy

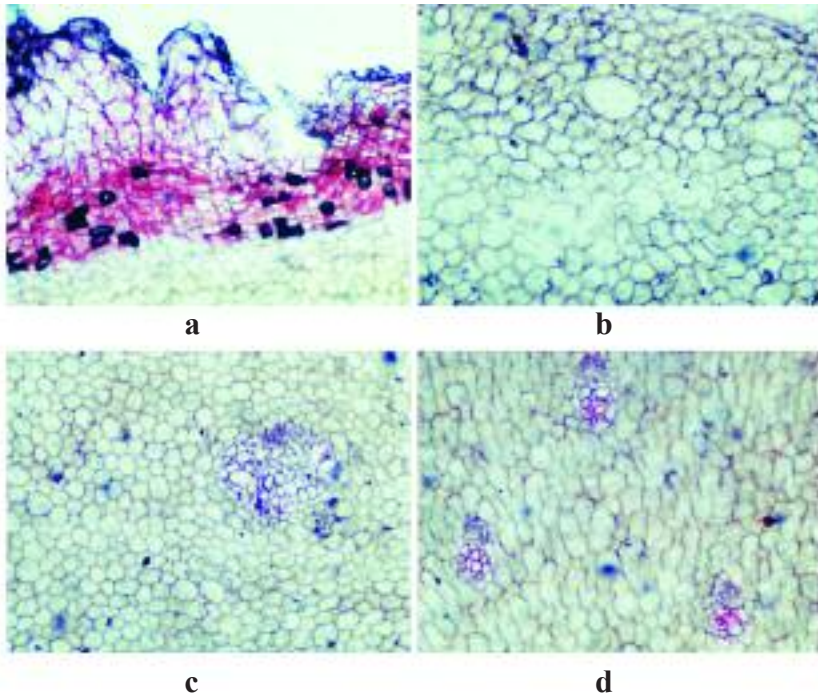


Plate 59: TS of rhizome of *Dioscorea deltoidea* a) Section showing cork region b) Section showing cortex c) Section showing cortex and vascular bundle d) Section showing vascular bundle in pith region.

Powder analysis

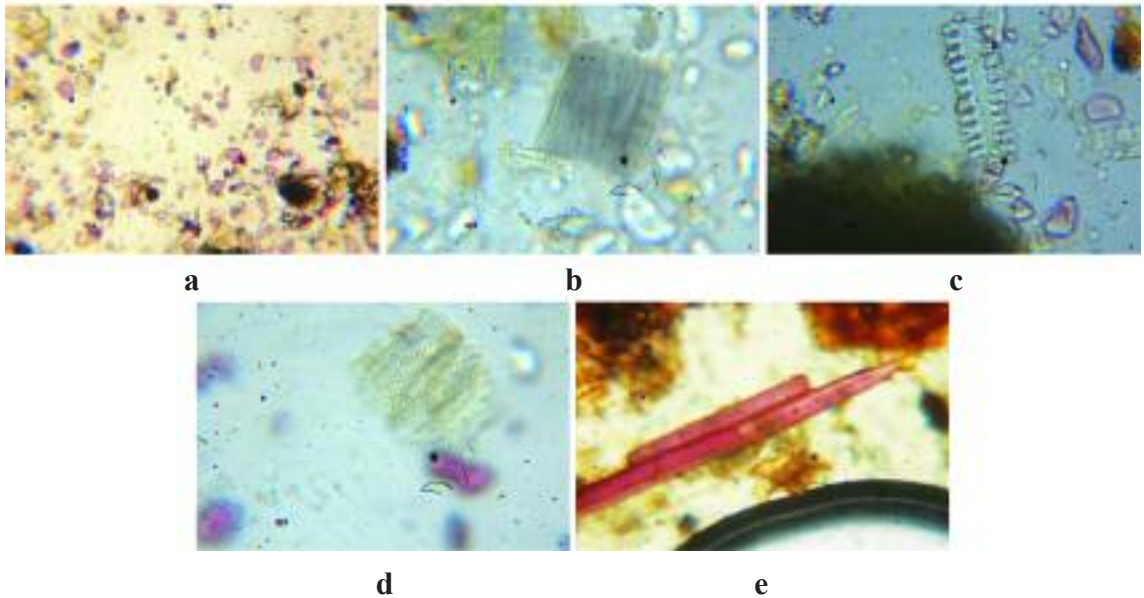


Plate 60: Powder characteristics rhizome of *Dioscorea deltoidea* a) Starch grains b) Acicular crystals c) Annular vessel d) Pitted vessels e) Fiber

सोमलता (Somlataa)

Scientific name : *Ephedra gerardiana* Wall. ex Stapf

Family : Ephedraceae

Other names : Ephedra (Eng), Somlata (Hind)

Description:

A rigid, tufted, 30 - 60 cm tall shrub grows in dry and rocky soil with numerous densely clustered slender, smooth, green, jointed branches having scales at the joints. Flowers are unisexual, male and female flowers in separate plants. Male flowers ovate, 6 - 8 mm long with 4 - 8 flowers, female cones are usually solitary. Fruits are ovoid, 7 - 10 mm with fleshy red succulent bracts enclosing two seeds (Medicinal Plant of Nepal, 2016).



Plate 61: Habit photo (photo ©: C. Khanal)

Flowering and fruiting : July – Aug.

Parts used : Whole plant.

Uses:

Liquid extract is used for controlling asthmatic problems. Tincture of Ephedra is useful in cardiac, circulatory and bronchial diseases. Juice of berries is efficacious in affections of respiratory diseases (Medicinal Plant of Nepal 2016).

Chemical constituents:

Aerial part contains ephedrine and ephedroxycane (Husain et al., 1992). It also contains norephedrine, n-methyl ephedrine, pseudo-ephedrine. Ephedrines are present in roots (Kokate, et al., 2002)

Distribution in Nepal: East to West, 2400 and 5000 m.

Macroscopic characters:

Dried stem pieces (Plate 62) are cylindrical, branched or un-branched, brittle, young pieces slender, green, measuring 1 to 2 mm in diameter but older ones are 3 to 5 mm in diameter.



Plate 62: Dried twigs

Brownish in color, surface longitudinally striated, nodes swollen, bearing opposite decussate, minute sheathing leaves or their bases completely surrounding the stem. Internodes measuring 2 to 8 cm in length. Fracture fibrous and fractured surface is reddish brown.

Organoleptic characteristics:

Powder is green in color, odor faint and characteristic, taste slightly bitter.

Microscopic characters:

Anatomy of Stem:

Transverse section of stem shows highly thick cuticle, papillose epidermis (Plate 63a), consisting of rectangular cells traversed with sunken stomata. Hypodermis is characterized with 2 to 4 rows of palisade like chlorenchymatous cells, embedded with groups of non lignified fibres, usually located under each of the ridge. Cortex is composed of oval to rounded 2 to 4 rows of loosely arranged parenchymatous cells, traverse with isolated or groups of lignified fibers.

Endodermis is distinct, a ring of conjoint, collateral wedge shaped vascular bundles (Plate 63a) capped with arc of lignified pericyclic fibres. Pith is wide, parenchymatous (Plate 63b) and often contains tannins. Small prismatic crystals of calcium oxalate are present throughout the cells of the cortex (Quality standards of Indian Medicinal Plants, 2010, Vol.4).

Powder microscopy:

Shows fragments of epidermal cells, exhibiting straight, thick-walled cells, reticulate vessels, bordered pitted tracheids, reddish brown masses of the tannins (Quality standards of Indian Medicinal Plants, 2010, Vol.4), micro prismatic crystals of calcium oxalate (Plate 64d) scattered and fibers (Plate 64b).

Photo plates

Anatomy

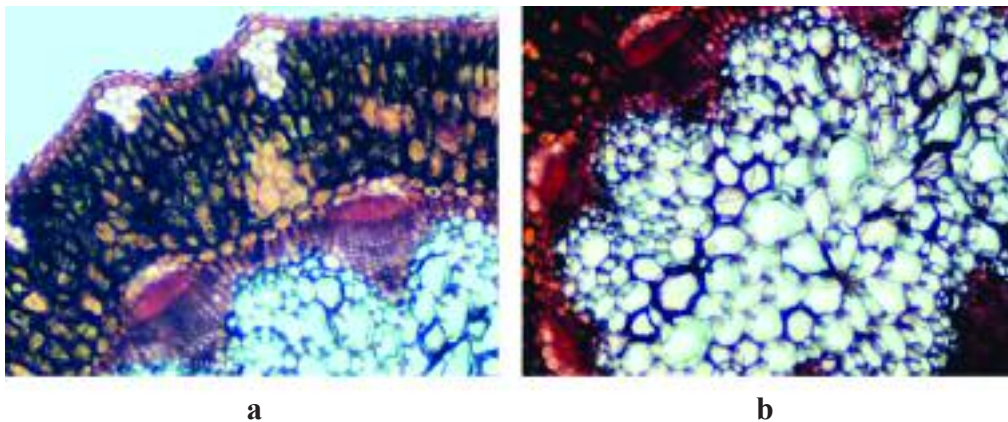


Plate 63: TS of stem of *Ephedra gerardiana* a) Section showing outer part b) Section showing pith region.

Powder analysis

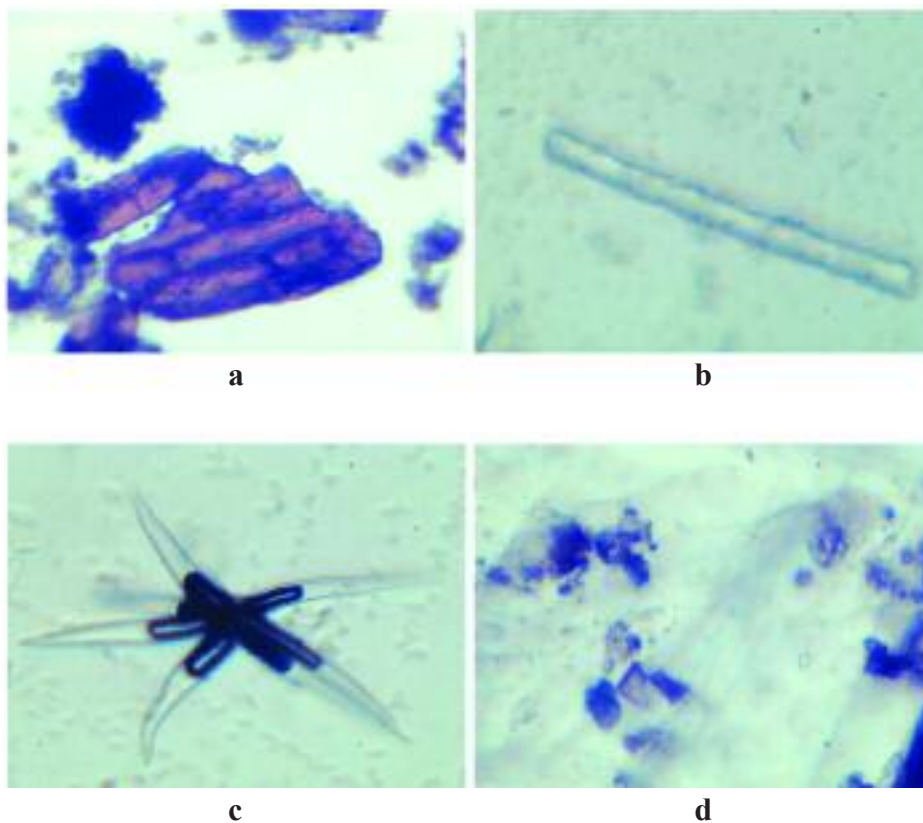


Plate 64: Powder characteristics of stem of *Ephedra gerardiana* a) Tracheids b) Fiber c) Stellate structure d) Crystal

घसिंगरे (Dhasingare), पटपटे (patpate), मछिनो (Machhino)

Scientific name : *Gaultheria fragrantissima* Wall.

Family : Ericaceae

Other names : Wintergreen (Eng), Gandhapura (Hind), Hemanta harit (Sans)

Description:

A much branched evergreen aromatic shrub about 3 m tall. Leaves simple, alternate, stalked, oblong-lanceolate to elliptic, serrate, stiffly coriaceous, dotted with glands, upto 13 cm long. Inflorescences short axillary racemes. Flowers are small, greenish white color. Fruits capsule are sub globose, enclosed in bluish sepals (Medicinal Plants of Nepal, 2016).



Plate 65: Habit photo (photo ©: R. Tamang)

Flowering and fruiting : April–May

Parts used : Twig and leaf

Uses:

The winter green oil, obtained from the distillation of fresh twigs and leaves is aromatic, stimulant, carminative and antiseptic. It is also used in various forms of rheumatism and applied externally in liniments in the form of a suitable ointment to counteract their irritating effects. It has vermifugal action against hookworm (Medicinal Plant of Nepal, 2016).

Chemical constituents:

Leaves contain hyperoside (quercetin-3-galactoside, ursolic acid, β -sitosterol and essential oil containing methyl salicylate (major constituents) (Husain et al., 1992). Phytochemical analysis of aerial parts of *Gaultheria fragrantissima* Wall. extracted with methanol and analysed using GC-MS revealed nearly fifteen bioactive chemical compounds predominantly, m-Ethylbenzotrile, 1-Methoxy-1-buten-3-ene, 4-Fluorobenzyl alcohol, 5-Methylcyclopent-1-ene-1-carboxyl, Methyl Salicylate, 2-Hexenal, 2ethyl- and Cyclohexane, 1, 3-dimethyl-2-methyl (Padmavathy, et al., 2014)



Plate 66: Dried twigs

Distribution in Nepal: East to West, 1200–2600 m.

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

Leaf shape oblong-lanceolate to elliptic, margin serrate, upper surface is greener than lower surface. Stem cylindrical and reddish brown in color (Plate 66).

Organoleptic characteristics:

Powder is green in color, characteristic odor.

Microscopic characters:**Anatomy of Leaf:**

Vertical section shows the upper epidermis cells large and distinct than lower epidermis cells. Ventral side is convex and dorsal side is rounded with some elevation (Plate 67a). Vascular bundle (Plate 67a) is very distinct, conjoint, collateral and hemisphere in shape. Many xylem bands are seen covering with phloem arc. Outer to phloem is covered with few layer (pericycle) sclerenchymatous cells (Plate 67a). Mesophyll tissue (Plate 67b) is differentiated into palisade and spongy parenchyma and centre region contain pith.

Powder microscopy:

Shows, stone cells, rosette crystals, short covering trichomes, pitted parenchyma, anomocytic stomata (Plate 68) and few starch grains.

