Importance of Standardization of Plant Materials –Critical to GMP: A Medisynth Perspective

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Abstract

The standardization/testing of medicinal plant material is a matter of paramount concern in homoeopathic drug industry. Mother tincture prepared from plants can vary in quality and chemical constituent profile, if there are any variations in botanical materials. Standardization of herbal drug entails a process of prescribing a set of standards, constant parameters, definitive quality value that carry an assurance of quality, efficacy, safety and reproducibility of the finished products. It is a process of developing and agreeing upon technical standards.

A significant factor which can add consistent quality to medicinal plants is satisfactory standardization. A complete array of authentication and evaluation tools can be utilized to provide a well-rounded scientific approach to the standardization of medicinal plant material. It is vital that the authenticity of plant material be established/tested using appropriate analytical tools before it is processed for making mother tincture. The use of homoeopathic medicine has increased tremendously over the past few decades.The quality control and standardization of medicinal plants is getting more attention in recent years since the commercialization of homoeopathic medicines has increased many folds.A wide range of methods can be applied for standardization/quality control of medicinal plants.Moreover,the Homoeopathic Pharmacopoeia of India (HPI) and other international pharmacopoeias propose organoleptic, macroscopic, microscopic, TLC, chemical and UV studies for standardization/quality control of homoeopathic medicines. The Government of India has published 10 volumes of HPI and revision of monographs is also undertaken. This shows the commitment of the Government of India towards quality of homoeopathic medicines.

A general layout for pharmacognostic (standardization) evaluation of plants based on HPI and other international pharmacopoeias is shown in Fig.1.

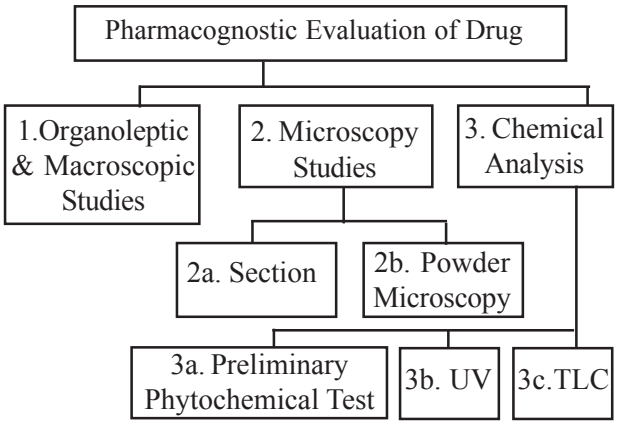

Fig. 1

1. ORGANOLEPTIC AND MACROSCOPIC STUDIES

This refers to drug evaluation by taking the help of characteristics like colour,odour,taste,shape and texture of plant material. It also includes the study of morphology and macroscopic characteristics. The simplest and easy are the organoleptic characteristics, which help botanists identify the plant in the first stage.

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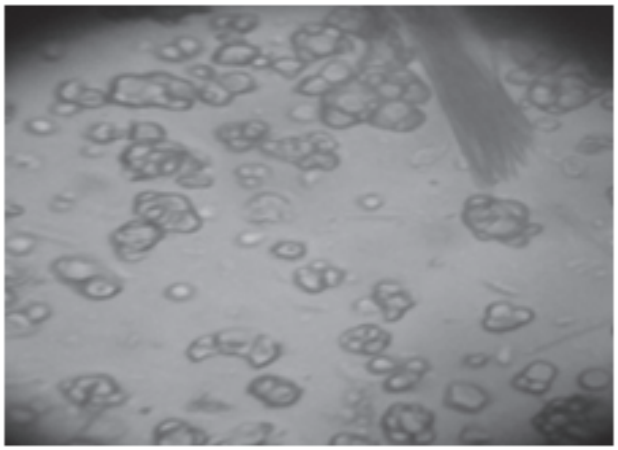
For example,the powder of Ipecacuanha root is often very irritating to the throat and nostrils, producing violent coughing and sneezing.

Plants are identified mostly by features such as leaves, stem, flowers, fruits and roots, which can readily be observed using a hand lens or dissecting microscope. Basic identification work usually relies upon characteristics.So when we say the particular genus has 10 species, what we mean is that the known specimens of that genus can be separated into 10 groups that share unique combination of morphological features. These characteristics can be observed in the dried material or herbarium specimen kept as a reference in the quality control laboratory.