Photo plates

Anatomy of Leaf

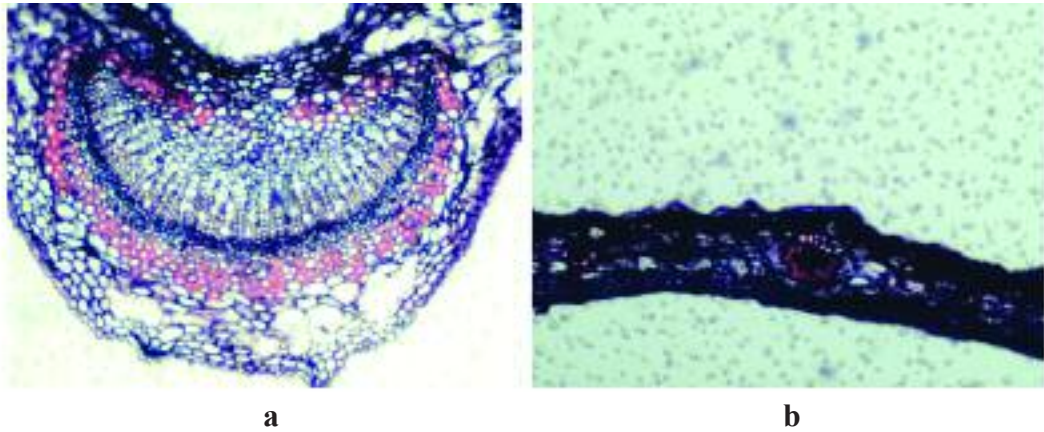


Plate 67: VS of leaf of *Gaultheria fragrantissima* a) Section showing upper epidermis, lower epidermis and vascular region b) Section showing mesophyll region.

Powder analysis

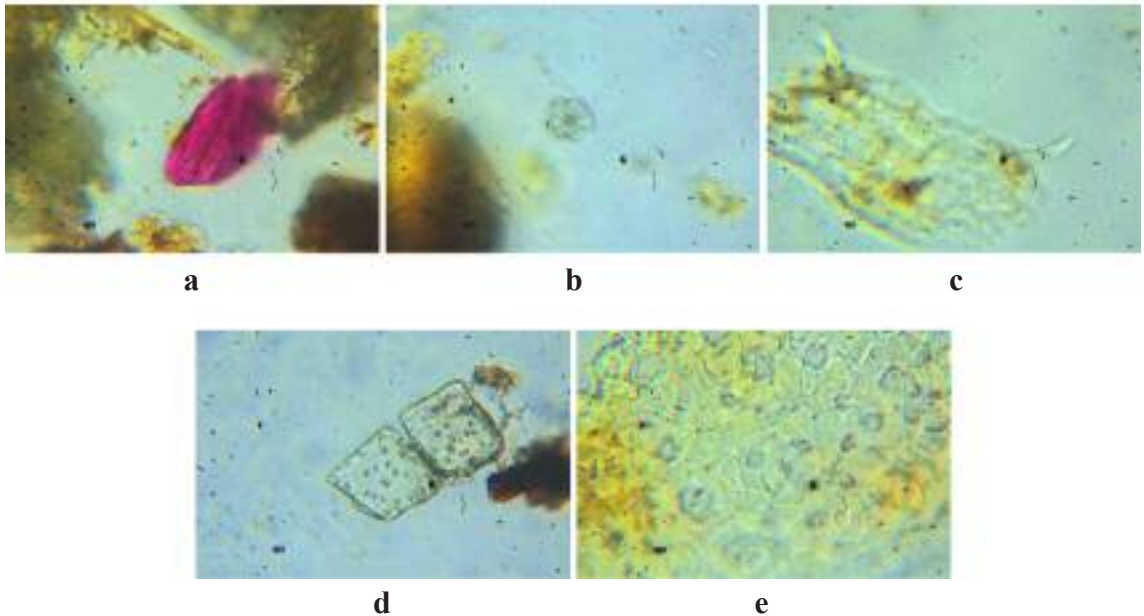


Plate 68: Powder characteristics of twig of *Gaultheria fragrantissima* a) Stone cells b) Rosette crystals c) Short covering trichomes d) Pitted parenchyma e) Stomata

मीठानिम (Meethaaneem), करीपत्ता (Kareepatta)

Scientific name : *Murraya koenigii* (Linn.) Spreng.

Family : Rutaceae

Other names : Curry leaf tree (Eng), Mithanim, Kathnim, Kari patta (Hind), Kalasakah, Kaidaryah (Sans)

Description:

A shrub is 3 m tall. Leaves are pinnately compound, imparipinnate, stalked, leaflets alternate, obliquely lanceolate, acute, entire and glabrous. Inflorescence is corymbs. Flowers are white and fragrant. Fruits ovoid or sub-globose and black when ripe (Medicinal plants of Nepal, 2016).

Flowering and fruiting : April - May

Parts used : Whole plant



Plate 69: Habit photo (photo ©: C. Khanal)

Uses:

Plant is tonic, and stomachic. Bark and roots are used as stimulant, and externally used to cure eruptions. Leaves and roots anthelmintic, analgesic, cure piles, inflammations and are useful in leucoderma and blood disorders (Medicinal plants of Nepal, 2016).

Chemical constituents:

Leaves produce essential oil containing sabinene, β -caryophyllene, α -pinene and β -phellandrene as major component. Among the minor constituents of essential oil are α -terpinene, terpinen-4-ol, linalool, β -ocimine, β -pinene, etc. Numerous carbazole alkaloids-koenigicine, koenimbine, girinimbine, mahanimbine, curryangine, mahanine, koenine, koenidine, mahanimbicine, bicyclomahanimbicine, cyclomahanimbine, murrayanine, mahanine, isomahanimbine, curryanine, mukonine, mukonicine, bismurrayafoline E are reported from the leaves (Gupta et al., 2003).

Distribution in Nepal: East to West, 150 – 1450.

Macroscopic characters:

Leaflet:

Leaves are compound, imparipinnate, rachis slender and pubescent, petiolated slender, terete, alternate,



Plate 70: Dried leaves

ovate, lanceolate or rhomboid. Margin crenate, base obliquely subcuneate, tip acuminate, minutely notched, dull green dorsally and greenish- white ventrally. Texture is papery to sub-coriaceous and slightly brittle when dry (Quality Standards of Indian Medicinal Plants, 2003, Vol.1).

Organoleptic characteristics:

Powder is green in color, Characteristic odor and taste.

Microscopic characters:

Anatomy of Leaf:

Vertical section shows epidermis composed of cubical to slightly tangentially elongated cells. The upper epidermal cells (Plate 71) in surface view are polyhedral and straight walled. Trichomes (Plate 71 b) are unicellular. Stomata anomocytic, palisade of two layers, irregularly arranged isodiametrical or rectangular cells constitute the spongy parenchyma. Calcium oxalate crystals present in the form of prisms. Secretory canals (Plate 71a and c) are large and circular. The midrib shows an arc of radiating xylem with phloem below. Pericyclic fibres appear in patches below the phloem. Inner to the lower epidermis is present 1 to 3 layers of collenchyma. Ground tissue is composed of thin parenchymatous polygonal cells (Plate 71a).

Powder microscopy:

Unicellular, bent or curved trichomes(Plate 72d), two layered palisade(Plate 72c), portion of secretory canals, well developed pericyclic fibres and a few prismatic crystals of calcium oxalate (Plate 72b) are the important identifying characters.

Photo plates

Anatomy

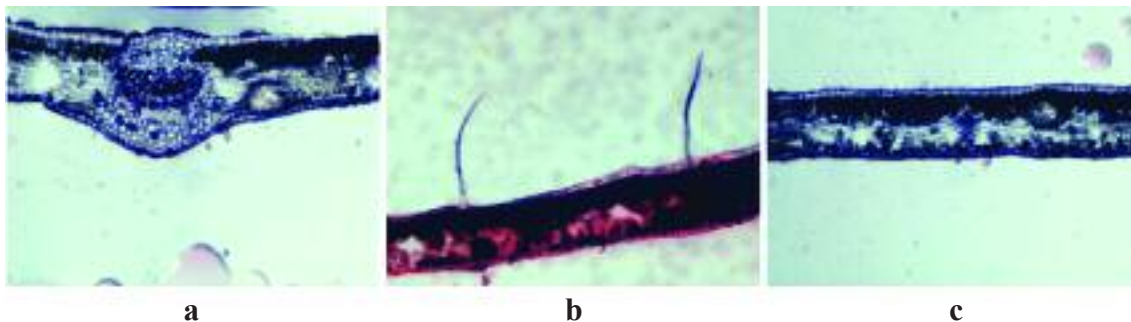


Plate 71: VS of Leaf of *Murraya koenigii* a) Section showing vascular region b) Section showing trichome c) Section showing upper epidermis, lower epidermis, palisade and spongy cells.

Powder analysis

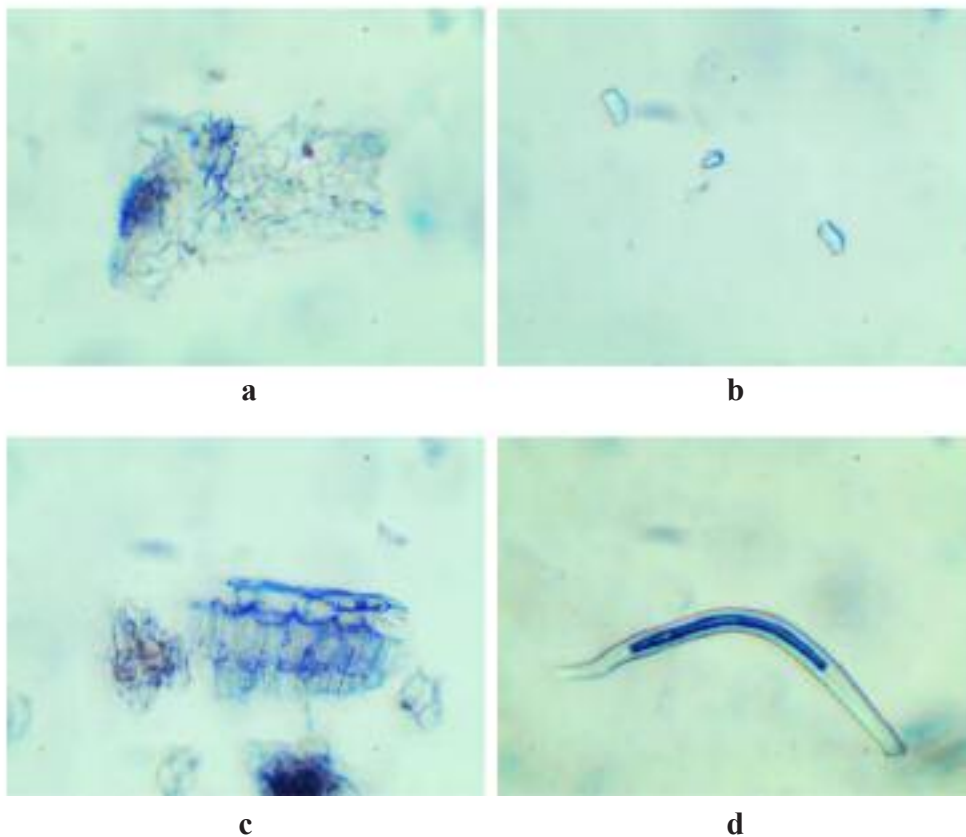


Plate 72: Powder characteristics of leaf of *Murraya koenigii* a) Epidermal cell with stomata b) Crystal c) Epidermis with palisade d) Trichome.

जटामसी (Jatamasee), भूत्ले (Bhute)

Scientific name : *Nardostachys jatamansi* DC.

Nardostachys grandiflora DC.

Family : Caprifoliaceae

Other names : Spikenard (Eng), Jatamansi, Bhutkeshi, Balchhar (Hind)

Description:

An erect perennial herb, 15–25 cm tall with rootstock covered with the dark fibers. Root stocks 8-10 mm thick, dark grey, bitter and aromatic. Radicle leaves elongate, linear to lanceolate, 15–20 cm long, acuminate, base narrowed into petiole. Cauline leaves sessile or sub-sessile with rounded base. Inflorescence terminal cymes. Flowers rose purple to pinkish white in color. Fruits capsules (Medicinal plants of Nepal, 2016).



Plate 73: Habit photo (photo ©: D. Saud)

Flowering and fruiting : June–July

Parts used : Root and rhizome

Uses:

The root is excellent substitute of valerian. The oil obtained from the roots is well known hair tonic. The rhizome is considered as tonic, stimulant, antispasmodic, diuretic, deobstruent, emmenagogue, stomachic and laxative. An infusion of the rhizome is reported to be useful in epilepsy, hysteria, palpitation of heart, and cholera. A tincture of it is given in intestinal colic and flatulence. It is also used as aromatic adjunct in the preparation of medical oils (Medicinal Plants of Nepal, 2016).

Chemical constituents:

Rhizome and roots afford essential oil containing valeranone (jatamansone), spirojatamol, patchouli alcohol, norseychelanone, α - and β -patchoulene, jatamol A & B, jatamansic acid, terpenic coumarins- oroseol, jatamansin (Sipahimalani, 2002).

Distribution in Nepal: East to West, 3200–5000 m.

Pharmaceutical notes:

It is available in powder and pill form. Some of the formulation available in the market are Dasanga – Lep, Dhanyapanchak Churna, Pipalyasav, Shringarabhra, and Sudarshan – Churna. (<http://eson.org.np/database/index.php>).

Conservation status:

Vulnerable, Listed in CITES Appendix II, Ban for export without processing from Nepal.

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

The matured dried rhizome is completely hidden deeply inside the bunch of long, fine tough fibers of withered leaf base arising closely from all over its surface. It is cylindrical, occasionally branched, straight or slightly bent surface rough encircled completely by closely arranged nodal scars and occasional few lateral root scars, fracture short and brittle (Plate 74).



Plate 74: Dried rhizomes

Organoleptic characteristics:

Powder is light brown in color, odor strong and valerianaceous, taste acrid and slightly bitter.

Microscopic characters:**Anatomy of Rhizome:**

Transverse section shows the outermost narrow band of dark brown coloured cork, broken at many places (Plate 75a). Underneath this lies 1 to 3 rows of radially elongated rows of oil cells, followed by 3 to 5 rows of collenchymatous cells. Cork cambium at places penetrate and ramify irregularly throughout the cortex and phelloderm cells.