2. MICROSCOPY

Microscopy is the observation of anatomical features of plant partsat the cellular level using a light microscope. It is used as an aid to confirm the identity of plant material.This may involve section cutting of plant parts, their staining and observation under microscope. Sometimes, plant drugs are supplied in the crushed (powdered) form.In sucha case, powdered microscopic identification of part of plant is performed. Microscopy is an important tool because it is observed that two roots/stems that appear morphological identical may contain different type of anatomical structure/ pattern such as size of xylem vessels, medullary rays, starch grain, crystals, hairs, etc.

Ipecac root powder– Microscopic view



Tips for Identification of Unknown Powder such as that of a Leaf

The following are the most reliable characteristics of a leaf powder:

1. The presence of an epidermis with stomata,hairs
2. The presence of palisade tissue
3. The presence of abundance of chlorophyll
4. The presence of veins and veinlets

Microscopy of Leaves

The following microscopic characteristics help to identify the leaf of a particular genus.

Most leaves bear stomata,either on the upper surface or lower surface or both,but submerged leaves are usually free from them.They are not necessary uniformly distributed over the surface.The guard cells of the stomata assume a particular arrangement,which is constant for the same species.

There are 8 types of stomata found in the leaf. The most common are:1. Anomocytic (irregular celled) – Ranunculaceae,Malvaceae, etc. 2. Anisocytic (unequal celled)– Cruciferaceae, Solanum, etc. 3. Paracytic (parallel celled) – Rubiaceae. 4. Diacytic (cross celled) – Acanthaceae,Caryophyllaceae, etc. 5. Actinocytic – Araceae, etc. 6. Cyclocytic – Palmae, etc.

Stomatal number: The average number of stomata present per square millimeter of the epidermis is known as stomatal number.

For example:

1. *Atropa*belladona: Upper epidermis: 7–10
   Lower epidermis: 77–115
2. *Datura metel*: Upper epidermis: 147–160
   Lower epidermis: 200–209
3. *Ocimum sanctum*: Upper epidermis: 64–72
   Lower epidermis: 175–250

Stomatal Index

The stomatal index is the percentage proportion of the number of stomata to the total number of epidermal cells. Stomatal number varies considerably with the age of the leaf but stomatal index is relatively constant for a given species.

Stomatal index is calculated as follows:

$$SI = S/E+S$$

where SI is the stomatal index, S is the number of stomata per unit area and
E is the number of epidermal cells in the same unit area.

For example:
Atropa belladona:
Upper epidermis: Nil
Lower epidermis: 20.2–23.0

Palisade Ratio

The palisade ratio represents the average number of palisade cells beneath one epidermal cell, using four continuous epidermal cells for the count.

For example:
Adhatoda vasica: 5.5–6.5
Cassia angustifolia: 5.5–10 (upper epidermis)
4.0–7.4 (lower epidermis)

Leaves

Hairs: Many leaves are glabrous,but it is more common to find hairs either distributed over the lamina or restricted to veins, e.g. *Hamamelis virginiana* bears fruits and stellate hairs around the veins.These hairs exhibit an infinite variety in shape and nature, but they are constant in the same species.They possess, therefore, very great diagnostic value. Hairs may be divided into two classes:simple hairs andglandular hairs.

Mesophyll

The mesophylls can be homogeneous or heterogeneous and assume distinctly different forms.Most leaves possess a distinctly dorsiventral mesophyll,and the presence of an isobilateral structure shouldtherefore be carefully noted. The shape and size of both the palisade and the spongy parenchyma should be carefully observed, as well as the nature of their contents, and the presence or absence of crystals (foxglove leaf – *Digitalis purpura*). In case of crystals, their shape and naturehelp as valuable evidence in establishing the identity of leaf. They generally consist of calcium oxalate.

- Belladona: Assume the form of sandy crystals
- Henbane: Small prisms
- Stramonium: Cluster crystals
- Senna: Both prisms and cluster crystals
- *Digitalis purpurea*: Absence of crystals

The mesophyll may also contain various forms of secretary tissues, such as oil cells, oil glands,secretory ducts,laticiferous cells and laticiferous vessels:

- Secretion cells – Rutaceae, etc.
- Elongated –Asteraceae, etc.
- External schizogenous glands – Rutaceae, Rubiaceae, etc.
- Secretion ducts –Anacardiaceae, etc.
- Laticiferous cells – Apocynaceae, etc.