Interxylary cork cambium of the stellar region also rami fy throughout and produce abnormal development of the cork. Parenchymatous cells get obliterated and form air cavities or cleft throughout the section. On the peripheral region of the pith, medullary cork ring is seen. Pith cells are sclerenchymatous and on decaying empty space are left behind.

Powder microscopy:

Shows fragments of vessels (Plate 76d and e), fragments of cork (Plate 76a), fiber (Plate 76b) fragment of leaf base (Plate 76c) and brown coloring pigment (Plate 76f).

Photo plates

Anatomy

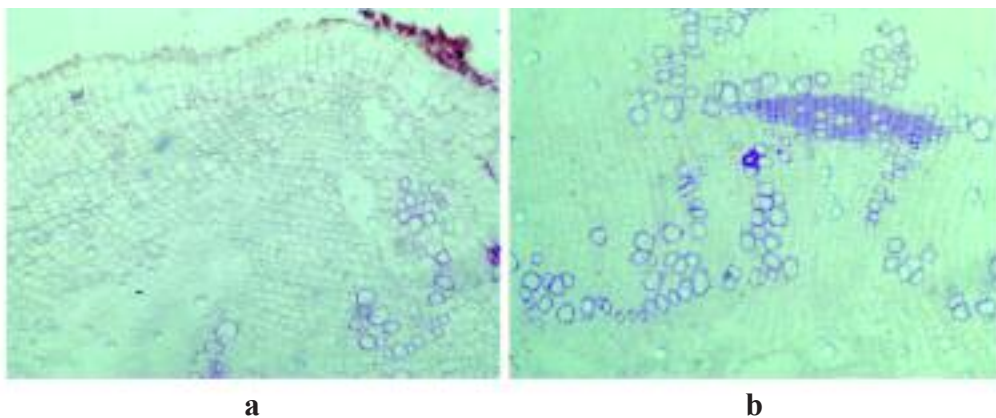


Plate 75: TS of rhizome of *Nardostachys jatamansi* a) Section showing cork and oil globule b) Section showing vascular region.

Powder analysis

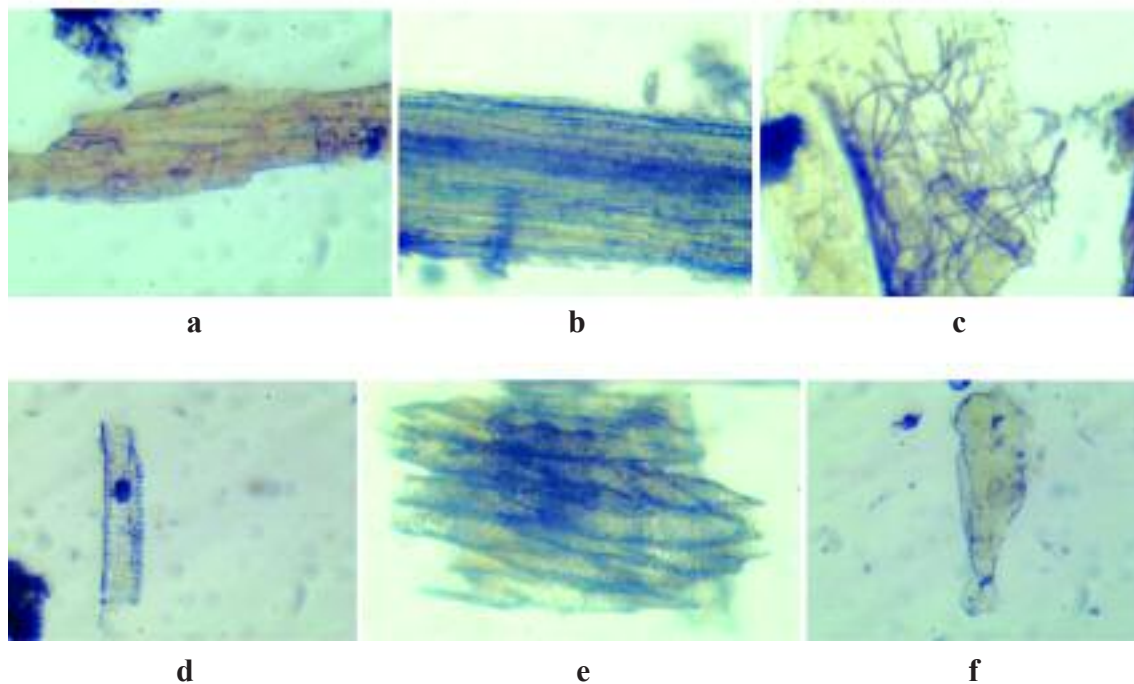


Plate 76: Powder characteristics of rhizome of *Nardostachys jatamansi* a) Cork cells b) Fibers c) Fragment of leaf base d) and e) Vessels f) Brown coloring matter.

कुटकी (Kutkee)

Scientific name : *Neopicrorhiza scrophulariifolia* (Penell) Hong

Picrorhiza scrophulariiflora Penell

Family : Scrophulariaceae

Other names : Picrorhiza (Eng), Kutki, Kuru, Katki (Hind), Aristha, Katavi, Matsyapitta,, Tikta, Vamaghni (Sans)

Description:

A prostrate herb with perennial woody rhizomes covered with old leaves at the base. Leaves are crowded at the tip. Each leaf 2 - 6 cm long, oblanceolate, narrowed below and margin toothed. Inflorescence is terminal spike. Flowers are dark blue – purple in color. Fruits are capsule, 6 – 10mm (Medicinal Plants of Nepal, 2016).

Flowering and fruiting : Jun. – Aug.

Part used : Rhizomes

Uses:

Rhizome is useful in dropsy, antiperiodic fever, anemia and jaundice. It promotes secretion of bile, improves appetite and stimulates gastric secretion (Medicinal plants of Nepal 2016).

Chemical constituents:

Rhizomes contain kutkin, kurrin, kutkiol and kutkisterol (Watanabe, et al., 2005). Rhizomes and roots contain picroside I, picroside II, kutkoside, minecoside, phenol glycoside (picein and androsin) and 4-hydroxy-3-methoxyacetophenone (Medicinal plants of Nepal, 2016).

Distribution in Nepal: East to West 3500 – 4500 m.

Pharmaceutical notes:

It is available in tablet, liquid and powder form. Some of the formulation available are Aarogyavardhani Vati, Amritastak - Kwath, Arogyavardhini Vati, Katukadya Lauha, Kirattikadi - Kwath, Kusthadi Manjana (<http://eson.org.np/database/index.php>).

Conservation status:

Permitted only the identity of species harvested as kutki should be *Neopicrorhiza scrophulariiflora* and this identity should be confirmed by Department of Plant Resources.



Plate 77: Habit photo
(photo ©: C.M. Gurmachhan)

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

The rhizomes and roots are available in the intact form. Rhizome are cylindrical in shape, light to brown in color with numerous leaf scars present and rootlet scars present in the root. There are presence of transverse short fractures and longitudinal wrinkles in rhizomes. Rhizomes are easily breakable with creamy brown inner portion and eight to twelve distinct vascular bundles are seen (Plate 77).



Plate 78: Dried rhizomes

Organoleptic characteristics:

Powder is light brown in color, slightly aromatic odor and strongly bitter taste.

Microscopic characters:

Anatomy of Rhizome:

Transverse section of rhizome shows outer many layered cork cells (Plate 79a) followed by parenchymatous cortex (Plate 79b). Endodermis is distinct encircling a ring of stellar vascular bundles, consisting of a narrow phloem and wide xylem composed of vessels, fiber and parenchyma (Plate 79b). Pith is wide, parenchymatous embedded with starch grains and brownish orange coloring matter.

Powder microscopy:

Shows fragments of tangentially elongated thin walled cork cells (Plate 80a), cortex cells (Plate 80b), parenchymatous pith cells (Plate 80d) and reticulate vessels (Plate 80c) are seen.

Photo plates

Anatomy

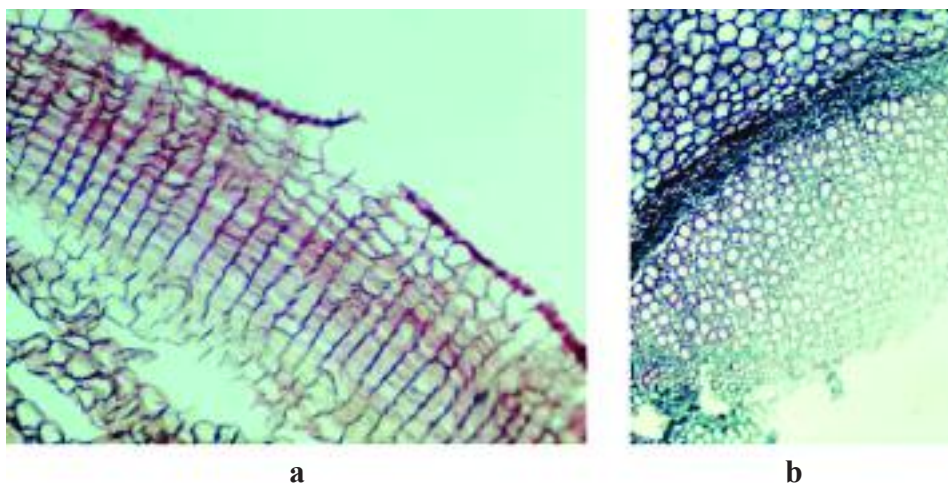


Plate 79: TS of rhizome of *Neopicrorhiza scrophulariifolia* a) Section showing cork region b) Section showing cortex and vascular region.

Powder analysis

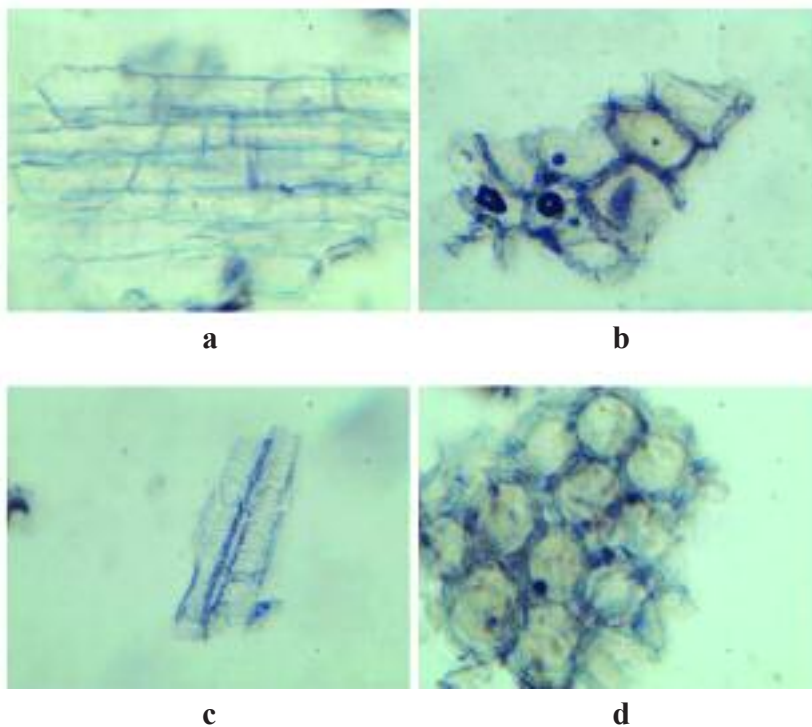


Plate 80: Powder characteristics of rhizome of *Neopicrorhiza scrophulariifolia* a) Cork cells b) cortex cells c) Reticulate vessels d) Pith.

पिपला (Pipalaa)

Scientific name : *Piper longum* Linn.

Family : Piperaceae

Other names : Long pepper (Eng), Pipla, Murjhang, Pipalamul (Hind) Pipali, Granthika, Magadhi (Sans)

Description:

A slender ascending or trailing aromatic plant. Leaves simple, alternate, ovate-cordate with broad rounded lobes at the base. Lower leaves, 6 – 10 cm long and 3 – 5 cm wide. Upper ones are oblong-oval, cordate at the base. Dark green and shining above and pale on lower surface. Inflorescence is solitary spikes, male spikes narrow and those of female circular, 1.3 – 2.5 long and 4.5 mm diameter. Fruits ovoid, yellowish orange, sunk in fleshy spikes (Medicinal plants of Nepal, 2016).



Plate 81: Habit photo (photo ©: R. Tamang)

Flowering and fruiting : June - Aug.

Part used : Roots and fruits

Uses:

Roots are carminative, improve appetite, useful in bronchitis, abdominal pains, and diseases of spleen. Unripe but dried fruiting spikes are used as medicine and spices. These are used to relieve from cold, cough, asthma, hoarseness and hiccup (Medicinal Plants of Nepal, 2016).

Chemical constituents:

The alkaloids piperine, piperlongumine (piplartine), piperlonguminine and also methyl-3,4,5-trimethoxycinnamate are the major constituents. Others are sesamin, a lignan, dihydrostigmaterol and two low melting unstable compounds, one of which appear to be isobutylamide of an unsaturated acid, n-isobutyl-deca-trans-2-trans-4-dieneamide. Essential oil consisting of n-hexadecane, n-heptadecane, n-octadecane, n-nonadecane, n-cicosane, n-hencosane, a-thujene, terpinolene, zingiberine, p-cymene, p-methoxyacetophenone, dehydrocarveol and two monocyclic sesquiterpenes. The presence of L-tyrosine, L-cysteine hydrochloride, DL-serine and L-aspartic acid as free amino acids also has been reported in the fruits. Seeds contain sylvatine dieudesmin. In addition to palmitic, hexadecenoic, stearic, linoleic, oleic, linolenic, higher saturated acids, arachidic and behenic acids are also reported (Gupta et al., 2003).

Distribution in Nepal: East to West, 200 – 800 m.

Pharmaceutical notes:

It is available in the powder, liquid, tablet and semisolid form etc. some available formulations are Anandabhairva Rasa, Avipattikara Churna, Chitrakadi Vati, Chyavanaprasha Avaleha etc (<http://eson.org.np/database/index.php>).

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

Fruit: Dried spike fruits (Plate 82) are grayish black to brown in color of 1-2 cm in length and 2-3 mm diameter. Spike of fruits are cylindrical, slightly curved and blunt. Surface is rough. Broken surface shows a central axis around which 5-7 fruitlets are arranged.



Plate 82: Dried fruits

Organoleptic characteristics:

Powder is grayish brown in color, odor aromatic, taste aromatic, very pungent.