Distinguishing Features of Jaborandi Leaves

As per HPI,*Pilocarpus jaborandi*and *Pilocarpus microphyllus* are mentioned for preparation of mother tincture of jaborandi.Pilocarpus grows in the open forests of Brazil.*Pilocarpus jaborandi* is abundant near Pernambuco, while *P.microphyllus* thrives near Maranham. Hence, the product of the former is known commercially as "Pernambuco Jaborandi" and that of the latter as "Maranham Jaborandi".

The distinguishing features are as follows:

Features	Pernambuco Jaborandi	Maranham Jaborandi
Outline	Elliptical,oblong to oblong-ovate, 8–15 cm long, 1.5–4.5 cm broad	Obovate to ovate1.5–5 cm long 1.5–2.2 cm broad
Base	Unequal	Tapering into petiole
Apex	Emarginate	Deeply emarginated
Margin	Entire and slightly revolute	Entire and revolute
Upper Surface	Darkgreen to brownish-green	Grayish to yellowish-green
Lower Surface	Yellowish-or greenish-brown	Grayish to yellowish-green.
Texture	Coriaceous,brittle	Coriaceous, but less than half as thick as Pernambuco variety
Odour	Slight	Slight
Taste	Bitter	Bitter

Accurate identification of Passiflora inarnata and its adulterant has been thoroughly studied by the scientists of Punjab University, Chandigarh, as follows:

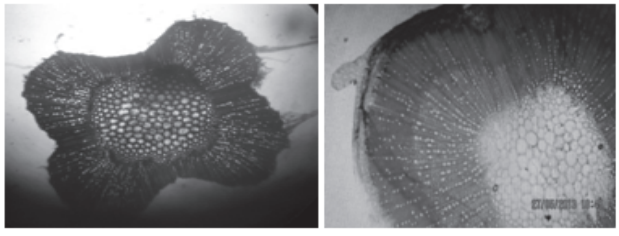
Parameters	*P. incarnata*	*P.edulis*
Vein-islet number	6.45	4.87
Vein-termination number	11.50–23.75	10.25–19.00
Stomatal number	111–142	49–102
Stomatal index	34.6,36.13,37.8	32.0,33.87,35.3
Water-soluble extractive value	10.51	12.72
Total ash value	12.49	6.38
Acid-insoluble ash value	5.95	1.37

Morphology and anatomy of *Echinacea purpurea*, *E.angustifolia*, *E.pallida* and *Parthenium integrifolium* is well discussed at length by Ingrid Mistrikovaand Stefania Vaverkova (*Biologia*, *Bratislava*, 62/1:2–5,2007).

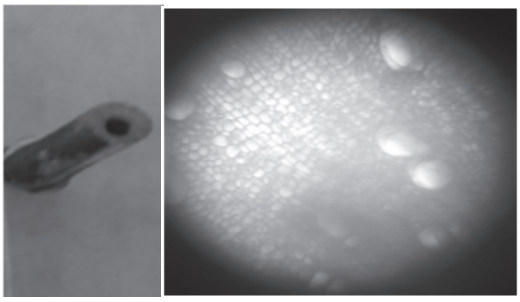
Diagnostic characterstic features of the stem are as follows:

This involves the study of epidermis, hypodermis, cortex, medullary rays,vascular bundles and pitt, etc.

The following are a few examples of microcopy of stem:

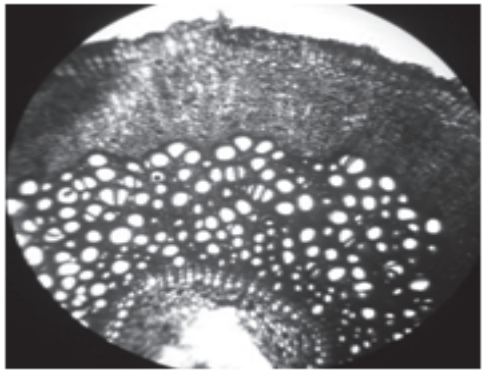


T.S of Andrographis *paniculata* stem



T.S of *Chelidonium majus*

T.S. of *Hypericum perfoliatum*. Transection shows a roundish outline; few layers of thin-walled,brown cork cells; cortex parenchymatous containing a few secretorycavities. Xylem and phloem in a close ring, phloem region containingsecretory cavities especially just above xylem rays; rays in phloem are notdistinct. Pith with very thin walled cells or hollow.