Microscopic characters:

Anatomy of spike fruit:

Transverse section shows outer epidermal layer (epicarp) of irregular cells filled with deep brown content covered externally by cuticle. It is followed by mesocarp, wide zone tangentially elongated parenchymatous tissue. Endocarp consists of outer thin walled colorless cells and inner tangentially elongated cells with reddish brown content (Heera et al., 2014). Vascular bundles (Plate 83c) showing xylem and phloem.

Powder microscopy:

Shows starch grains (Plate 84a), stone cells (Plate 84b) of epicarp and endocarp with reddish-brown substance, fibers (Plate 84d).

Photo plates

Anatomy

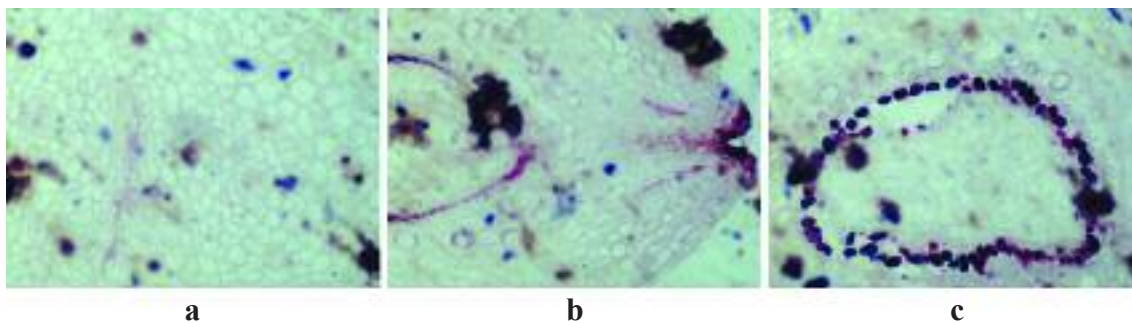


Plate 83: TS of Fruit of *Piper longum* a) Section showing outer layer b) Section showing pith region c) Section showing vascular region.

Powder analysis

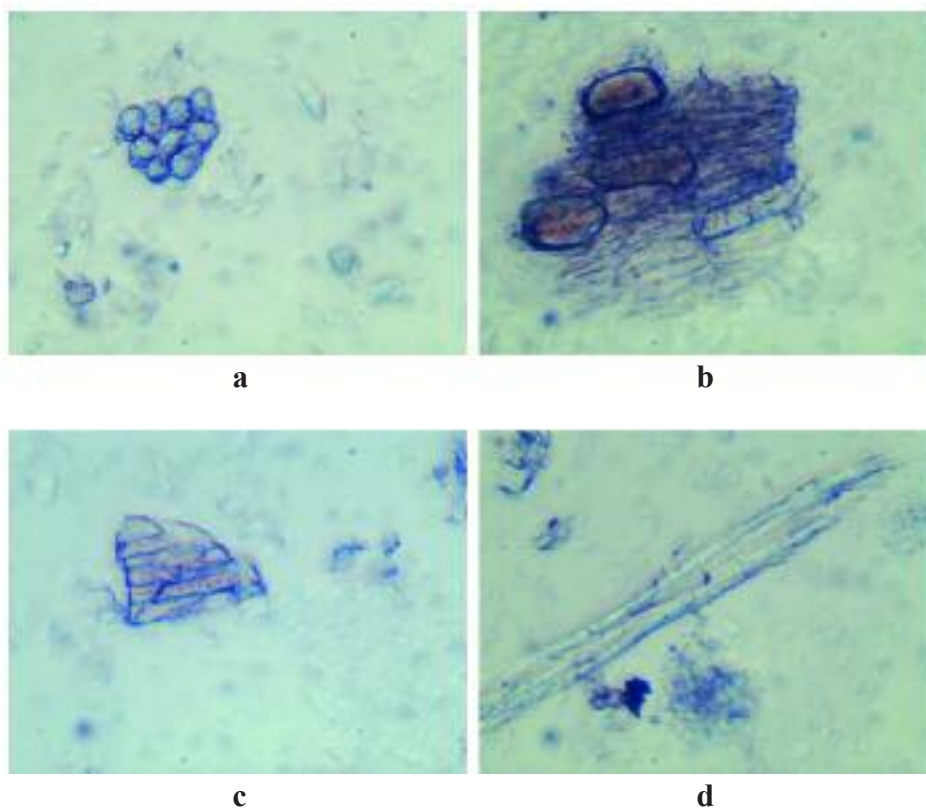


Plate 84: Powder characteristics of fruit of *Piper longum* a) Starch grains b) Stone cells c) Fragments of cells d) Fiber.

सर्पगन्धा (Sarpagandha)

Botanical name : *Rauvolfia serpentina* (L.) Benth.ex Kurz

Family : Apocynaceae

Other names : Rauvolfia, Serpent Wood, Serpentine (Eng), Chotachand, Chandmaruwa (Hind), Chandrika, Sarpagandha

Description of plant:

It is an evergreen, perennial, glabrous and erect under shrub grows up to a height of 60 cm (rarely more than it). Roots tuberous, cylindrical, brownish yellow, 4-10cm long, 0.5-1.5cm broad. Leaves whorls of three, elliptic to lanceolate or obovate, bright green above, pale green below, tip acute or acuminate, base tapering and slender, 10cm long and 5cm broad. Petioles short, Inflorescence is corymbs cymes. Flowers are irregular pinkish white. Fruits are drupe, 0.5cm in diameter and shiny black when full ripe (Medicinal plants of Nepal, 2016).



Plate 85: Habit photo (photo ©: C. Khanal)

Flowering and Fruiting : May - July

Distribution in Nepal : East to West, 100-900 m.

Part used: Root

Uses

Root is used in reducing blood pressure. It is also used as sedative and hypnotic. Roots are also useful in bowel disorder and fever. It is used in the treatment of insomnia, mental imbalance and insanity (Medicinal Plants of Nepal, 2016).

Pharmaceutical notes:

It is used in powder form and the formulations available in the market are sarpagandha vati and Sarpagandha Churna (Rajbhandary & Ranjitkar, 2006).

Conservation status:

Listed in CITES Appendix II, Ban for export without processing from Nepal.



Plate 86: Dried roots

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

The dried plants are broken into pieces measuring 4-8cm length. Outer layer creamy brown in color with inner yellowish solid layer. Numerous longitudinal fractures are seen (Plate 86).

Organoleptic characteristics:

Powder is yellowish green in color, do not have any characteristics odor and bitter in taste.

Chemical constituents:

Plant contains amino acids-arginine, lysine, serine, aspartic acid, glutamic acid, threonine, alanine, proline, valine, tyrosine, phenylalanine, iso-leucine, leucine, cystine, histidine, asparagine, glutamine, tryptophan and γ -aminobutyric acid. Root and root bark contain alkaloids-reserpine, ajmaline, ajmalicine, ajmalinine, yohimbine, coryanthine, iso-ajmaline, neo-ajmaline, papavarine, raubasinine, rauwolscine, reserpine, rescinnamine, sarpagine, serpentine, serpentinine and deserpidene. Roots also have α - and β -sitosterol (Husain et al.,1992). From the dried roots of *Rauwolfia serpentina* isolated five new indole alkaloids, N_b -methylajmaline, N_b -methylisoajmaline, 3-hydroxysarpagine, yohimbinic acid, isorauhimbic acid, a new iridoid glucoside, 7-epiloganin and a new sucrose derivative, 6-*O*-(3,4,5-trimethoxybenzoyl) glomeratose A (Itoh, et al.,2005)

Microscopic characters:

Anatomy of Root:

Transverse section of root shows outermost multilayered stratified cork (Plate 87a) composed of alternate bands of 5 to 10 rows of small sized suberised cells and 2 to 5 rows of big sized lignified cells. Phelloderm is parenchymatous embedded with starch grains and small sized crystals of calcium oxalate.

Phloem is narrow, parenchymatous, tranversed with medullary rays, latex cells, calcium oxalate crystals and starch grains. Cambium ring is distinct. Xylem (Plate 87b) is lignified, composed of few small sized isolated or radially arranged xylem vessels, tracheids and fibers alternating with uni or multiseriate medullary rays, parenchymatous cells are pitted and embedded with starch grains.

Powder microscopy:

It consists of fragments of cork cells (Plate 88b), small sized prismatic crystals of calcium oxalate (Plate 88d) and starch grains (Plate 88c). Longitudinally cut fragments xylem vessels (Plate 88a), xylem fiber (Plate 88e) and latex cells (Plate 88f) are also seen.

Photo plates

Anatomy

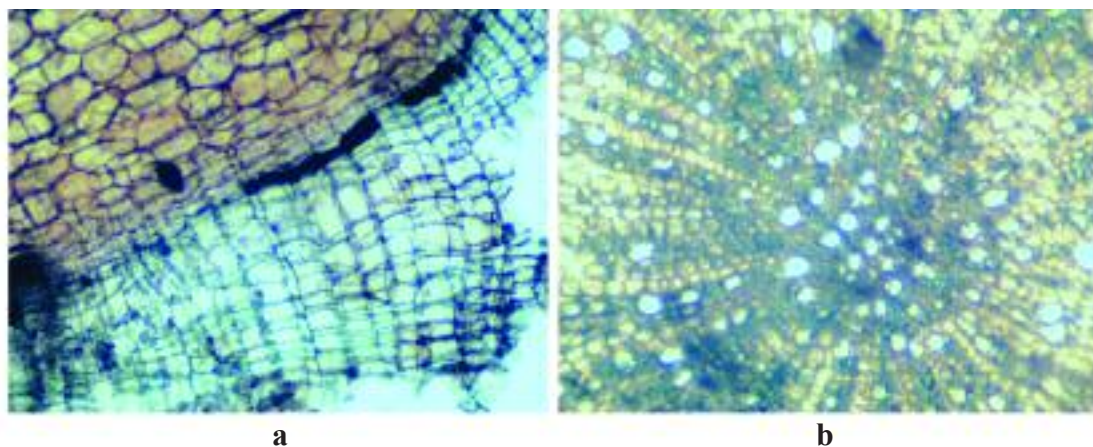


Plate 87: TS of root of *Rauvolfia serpentina* a) Section showing Cork and cortex b) Section showing xylem vessels.

Powder analysis

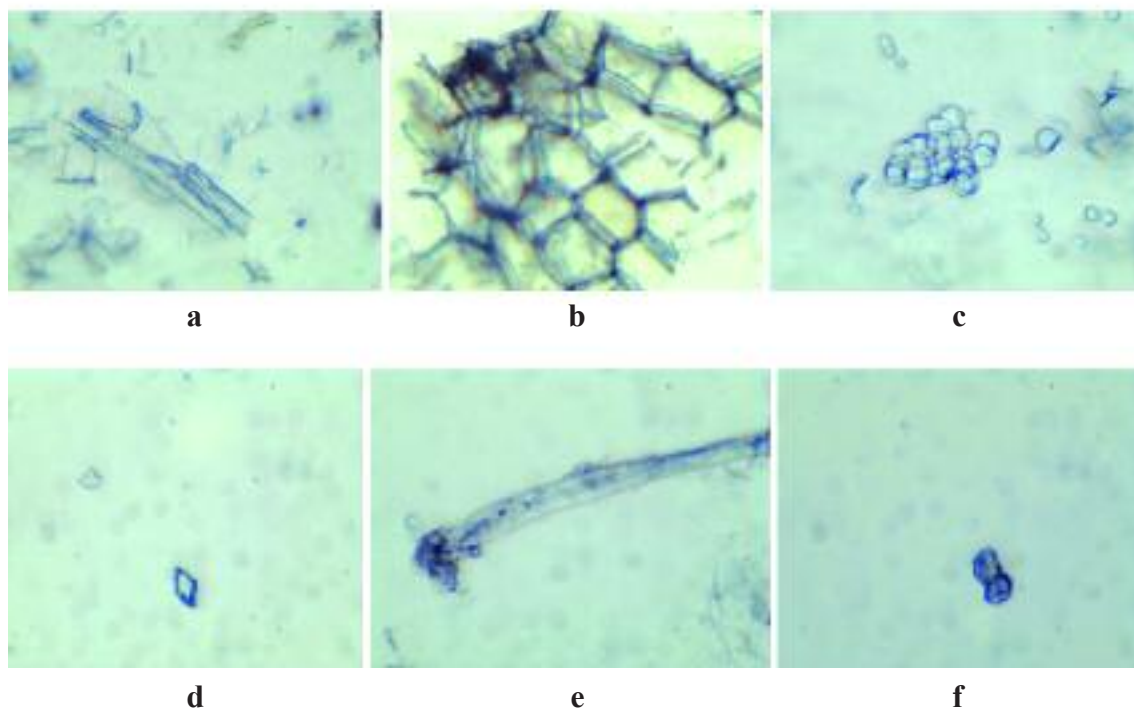


Plate 88: Powder characteristics of root *Rauvolfia serpentina* a) Vessel b) Cork cells c) Starch grains d) Crystal e) Xylem fiber f) Latex cells.

पदमचाल (Padamchaal)

Scientific name : *Rheum australe* D. Don

Rheum emodi Wall.

Family : Polygonaceae

Other names : Himalayan rhubarb (Eng), Revatchini (Hind) Revatchini, Pitimulika (Sans)

Description:

A tall and stout perennial herb, 1-1.5 m tall. Leaves simple, alternate, radical, petiole 30–45 cm long, orbicular or broadly ovate, cordate, very large often 60 cm in diameter. Inflorescence is branched and straight panicle, panicle 0.6–0.9 m long. Flowers small and dark reddish purple in. Fruits ovoid, oblong, 13 mm long, purple and 3 winged (Medicinal Plants of Nepal, 2016).



Plate 89: Habit photo
(photo ©: R. Tamang)

Flowering and fruiting : June–September

Parts used : Rhizome

Uses:

Rhizome is purgative, astringent, tonic and also useful in dysentery and loss of appetite. It should never be eaten by those who have tendency to gout, rheumatism, epilepsy or any uric acid diseases owing to the oxalic acid it contains (Medicinal Plants of Nepal, 2016).

Chemical constituents:

It contains chrysophanic acid, rheotannic acid (tannin), calcium oxalate, several resins, starch, sugar, and pectin (Watanabe et al., 2005). Rhizomes contain anthraquinone derivatives- rhein and emodin. The plant contain sennosides A-F also (Husain et al., 1992). It also contains five anthraquinones (chrysophanol, emodin, aloe-emodin, physcion and rhein) and two stilbenes (piceatannol and resveratrol) in the roots of *Rheum australe* (Rokaya et al., 2012)

Distribution in Nepal: East to West, 3200–4200 m.