T.S. of *Hypericum perfoliatum*

Tips for Identification of an Unknown Powder such as that of a Bark

When examining a powder of unknown origin, it may become necessary to identify ifitis that of a powdered bark. There is only one characteristic element that is present in all bark powders.This is the sieve tube. Its presence necessarily indicates the presence of bast tissues, and as barks are composed more or less largely of bast, the presence of numerous and comparatively large sieve tubes is strong presumptive evidence that the powder is derived from a bark. Cork tissue is also present in most powdered barks, but not necessarily, since it is sometimes removed during the preparation for the market.Nevertheless, the occurrence of much cork tissue, as also bast fibres and sclerenchy matous cells, is strong confirmatory evidence of bark powder.

A powdered bark should be free from vessels, but fragments of wood may occasionally be found adhering to barks and constitute a source of contamination. Much vascular tissue would therefore indicate the presence of wood.Chlorophyll and the tissue in which it is chiefly found (palisade and spongy parenchyma)should also be absent, as well as epidermis; the presence of these would indicate admixture of leaf powder.Aleurone grains and fixed oil, characteristic reserve, and materials of seeds should also be absent.

Having determined that the powder is derived from a bark and is free from contamination with powder derived from other organs, attempt may be made to establish its identity.

Why are Morphological and Microscopical Studies of Plants Needed?

Raw drug materials of plant have to be put under morphological and microscopical studies. Chemical studies alone shall not be sufficient, because some active principle may be present in different genera or species and show different biological activity.

Active Principle and Its Activity	Found in the Plant	Homoeopathic or Therapeutic Use of the Plant
Acetyl Choline (Cholinergic)	Crataegus oxycantha	Myocarditis, arteriosclerosis, cardiac dropsy, valvular weakness
	Thlaspi bursa pastoris	Anti-haemorrhagic, anti-uric acid drug, chronic neuralgia, spermatic cord inflammation
	Urtica urens	Urticaria
	Viscum album	Gout neuralgia, sciatica
Aconite (Anti-pyretic, Painful Supra-orbital nerves)	Aconitum napellus	Nervous excitement
	Aconitum lycoctanum	Swelling of glands
Antabasine (Vertigo, Disturbed Vision, Photophobia, Nausea)	Dubosia myoporoides	
	Nicotiana tabacum	
Aconitic Acid (Equisetic Acid Achilleic Acid) Anti-spasmodic	Aconitum napellus	
	Aconitum lycoctanum	
	Equisetum hyemale	
	Achillea millifolium	

3. CHEMICAL IDENTIFICATION

Example 1

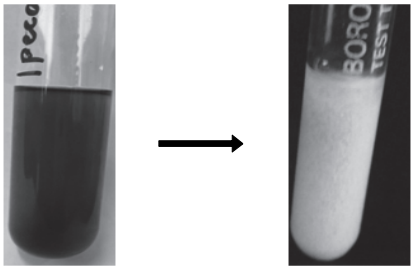
Echinacea Angustifolia:

A. Heat 1 ml of the mother tincture with 0.5 ml of phloroglucine solution R and 1 ml of hydrochloric acid R.A red or dark colour is produced.

B. To 1 ml of the mother tincture add 0.1 ml of iron (III) chloride solution R 1.An olive green or brown colour is produced.

Example 2

Ipecac Chemical examination: To 1 ml of 74% alcoholic water extract a few drops of Mayer's Reagent are added.Observation: White turbidity is produced.



Thin-Layer Chromatography–A Tool for Identification of Herbal Drugs

Another means of confirming the identity of a plant is the use of thin-layer chromatography (TLC).TLC is a common fingerprint method for herbal drug analysis.It provides information on the main active constituents of plant by providing chromatographic fingerprints. It is recommended by the HPI for monitoring the identity and purity of plants. It also helps in detecting adulterations and substitution. The literature of TLC plant analysis is expensive and it also helps to develop in-house standard.

Principle steps of chromatography are:

1. Sample preparation
2. Sample application
3. Developing a chromatogram
4. Derivitizations

TLC has been used since the 1960s to analyze and identify compounds in plants.

The special advantages of TLC are sensitivity, speed and versatility. TLC is fast due to the compact nature

of the adsorbentand this is an advantage when working with labilecompounds,which is often the case in plant analysis.Most TLC studies in plant chemistry have used silica gel as the sorbent.Many TLC studies of plant drugs are listed in different pharmacopeias of the world.

Why Fingerprint?

During chemical identification of a raw plant drug, a chromatographic fingerprint can be generated. The sample is extracted and then chromatographed. The result is specific sequence of zones (fingerprints) due to known or unknown compounds of the extract. The fingerprints of botanically authenticated raw drug serve as a standard (reference) against which unknown material can be characterized.

TLC – A Tool for Identification of Secondary Metabolites

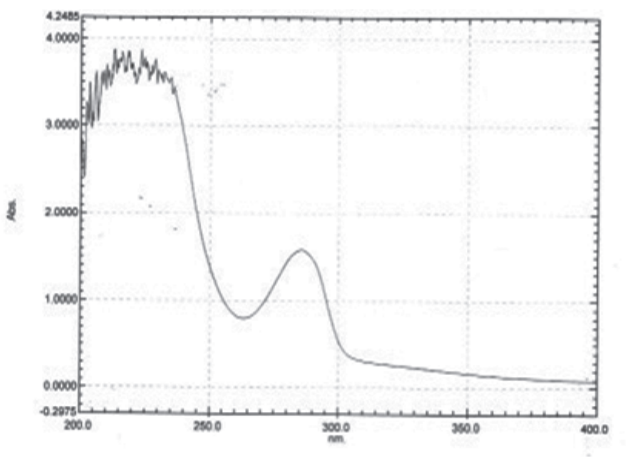
The detection of the active principles in medicinal plants plays a strategic role in the phytochemical investigation and is very important in regard to their potential pharmacological studies. However, in homeopathic medicine we are interested in total constituents of the plants. For this, TLC can be used for the proper identification of plant. This method is efficient, rapid and combines sensitivity and simplicity. Before starting TLC of plant material whose method is not given in pharmacopoiea,it is very important to perform preliminary phytochemical analysis of the plant material using the following test.

Phytoconstituent	Test
Alkaloids	Mayer's Test
	Wagner's Test
	Dragendorff's Test
	Hager's Test
Carbohydrates	Molisch's Test
	Benedict's Test
	Fehling's Test
Glycoside	Modified Borntrager's Test
	Legal's Test
	Kelle-Killiani Test
Saponins	Froth Test
	Foam Test
Phytosterols	Salkowski's Test
	Liebermann
	Burchard's Test
	Tshugajeu Test
Fats & Oils	Stain Test
Resins	Acetone–Water Test
Phenols	Ferric Chloride Test
Tannins	Gelatin Test
Flavonoids	Alkaline Reagent Test
	Lead Acetate Test
	Shinoda Test
Proteins & Amino Acids	Xanthoproteic Test
	Ninhydrin Test
	Biuret Test
Diterprenes	Copper Acetate Test

Developing Reagents for TLC

- Phosphomolybdic acid reagent for detection of essential oils (visible)
- Dragendorff reagent modified by Munnier and Macheboeuf
- Potassium hydroxide for coumarins (UV 365 nm)
- Libermann Burchard's reagent for triterpenes, steroids, saponins and cardiac glycosides (vis. & UV 365 nm)
- Polyethyleneglycol reagent for flavonoids (UV 365)
- Iron (iii) chloride reagent for phenolic for tannins and other phenolic compounds.

TLC analysis of *Echinacea pallida* and *E.angustifolia* roots in details has been very well studied by R.Bouer and H.Wagner **(*Planta Medica* 1988,p.426–430).**



Scientists of Punjab University, Chandigarh, using a TLC tool have established the difference between *P.incarnata* and *P.edulis*. The TLCs of the petroleum ether extract of *P.incarnata* and *P.edulis*,developed using petroleum ether-ethyl acetate-acetone (19:3:1), showed six spots (Rf = 0.94,0.90,0.86,0.67,0.52and 0.38) and four spots (Rf= 0.83, 0.67,0.48and 0.34), respectively.