Pharmaceutical notes:

Some available formulation is Lavanbhaskar-churna (<http://eson.org.np/database/index.php>).

Note: It is included in 33 prioritized plants for economic development of Nepal.

Conservation status:

Vulnerable

Macroscopic characters:

Rhizome and root are stout, cylindrical, barrel or plano-convex pieces. Outer surface irregularly longitudinally wrinkled, furrowed or ridged, with some pieces exhibiting transverse annulations or wrinkles and cracks. Fracture hard and fractured surface shows radiating medullary rays, a ring of cambium and central pith in rhizomes, absent in root, color reddish brown (Plate 90).



Plate 90: Dried rhizomes

Organoleptic characteristics:

Powder is reddish in color, odor somewhat fragrant and taste bitter and astringent.

Microscopic characters:**Anatomy of Rhizome:**

Transverse section of rhizome shows outermost tangentially elongated, radially arranged suberised cells of the cork (Plate 91a). Cork is followed by narrow parenchymatous cortex.

20 -30 rows of phloem tissue lies underneath this consisting of sieve tubes, parenchyma, companion cells and uni to biserate medullary rays, in continuation with that of xylem. Cambium is distinct, xylem (Plate 91c) consists of vessels, tracheids, fibres, parenchyma. Rosette crystals of calcium oxalate, simple and compound starch grains (Plate 91b) and occasional yellow pigment, traverse throughout the parenchymatous cells of the section.

Powder microscopy:

Shows macro-rosette crystals of calcium oxalate (Plate 92b), abundant simple and compound starch grains (Plate 92f) of various sizes and shapes. Non lignified reticulated xylem vessels (Plate 92c,d and e) and cork cells (Plate 92a) are seen.

Photo plates

Anatomy

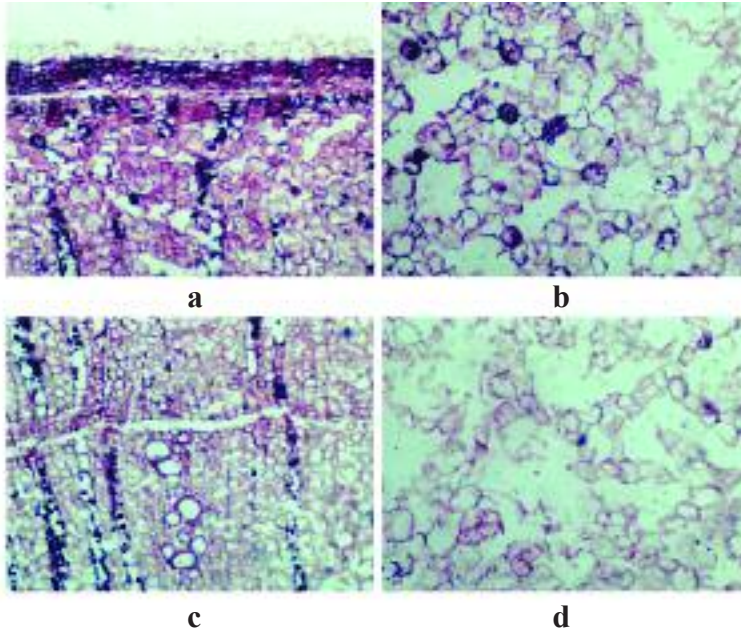


Plate 91: TS of rhizome of *Rheum australe* a) Section showing outer region b) Section showing parenchymatous cells with starch grain c) Section showing vascular bundle region d) Section showing pith region.

Powder analysis

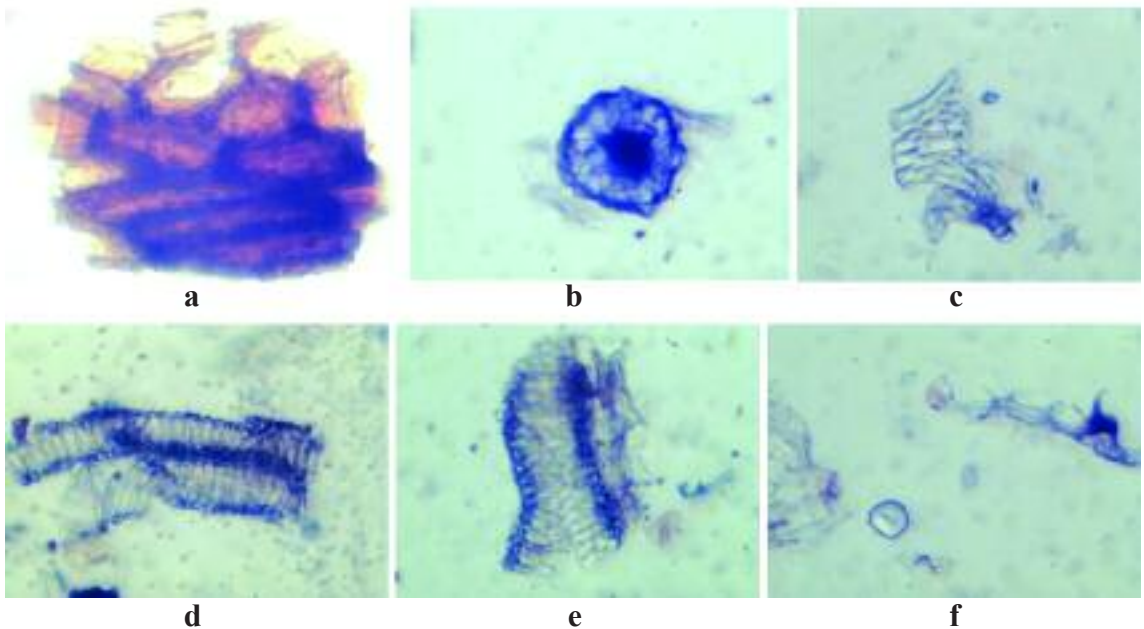


Plate 92: Powder characteristics of rhizome of *Rheum australe* a) Cork b) Crystal c), d) and e) Vessels f) Starch grains.

चिराइता (Chiraito)

Scientific name : *Swertia chirayita* (Roxb.) Buch.-Ham. ex C.B. Clarke

Gentiana chirata Roxb. ex Fleming

Family : Gentianaceae

Other names : Chiretta (Eng), Chirayata (Hind), Kirata tikta (Sans)

Description:

An erect bi-annual herb, 0.3–1 m tall, robust branching. Root yellowish brown. Stem grayish brown, glabrous, quadrangular. Leaves simple, opposite, sub-sessile, about 10 cm long, 3 nerved, broadly lanceolate. Inflorescence large panicle. Flowers small, tubular, pale greenish white. Petals lobe with a pair of green glands. Fruits capsules 6 mm, ovoid (Medicinal Plants of Nepal, 2016).



Plate 93: Habit photo (photo ©: R. Tamang)

Flowering and fruiting : July-August

Part used : Entire plant

Uses:

The plant is excellent drug for intermittent fever, skin diseases, intestinal worms, and bronchial asthma. It is also used in diarrhea and liver problem. It is prescribed in dyspepsia, debility of convalescence (Medicinal Plants of Nepal, 2016).

Chemical constituents:

Plant contains amarogentin and amarosweren as major component and others are chiratol, methyl bellidifolin, decussating, 7-O-methylswertianin, magniferin, swertianin, swertinin, chiratanin, gamacer-16-en-3 β -ol, 21 α -H-hop-22(29)-en-3 β -ol, swettenol, episwertenol, pichierenol, kairatenol, secoiridoidglycosides: swertiamarin, gentiopicroside and alkaloids: gentianine and enicoflavine (Medicinal Plants of Nepal, 2016).

Distribution in Nepal: East to Central, 1500–2500 m.

Pharmaceutical notes:

It is available in the powder and tablet form. Some available formulations are Chandraprabha Vati, Mahasudarshana Churna, Phaltrikadi Kwatha and Sudarshan Churna etc (<http://eson.org.np/database/index.php>).

Conservation status:

Vulnerable.

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

The dried plant (Plate 94) is broken into pieces. Root cylindrical with hair like secondary roots. Stem cylindrical at base whereas quadrangular at top. Roots more or less rough with scar of secondary roots, fracture short and conspicuous. Stem smoother than root with leaf scar, fracture short and inconspicuous. Root is brownish and stem is greenish brown in color. Leaf somewhat rough but glabrous, three to five nerve, dark greenish in color, petiole absent.



Plate 94: Dried stems, roots and fruits

Organoleptic characteristics:

Powder is brown in color, odor bitter and extremely bitter taste.

Microscopic characters:**Anatomy of Stem:**

Transverse section of stem shows the outermost single layered epidermis made up of barrel shaped cells with anticlinal walls. Epidermal cells are covered by a thick cuticle. Epidermis is followed by 4-5 layered parenchymatous cortex. Cortex is followed by distinct endodermis showing anticlinal or periclinal walls (Plate 95a).

It posses a distinct amphipholic siphonostele. Xylem is composed of tracheids, fibers and few vessels, mostly single or rarely in groups of two (Plate 95b). Medullary ray absent. The central part of the stele is occupied by alarge easily separable pith having pronounced intercellular spaces. Cells contain minute acicular crystals in abundance (Plate 95c).

Powder microscopy:

It contains abundant pith parenchyma (Plate 96c), vessels with spiral and pitted walls (Plate 96a and b), fibers (Plate 96d) and cork cells (Plate 96e) are seen.

Photoplates

Anatomy

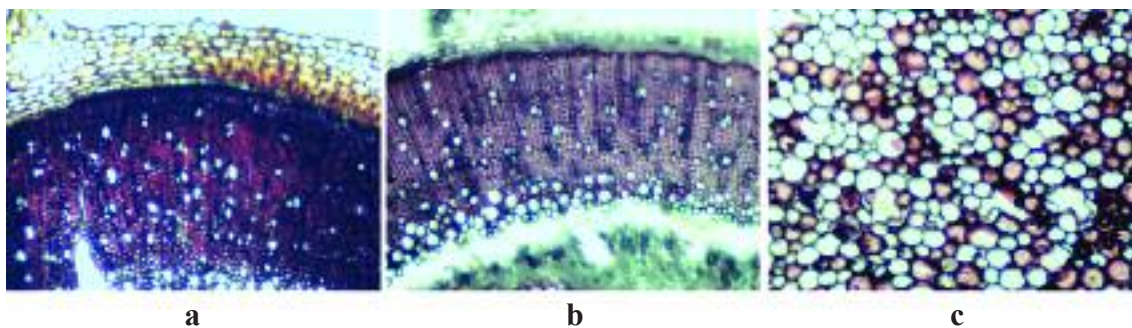


Plate 95: TS of stem of *Swertia chirayita* a) Section showing epidermis and cortex b) Section showing vascular region c) Section showing pith region.

Powder analysis

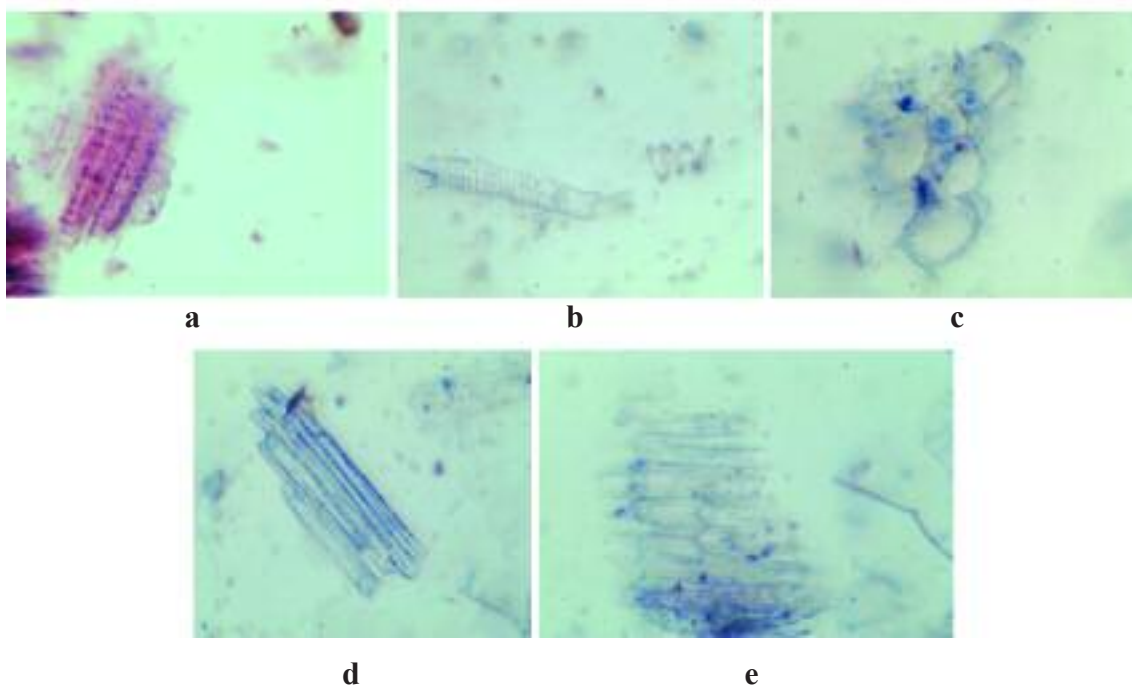


Plate 96: Powder characteristics of aerial part of *Swertia chirayita* a) Spiral vessel b) Pitted vessel c) Parenchyma d) Fiber e) Cork.

लोठसल्ला (Lothsallo)

Scientific name : *Taxus wallichiana* Zucc.

Family : Taxaceae

Other names : Himalayan Yew (Eng), Talispatra (Hind), Madhuparni, Talis (Sans)

Description:

An evergreen much branched coniferous tree to nearly 30 m tall. Leaves linear, flat, curved, spine tipped, leathery and dark glossy green, 2–3.5 cm long and 3 mm broad. Flowers unisexual; male flowers with short stalk in axils of leaves; female flowers solitary, axillary, green. Fruits red fleshy, 8 mm in diameter. Seeds encircled by a fleshy red aril (Medicinal Plants of Nepal, 2016).



Plate 97: Habit photo (photo ©: R. Tamang)

Flowering and fruiting : May-August

Parts used: Bark and leaf

Uses:

Taxol extracted from bark and leaves of this plant is used as anti-tumor agent and also to cure cancer particularly of breast and uterus. It is also used in asthma and bronchitis (Medicinal Plants of Nepal, 2016).