TLC analysis also helps in identification of adulterant species, e.g.root extractsof *Cephaelis acuminata*, zones of emetine and cephaeline are of similar intensity,while in extracts from roots of *C. ipecacuanha*,the zone of emetine is much more intensivethan that of the cephaeline

Once we know the category of phytochemicals present in the plant drug,we select the mobile phase (solvent system) accordingly for TLC studies, as shown in the following table.

Phytochemical Constituents of Plant	Mobile Phase
Alkaloids	Toluene-ethyl acetate-diethylamine (70:20:10)
	Ethyl acetate-methanol-water (100:13.5:10)
	n-Propanol-formic acid-water (90:1:9)
	Chloroform-diethylamine (90:10)
Flavonoids	Ethyl acetate-formic acid-glacial acetic acid-water (100:11:11:27)
	Chloroform-acetone-formic acid(75:16.5:8.5)
	n-Butanol-glacial acetic acid-water (40:10:50) (upper phase)
Cardiac glycosides	Ethyl acetate-methanol-ethanol–water (81:11:4:8)
	Chloroform-methanol-water (65:35:10)
	Ethyl acetate-methanol-water (100:13.5:10)
Saponin	Chloroform-methanol-water (64:50:10)
	n-Butanol-glacial acetic acid –water (50:10:40) (upper phase)
	Chloroform-methanol-water (70:30:4)
Bitter principle	Acetone-chloroform-water (70:30:2)
	Ethyl acetate-Methanol-water (77:15:8)
Coumarin	C-1 toluene-ether (1:1,saturated with 10% acetic acid
Alkaloids	Dragendorff's reagents for alkaloids (visible)
Coumarin	Potassium 5 or 10 % ethanolic potassium hydroxide reagent for coumarins
Flavonoids	Natural products-polyethylenglycol reagent (NP/PEG)
Cardiac glycosides	Sbcl3 20% (Antimony-trichloride reagent)
Saponin	Vanillin-sulphuric acid reagent
Bitter principle	Vanillin-sulphuric acid reagent

Ipecac TLC

UV pattern of Ipecac MT

3b.UV Studies

Determination of lambda max by U.V. spectrophotometer is mentioned in HPI Vol-4 in Appendix II as follows.

A. For single bean instruments:

1. Take blank reading of solvent (distilled water / dispensing alcohol)
2. Take 0.5–1.0 ml sample (mother tincture) in the curvette and add the solvent and adjust till the absorption is below 2.00 Optical Density (O.D) using UV spectrophotometer. Then take 2.p-2.5 ml of the above sample solution in another cuvette and take reading in UV region, i.e. 360–200 nm and record the absorption maxima.

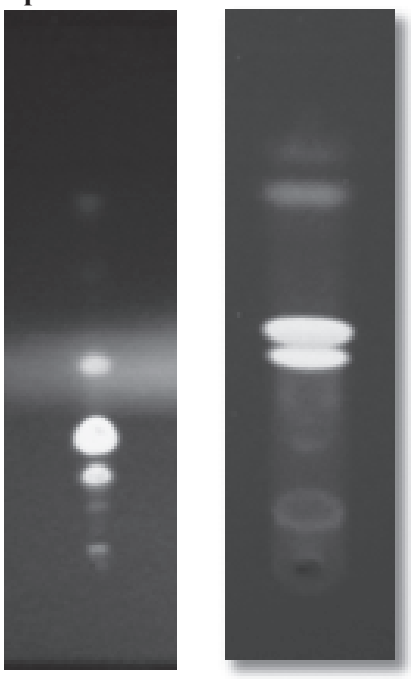
3. Tolerance limit in lambda max is ±4 nm for sharp peaks and ±7 nm for broad peaks.