Chemical constituents:

Plant contains mainly baccatin, 19-hydroxybaccatin III, cephalomannine, 10-deacetylcephalomannine, taxol, 10-deacetyltaxol, 13-hydroxybaccatin I, 10-deacetyl baccatin III, 13-deacetyl baccatin VI, 2-deacetoxytaxinine, baccatin IV and many taxoids (McLaughlin et al., 1981). A new taxane diterpenoid, 7 α , 9 α , 10 α , 13 α , 15-pentahydroxy-2 α , 4 α -diacetoxy-abeo-baccatin-VI, has been isolated from the bark of *Taxus wallichiana* Zucc along with three known substances, 4-(4'-hydroxyphenyl)-2-butanone, 4-(4'-hydroxyphenyl)-2-butanol and 9-hydroxy-4,7-megastigmadiene-3-one-3-oxo- α -ionol (Rahman, et al., 2003).

Distribution in Nepal: East to West, 2300-3400 m.

Pharmaceutical notes:

Some available formulations are Talisadi Bati and Talisadi Churna (<http://eson.org.np/database/index.php>).



Plate 98: Dried leaves

Conservation status:

Listed in CITES Appendix II. Ban to export without processing from Nepal.

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

Dried drug consist of entire or broken pieces of needles. Needles simple, linear and narrow, glabrous, 1.5 to 4 cm long and 1.5 to 2 mm wide, margin entire or recurved, base twisted, narrowing into a short petiole, apex acute, midrib prominent on upper side. Dorsal surface greenish brown to copper brown and ventral surface greenish yellow (Plate 98)

Organoleptic characteristics:

Powder is dark brown in color, odor characteristic and taste astringent and bitter.

Microscopic characters:**Anatomy of Needle:**

Transverse section of needle shows upper epidermis (Plate 99a) consisting of polygonal tubular cells filled with dark brown contents and covered with thick cuticle. Lower epidermis (Plate 99a) of smaller cells with dark brown contents and papillose cuticle. Upper epidermis is followed by bilayered palisade and loosely packed spongy parenchymatous cells (Plate 99b). Vascular strand consists of a radiate xylem and phloem. An arc of compact sclerenchymatous tissue is present over xylem and encircled by a parenchymatous layer containing dark brown contents.

Powder microscopy:

Shows fragments of upper epidermis of thin-walled polygonal cells (Plate 100b), fragments of lower epidermis of thin-walled rectangular cells with papillose cuticle and rows of sunken stomata guarded by orange colored guard cells (Plate 100a), fragments of bilayered palisade with attached epidermis (Plate 100c) and fiber (Plate 100d).

Photo plates

Anatomy

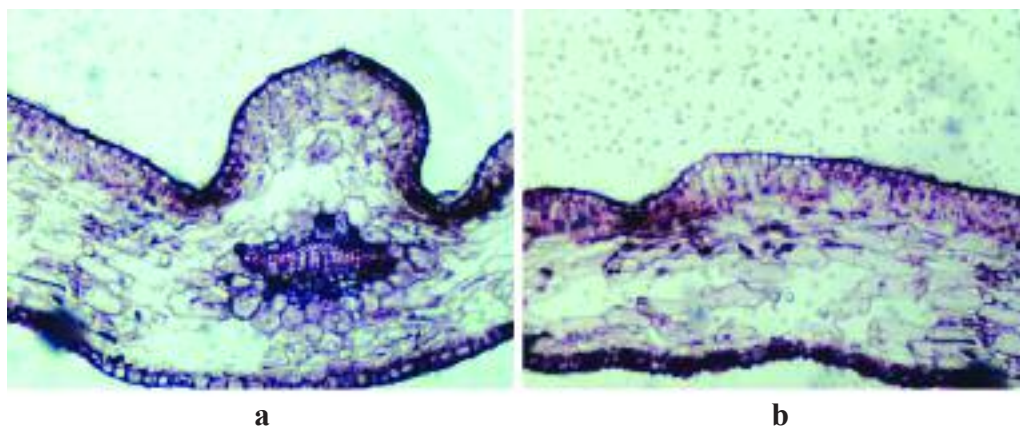


Plate 99: Vs of Leaf of *Taxus wallichiana* a) Section showing upper epidermis parenchyma and vascular region b) Section showing epidermis, palisade layer, spongy parenchyma and lower epidermis.

Powder analysis

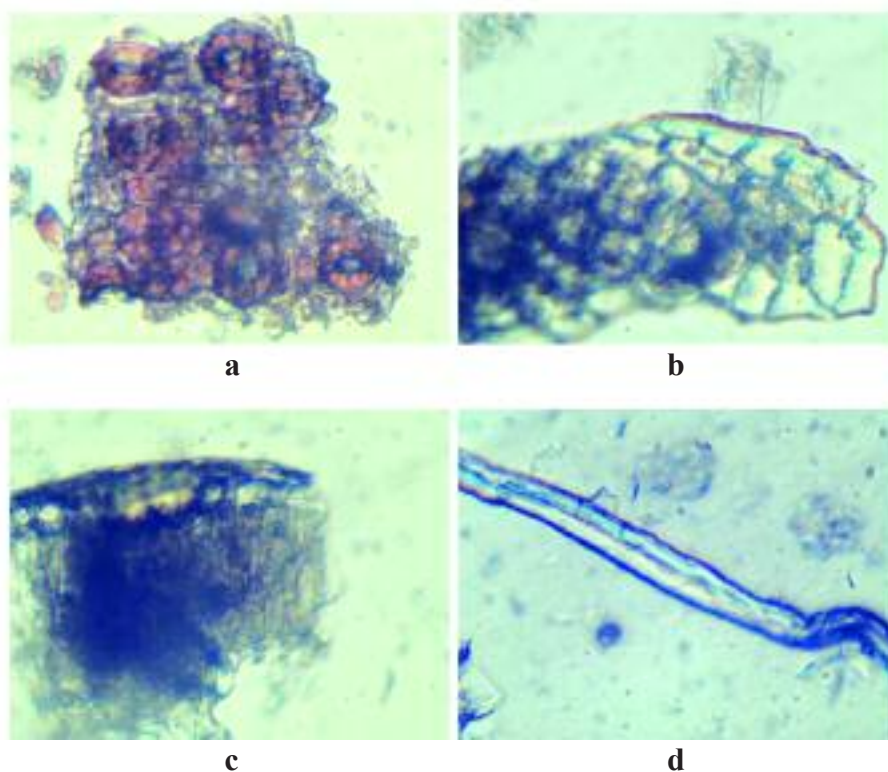


Plate 100: Powder characteristics of leaf of *Taxus wallichiana*. a) Lower epidermis with papillose cuticle and sunken stoma b) Upper epidermis c) Epidermis with palisade, d) Fiber

अर्जुन (Arjun)

Scientific name : *Terminalia arjuna* (Roxb. ex DC.) Wight & Arn.

Pentaptera arjuna Roxb.

Family : Combretaceae

Other names : Arjun (Eng), Arjun, Kahuwa (Hind), Arjunah, Kakubhah (Sans)

Description:

A large evergreen tree of 10-20 m tall. Leaves simple, sub-opposite, stalked, oblong or elliptic, coriaceous, crenulate, pale dull green above, pale brown beneath, unequal sided, nerves 10–12 pairs. Inflorescence is terminal panicle spikes. Flowers white. Fruits ovoid or oblong with 5–7 short hard angles or wings (Medicinal Plants of Nepal, 2016).



Plate 101: Habit photo
(photo ©: R. Tamang)

Flowering and fruiting : May - June

Parts used : Bark

Uses:

Bark is astringent, cooling, aphrodisiac, demulcent, cardio-tonic, dysenteric and tonic. Juice of fresh leaves is applied in ulcer and earache (Medicinal Plants of Nepal, 2016).

Chemical constituents:

Fruits contain flavanones- arjunone and 5,7,2',4'-tetramethoxyflavone; a calcone- ceracedin, β -sitosterol, friedelin, methyloleanolate, gallic acid, ellagic acid, and arjunic acid. Bark affords arjungenin, triterpene glucosides I, II, and III; stem bark yields flavones- baicalein and arjunolone (Husain et al., 1992). Arjuna contains specific active constituents namely Arjunilic acid, Tomentosic acid, Sitossterol, Triterpine glycosides like Arjunetosides , Arjunine and Arjunetein. The bark is rich in Saponnins, natural anti-oxidants (flavonoids- arjunone, arjunolone, leteilin), gallic acid, ellagic acid, phytosterols, rich in minerals like calcium, magnesium, zinc and copper, reducing sugars & coloring matter (Kumar, 2014).

Distribution in Nepal: Cultivated

Macroscopic characters:

Flat or slightly curved, varying in size up to 15 cm or more in length, 10 cm in width, 0.5 to 1.5 cm in thickness. Outer surface smooth, pale greenish yellow, inner surface



Plate 102: Dried barks

finely longitudinally striated and pinkish in color, fracture laminated (Plate 102).

Organoleptic characteristics:

Powder is reddish brown in color and taste astringent.

Microscopic characters:

Anatomy of Bark:

Transverse section shows outer cork (Plate 103a) consists of a few layers of tangentially running and radially elongated cells, phellogen, 2 to 4 celled thick, phelloderm narrow, consisting of 4 to 6 rows of tangentially elongated and radially arranged cells.

Phloem (Plate 103c), very broad, traversed by uniseriate medullary rays running straight and parallel, occasionally becoming slightly curved near the rosette crystal, groups of phloem fibres, lignified, thin-walled, tangentially arranged, associated with idioblasts containing clusters and rosettes of calcium oxalate. Some parenchymatous cells of cortex (Plate 103b) and secondary phloem contain reddish brown pigment and some cells contain starch grains.

Powder microscopy:

Powder exhibits cork cells (Plate 104c), clusters and rosettes of calcium oxalate crystals (Plate 104a and b), starch grains (Plate 104e) and fragments of thin-walled fibers (Plate 104d).

Photo plates

Anatomy

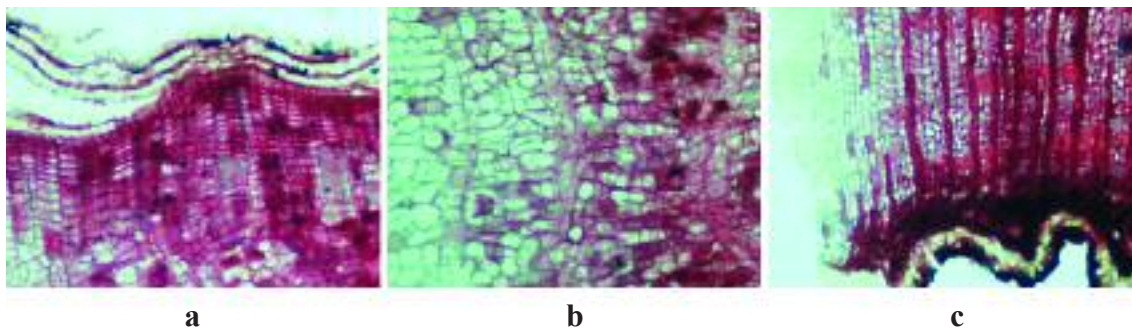


Plate 103: TS of bark of *Terminalia arjuna* a) Section showing cork region b) Section showing cortex region c) Section showing phloem and medullary rays.

Powder analysis

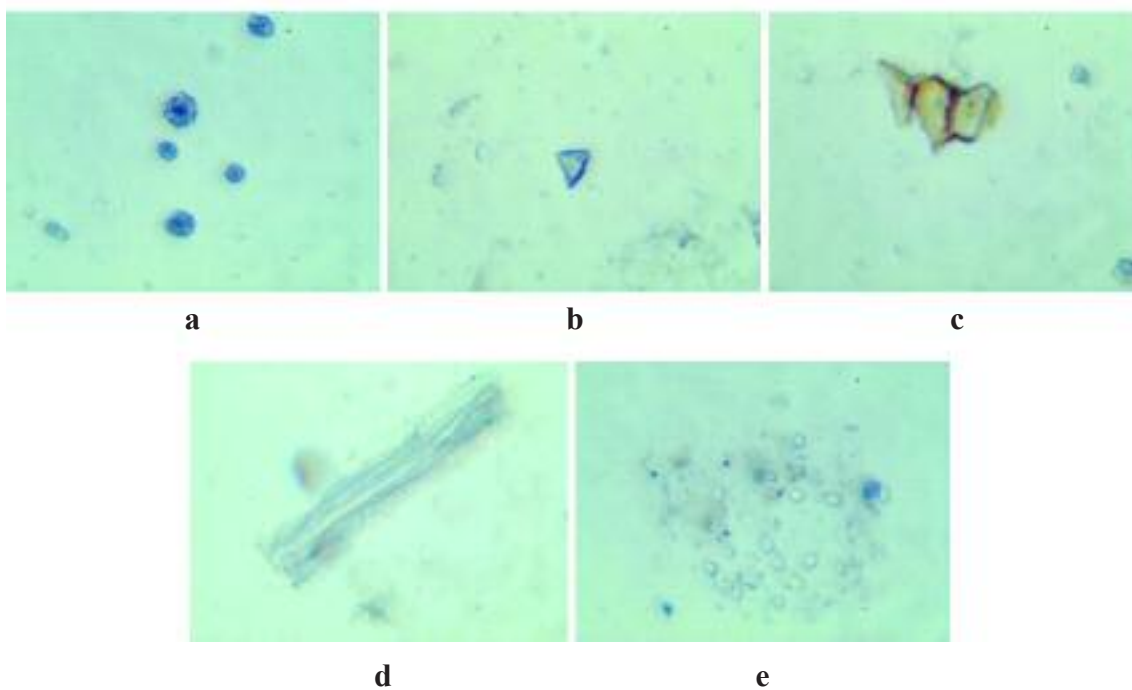


Plate 104: Powder characteristics of bark of *Terminalia arjuna* a) and b) Crystals c) Cork cells d) Fiber e) Starch grains.

गुर्जो (Gurjo)

Botanical name : *Tinospora sinensis* (Lour) Merr.

Family : Menispermaceae

Other names : Heart leaved moonseed (Eng), Giloe, Gilayo, Gurcha (Hindi), Amritavalli, Guduchi, Madhuparni (Sans)

Description of plant:

A large deciduous climber with succulent stem, aerial roots branches. Leaves simple, alternate, stalked, 7-9 nerved, ovate or roundish, cordate at the base, 5-10 cm. Flowers very small, male and female separate, male flowers grouped in axils of bracts; female solitary yellow. Fruit red drupe, as the size of pea (Medicinal Plants of Nepal, 2016).