B. For double beam instruments: Corresponding adjustments can be made.

4. HPLC Studies in Helping the Adulterant

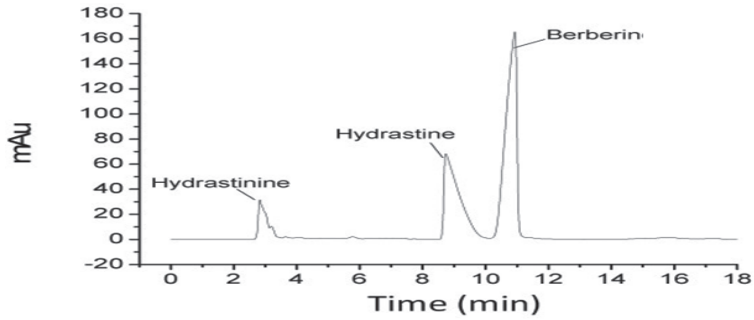
Considerable research work has been done and it has been established that in some cases HPLC studies help in identification of adulterants. For example,*Hydrastis canadensis* adulterated with *Coptis trifolia*and*C. chinensis* can be very well studied with the help of HPLC.*Hydrastis canadensis* does not contain coptisine and palmatine.The peaks of these two show the adulterants, as shown below.

Ipecac TLC

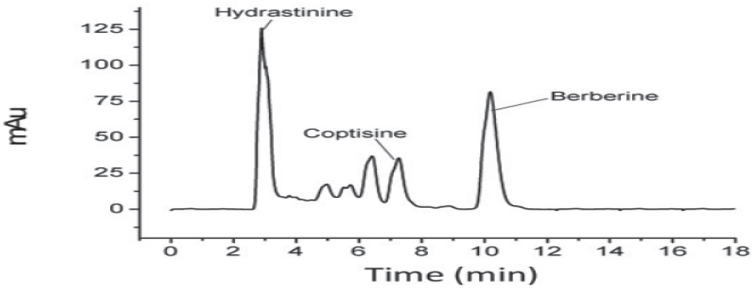


Ipecac Berberis aquifolium

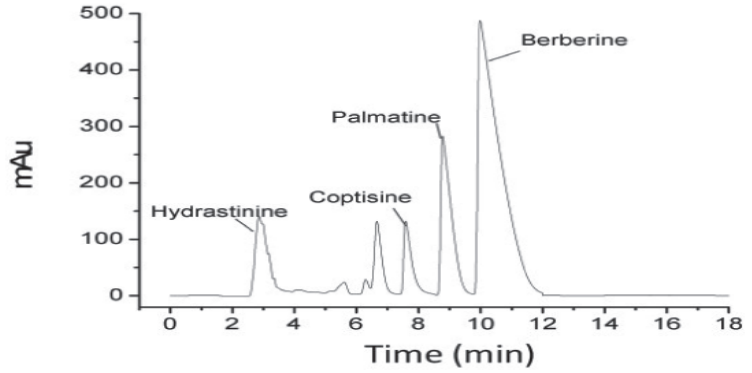
UV pattern of Ipecac MT



Hydrastis canadensis.