Plate 105: Habit photo (photo ©: D. Saud)

Flowering and Fruiting : April-May

Distribution: Central and Eastern, 300m-500m.

Chemical constituents:

Leaves give cordifolone and heptacosano L. Stems afforded cordifol, tinosporidine, tinosporide, perberilin, hepatacosanol and β -sitosterol. The creeper contains tinosporon, tinosporic acid, tinosporol, Tinosinen, Tinosinside B (Medicinal Plants of Nepal, 2016).

Parts used: Stem

Uses:

It is immunomodulator and hepatoprotective (Medicinal Plants of Nepal, 2016).

Pharmaceutical notes:

It is available in powder, tablet and liquid form. Some available formulations are Guduchayadi Churna, Chyavanaprasha Avaleha, Dashmularista, Kamadugha Rasa and Sanjivani Vati etc (<http://eson.org.np/database/index.php>). .

Conservation status:

Vulnerable

Note: It is included in 33 prioritized plants for economic development of Nepal.



Plate 106: Dried stems

Macroscopic characters:

Dry stems with bark intact constitute the drug. Stem terete, scarcely lenticellate and often producing filiform aerial roots. Young stem green with a smooth surface, older ones have a warty surface due to the presence of circular lenticels. Fracture fibrous (Plate 106).

Organoleptic characteristics:

Powder is creamish brown in color, odorless and taste is intensely bitter

Microscopic characters:

Transverse section of stem shows the epidermis comprises of an outer zone of thick walled brownish compressed cells (Plate 107a). Epidermis is followed by 2-3 layers of collenchymatous cortex and 4-6 layers of parenchymatous cortex consisting of circular to isodiametric types of cells (Plate 107a and b). Beneath the cortex, a ring of continuous pericycle composed of 4-6 layers of slightly thick walled lignified fibers capping the vascular bundle and medullary rays.

Vascular bundle is composed of discrete vascular strands with 10-12 or more wedge shaped strips of xylem, externally surrounded by semi circular strips of phloem, alternating with wide medullary rays. Cambium is of 1-2 layers. Xylem consists of vessel elements, tracheids, parenchyma and fibers (Plate 107d). Vessel elements are cylindrical in shape bearing bordered piths. Pith mostly made up of large thin walled cells containing starch grains (Plate 107c).

Powder microscopy:

It consists of starch grains (Plate 108d), fibers (Plate 108c), calcium oxalate crystals (Plate 108b), vessels with bordered piths (Plate 108e).

Photo plates

Anatomy

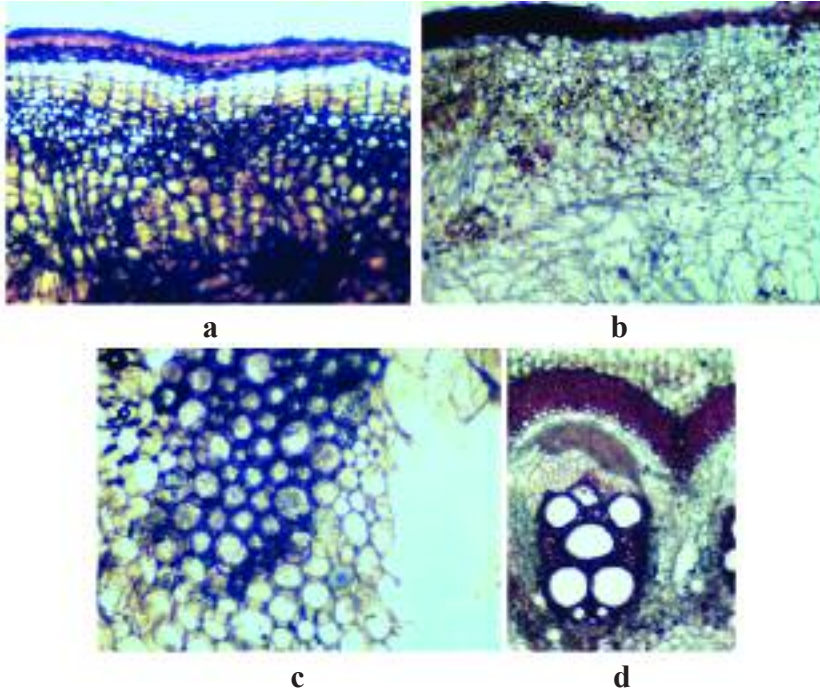


Plate 107: TS of stem of *Tinospora sinensis* a) Section showing epidermis b) Section showing cortex region c) Section showing pith region d) Section showing vascular bundle.

Powder analysis

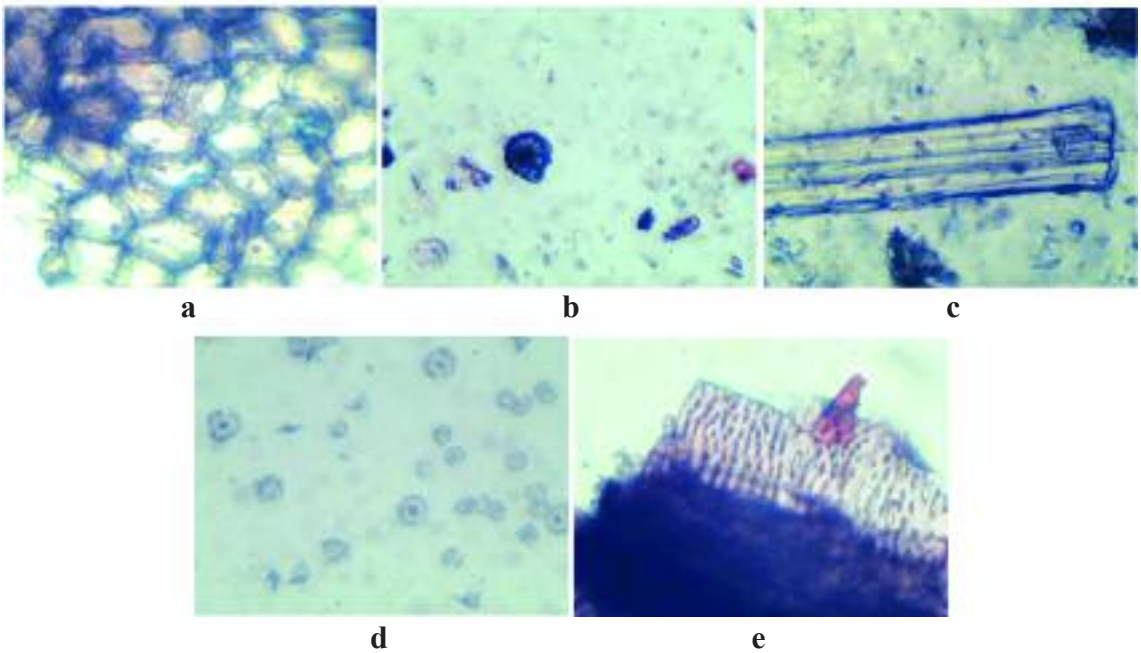


Plate 108: Powder characteristics of stem of *Tinospora sinensis* a) Cork cells b) Rosette crystal c) Fiber d) Starch grains e) Pitted vessels.

सुगन्धवाल (Sugandhawaal)

Scientific name : *Valeriana jatamansi* Jones

Valeriana wallichii DC

Family : Caprifoliaceae

Other names : Indian valerian (Eng), Tagar (Hindi), Natah, Tagar (Sans)

Description:

A perennial herb to 45 cm tall with thick, horizontal, nodular and aromatic root stock. Basal leaves with ovate-heart shaped, acute blade, 2.5–8 cm, and toothed or wavy-margined, long stalked. Stem leaves few, small, entire or pinnate lobed. Inflorescence in terminal clusters. Flowers white or pink tinged, borne on erect nearly leafless stem. Fruits small with persistent pappus like calyx (Medicinal Plants of Nepal, 2016).



Plate 109: Habit photo (photo ©: C. Khanal)

Flowering and fruiting : February–May

Parts used : Rhizome and root

Uses:

Rhizomes are used as a substitute of *Valerian*. Rhizomes and roots are useful in hysterical fits, other nervous disorders and flatulence. Roots are used in afflictions of eyes and blood and enlargement of liver and spleen. Oil extracted from the rhizome is used in cosmetics industries (Medicinal Plants of Nepal, 2016).

Chemical constituents:

Rhizomes and roots contain cyclopentapyrans, acacetin-7-O-rutinosides, valtrate, didrovaltrate, linarin *iso* valerinate, valepotriates and an iridoid ester glycoside-valerosidatum. Main acids present in the oil are isovaleric acid and (+)- β -methyl valeric acid. Other acidic constituents are formic, propionic, butyric, palmitic and stearic acids and isovaleryl ester of D(-)- α -hydroxyvaleric acid. Essential oil from roots with rootlets contain β -sitosterol, substantial amount of patchouli alcohol and small amount of patchouli alcohol and small amounts of α -, β - and $\tilde{\alpha}$ - patchoulene and maaliol in traces (Husain *et al.*, 1992). Hydrodistilled oil obtained from the whole plant of *Valeriana jatamansi* Jones. consisted mainly of sesquiterpenes viz. carotol, germacrene B, *cis*- $\tilde{\alpha}$ -farnesene, $\tilde{\alpha}$ -humulene and humulene oxide (Agnihotri *et al.*, 2013).

Distribution in Nepal: East to West, 1500–3300 m.

Pharmaceutical notes:

Some available formulation are Dasanga - Lep, Dhanyapanchak Churna, Pipalyasav, Shringarabhra and Sudarshan - Churna etc (<http://eson.org.np/database/index.php>).

Conservation status:

Vulnerable, Ban for export without processing from Nepal.

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

Dried pieces of the rhizome are sub-cylindrical, somewhat flattened dorsiventrally, often slightly curved, bear numerous long, wiry adventitious roots. They exhibit numerous encircling leaf scars and circular root scars at the side and at the lower surface. Pieces of rhizome are often connected by longitudinally wrinkled cylindrical stolon, with distinct nodes, internodes, color dark brown externally, pale brownish-yellow internally. Fractured short and horny (Plate 110).

Organoleptic characteristics:

Powder is dark brown in color, odor strong, unpleasant and penetrating, Taste camphoraceous and somewhat bitter.

Microscopic characters:**Anatomy of rhizome:**

Transverse section of rhizome shows outermost cork (Plate 111a) consisting of 3 to 5 rows of rectangular to squarish, thick-walled suberized cells. Underneath of which lies 1 to 2 rows of cork cambium and 5 to 8 rows of collenchyma. Cortex (Plate 111b) very wide, parenchymatous, consisting of 20 to 30 rows. Endodermis distinct, pericycle parenchymatous of 1 to 3 layers, occasionally containing tannins, enclosing a ring of the xylem (Plate 111c) isolated, or in small groups associated with thick-walled fibres and parenchyma inner vessels mostly radially arranged. Phloem (Plate 111c) wide, parenchymatous forming a cap over the xylem. Pith parenchymatous (Plate 111d), wide simple and compound starch grains of 2 to 5 components. Oil globules are filled in the parenchymatous cells of the whole section.

Powder microscopy:

Shows fragments of the thick-walled suberized cells of the cork (Plate 112a), longitudinally cut groups of spiral xylem vessels (Plate 112d), spherical simple, compound starch grains (Plate 112c) and yellowish brown oil droplets (Plate 112b).



Plate 110: Dried rhizomes

Photo plates

Anatomy

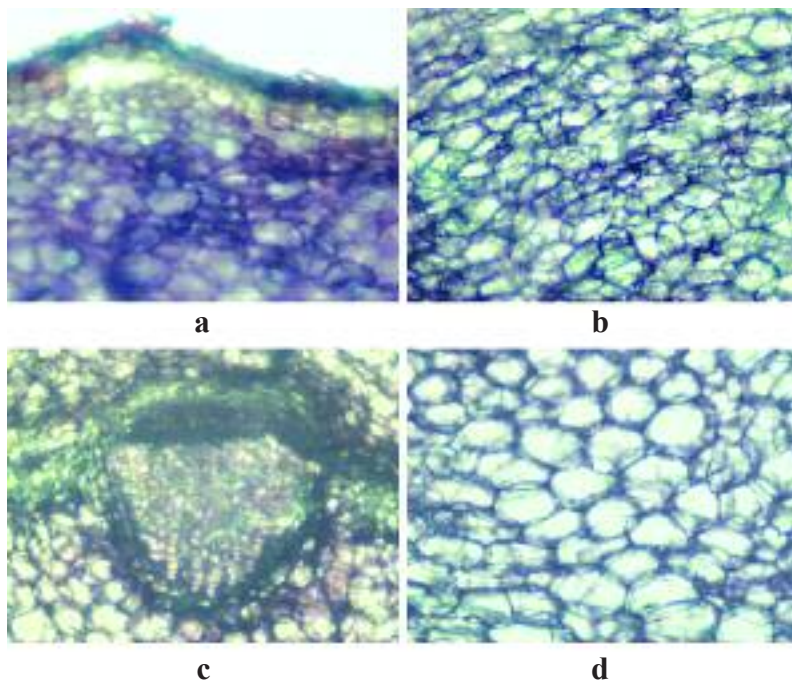


Plate 111: TS of rhizome *Valeriana jatamansi* a) Section showing epidermis and cortex b) Section showing cortex c) Section showing vascular bundle d) Section showing pith.

Powder analysis

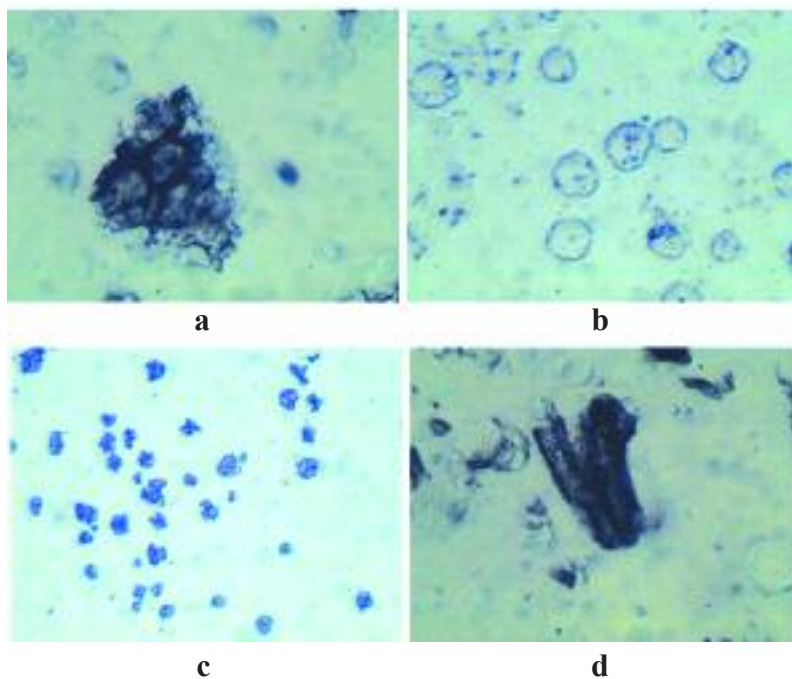


Plate 112: Powder characteristics of rhizome of *Valeriana jatamansi* a) Cork cells b) Oil globule c) Starch grains d) Vessels.

अश्वगन्धा (Ashwagandha)

Scientific name : *Withania somnifera* (L.) Dunal

Family : Solanaceae

Other names : Winter cherry (Eng), Asgandh, Punir (Hind), Asvagandha, Varahkarni (Sans)

Description:

An erect shrub upto 1.5 m tall, densely velvety stems. Leaves simple, short stalked, alternate, ovate 5 -10 cm long. Inflorescence in umbelliform cymes. Flowers greenish or yellowish white. Fruits globose berries, orange when mature, enclosed in a persistent calyx (Medicinal Plants of Nepal, 2016).

Flowering and fruiting : July – September

Parts used : Root, leaf, fruit and seed.



Plate 113: Habit photo (photo ©: R. Tamang)

Uses:

Roots are alterative, aphrodisiac, tonic, deobstruent, diuretic, narcotic, abortifacient and also used in rheumatism and debility from old age and emaciation of children. Infusion of leaves is given in fever. Bruised leaves and ground root are locally applied to painful swellings, carbuncles and ulcers. Fruits are diuretic. Seeds are hypnotic, diuretic and used for coagulating milk (Medicinal Plants of Nepal, 2016).

Chemical constituents:

Root contains alkaloids- nicotine, somnine, somniferine, somniferinine, withanine, withananine, withananine, pseudo-withanine, tropine, pseudotropine, 3 α -tigloyloxytropine, choline, cusculohygrine, anaferine, anahygrine, withasomine, visamine and withanolides. Leaves contain withanolides (Medicinal Plants of Nepal, 2016).

Distribution in Nepal: Cultivated

Pharmaceutical notes:

Some available formulations are Ashvagandha Churna, Ashvagandha Ghirt, Ashvagandha Taila, Shaktivardhaka Yoga and Ashwagandharishta (<http://eson.org.np/database/index.php>).



Plate 114: Dried roots

Macroscopic characters:

Dried root is conical to cylindrical, rough longitudinally wrinkled at places exhibit lenticels and wiry brittle rootlets or scars left by their removal, fracture short and starchy, externally buff, internally white.

Organoleptic characteristics:

Powder is yellowish in color, taste slightly sweet and odor characteristic.

Microscopic characters:**Anatomy of Root:**

Transverse section of roots shows outermost 4 to 8 rows of suberised cells of cork (Plate 115a), occasionally at places interrupted by lenticles. Followed by 15 to 25 layers of cortical parenchyma (Plate 115b), loaded with simple, compound starch grains and microsphenoidal crystals of calcium oxalate. Underneath this lies narrow parenchymatous phloem (Plate 115c) containing starch grains, uni to multiseriate medullary rays in continuation with xylem. Cambium is distinct. Xylem (Plate 115c) is wide consisting of isolated or rarely groups of 2 to 3 vessels embedded in thin-walled fibers occupying the major area of the wood.

Powder microscopy:

Shows abundant, simple and compound, spherical, oval or cup shaped starch grains (Plate 116e and f), microsphenoidal crystals of calcium oxalate embedded in the parenchymatous cells of the cortex, fragments of suberised cork (Plate 116a), fragments of longitudinally cut pitted vessels (Plate 116c and d) and fibers (Plate 116b).

Photo plates

Anatomy

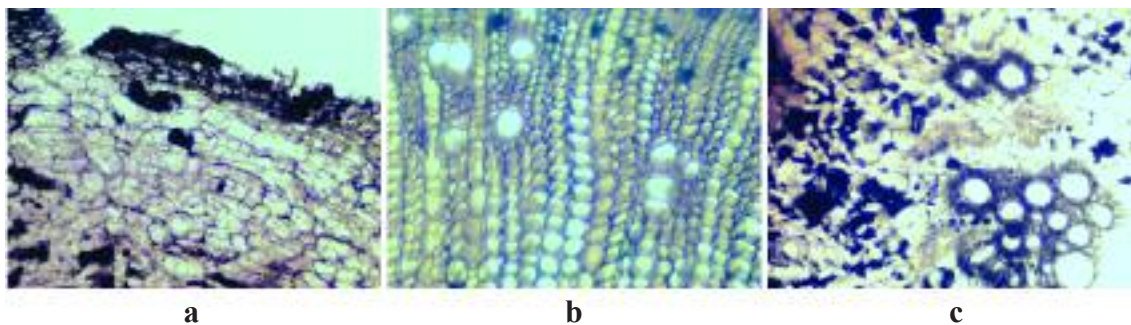


Plate 115: Transverse section of root of *Withania somnifera* a) Section showing cork and cortex b) Section showing cortex region c) Section showing vascular bundle.

Powder analysis

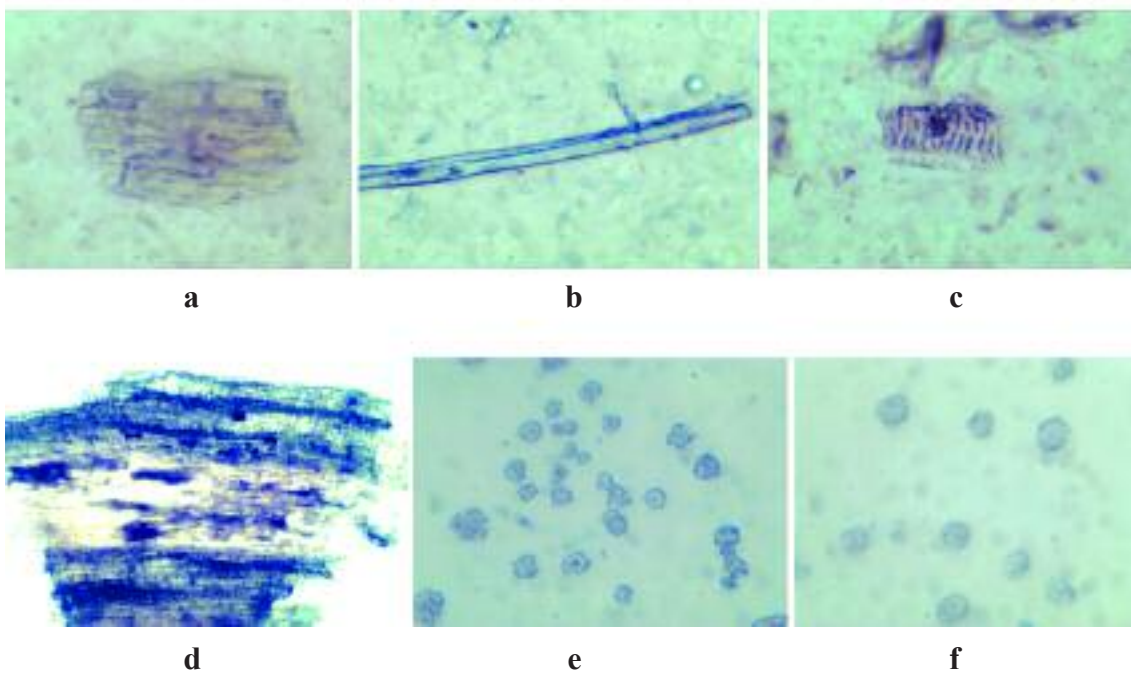


Plate 116: Powder characteristics of root of *Withania somnifera* a) Cork b) Fiber c) and d) Vessels e) and f) Starch grains.

टिमुर (Timur)

Scientific name : *Zanthoxylum armatum* DC.

Zanthoxylum alatum Roxb.

Family : Rutaceae

Other names : Toothache tree, Prickly ash (Eng), Timru (Hind), Tumburu (Sans)

Description:

A prickly shrub or small tree upto 6 m tall growing on shrubberies. Leaves pinnate, leaflets 5 -11, lanceolate, more or less serrate, each serrature with a pellucid gland, dark glossy, terminal one larger than laterals. Inflorescence is terminal or axillary panicles. Flowers small, yellow. Fruits globose, wrinkled, reddish when ripe, aromatic. Seeds globose, shining black (Medicinal Plants of Nepal, 2016).

Flowering and fruiting: April–August

Parts used: Seed and bark.

Uses:

Seeds and barks are used as a tonic in fever, dyspepsia and cholera. Fruits are used in toothache and considered as carminative and stomachic. Fruits, branches and thorns are also used as fish poison (Medicinal Plants of Nepal, 2016).

Chemical constituents:

Dried seeds afford an essential oil containing lemonene, linalool and methyl cinnamate as major components and *l*-pinen, *l*-thujene, β -pinene, sabinene, myrcene, α -terpinene, *p*-cymene, terpenin-4-ol, piperitone, carvone, cuminaldehyde, methyl cinnamate as other constituents (Dried bark and branches contain lignans-sesamin, fargesin, eudesmin and epi-eudesmin; a neutral lactone – pulviate, dictamine, 8-hydroxydictamine and α -fagarine. Wood and bark contain magnofluorine and xanthoplanine. Roots contain magnofluorine, xanthoplanine, Adhikari and Karlsen, 1987). skimmianine, dictamine and γ -fagarine and root-bark-spilanthol. Seeds contain flavonoids-tambulin and tambulol (tambuletin) (Husain *et al.*, 1992). Phytochemical investigation of the stem bark of *Zanthoxylum armatum* led to the isolation of three phytoconstituents characterized as 1-linoleo-2,3-diolein, α -amyrin acetate, and armatonaphthyl arabinoside. Among the isolated compounds, armatonaphthyl arabinoside is a new naphthyl glycoside (Agnihotri, *et al.*, 2017). Essential oil from *Zanthoxylum armatum* extracted through hydro-distillation identified 34 components through GC-MS, the major constituents are beta- Linalool, Bergamot mint oil, alpha-



Plate 117: Habit photo
(photo ©: R. Tamang)

Limonene diepoxide, alpha- pinene, beta- Myrcene and D-Limonene (Muhammad Ibrar, et al., 2013)

Distribution in Nepal: East to West, 1200 –2400 m.

Pharmaceutical notes:

Some of the ayurvedic products available are S. V. Dantamanjan, Tejovatyadya Ghrita and Tumarvadi Churna (<http://eson.org.np/database/index.php>).

Note: It is included in 33 prioritized plants for economic development of Nepal.

Macroscopic characters:

Shows Sub-globose to ovoid, trilocular, valvate capsule (Plate 118), 4 to 5mm in diameter, frequently dehiscent half-way into two carpels, each with 2 loculi, exposing a solitary seed. Surface rough, covered with compactly packed prominent spherical oily tubercles. Apex is pointed, base rounded attached with short 1 to 2 mm long pedicle, outer surface dark brown, inner pale brown, exhibiting papery partitioned walls of ovary .



Plate 118: Dried fruits

Organoleptic characteristics:

Powder is dark brown in color, strong characteristic odor and taste aromatic.

Microscopic characters:

Anatomy of fruit:

Transverse section of fruit shows a layer of epicarp followed by thick-walled yellowish brown pigment cells of hypodermis. Hypodermis is followed by irregular thin walled parenchymatous mesocarp embedded with large lysoschizogenous oil glands in the peripheral regions (Plate 119a). Endocarp (Plate 119b) is sclerenchymatous, many layered consisting of an outermost continuously running compactly arranged radially elongated, thick-walled narrow lined palisade like cells, followed by discontinuous rows of similar cells penetrated at places . Inner endosperm (Plate 119c) is made up off parenchymatous cells.

Powder microscopy:

Shows rosette and few prismatic crystals of calcium oxalate (Plate 120d), spiral vessels (Plate 120e), fragments of epicarps (Plate 120b), fibers (Plate 120c) and fragments of endosperm (Plate 120a).

Photo plates

Anatomy



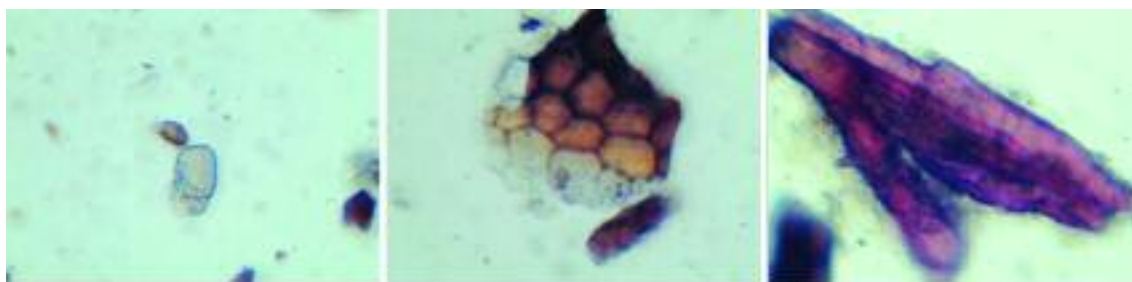
a

b

c

Plate 119: TS of fruit of *Zanthoxylum armatum* a) Section showing epicarp, mesocarp and oil glands b) Section showing endocarp c) Section showing endosperm.

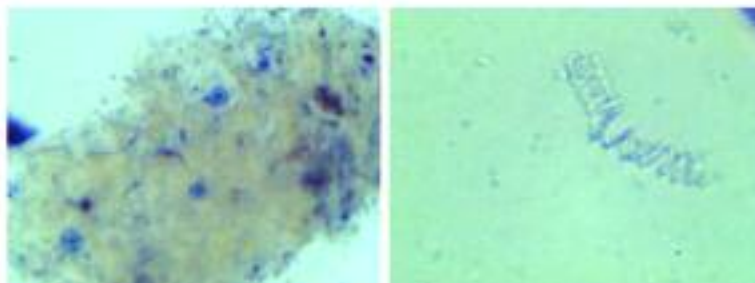
Powder analysis



a

b

c



d

e

Plate 120: Powder characteristics of fruits of *Zanthoxylum armatum* a) Endosperm cell b) Epicarp fragments c) Fiber d) Rosette crystal e) Spiral vessel.

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