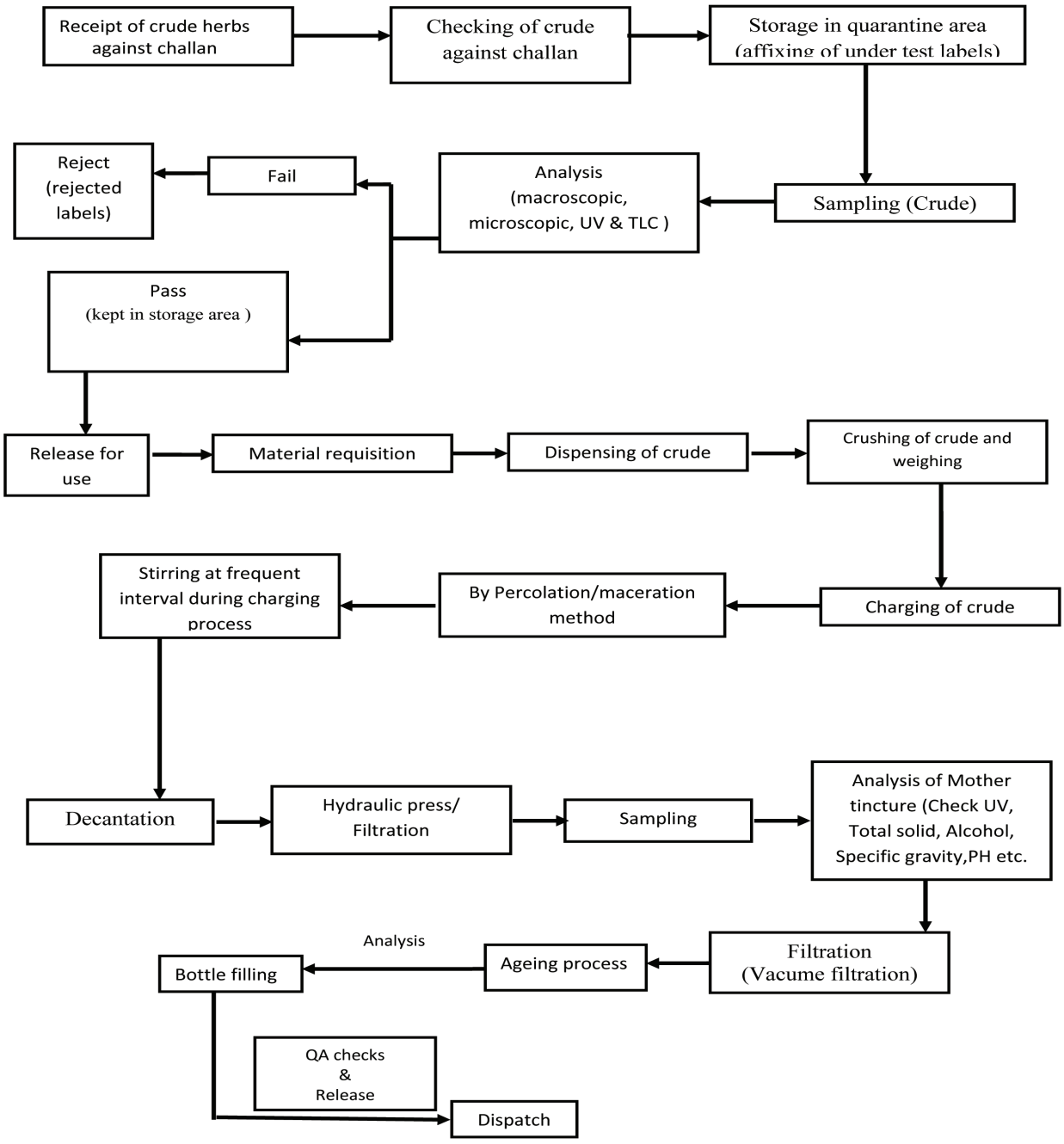


Coptis trifolia.



Coptis chinensis.

General SOP for Preparation of Mother Tincture followed by MEDISYNTH CH. PVT. LTD



Adulterants/ substitutes of the Medicinal plants

S. No	Plant used	Substitute
1.	Arnica Montana	Heterotheca inuloides Cass (Mexican Arnica)
2.	Apium graveolens L.	Ammi Majus L. (Bishop's Weed)
3.	Adonis vernalis L.	A.aestivalis L.
4.	Actaea racemosa (Cimicifuga racemosa)	A. pachypada Elliott & A.podocarpa
5.	Artemisia annua	A.biennis
6.	Capsella bursan-pastoris	Capsella orientalis
	Stem sparsely pubescent	densely hairy
7.	Equisetum arvense	E.palustre
8.	Hippocastinum	Aesculus indicum
9.	Senega (Polygala senega)	Indian senega (Polygala chinensis)

Key Identification of genuine plant and adulterants

1. *Hamamelis virginiana*(base asymmetrical and bearing tufts of stellate hairs around veins usually adulterated with *Corylus avellana*(the leaves have nearly symmetrical base and no stellate hairs)

2. *Matricaria chamomilla*(receptor conical hollow) adulterate with *Anthemis cotula* (receptor solid)

3. *Passiflora incarnate P. edulis*

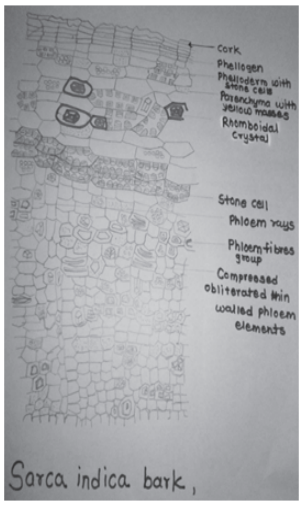
4. Sambucus nigra (corolla whitish when fresh or yellowed; anthers pale yellow) Sambucus ebulus (corolla often reddish, anthers reddish)

5. *Turnera diffusa* (*damiana*) (apex obtuse, margins revolute, upper surface olive to dark or pale green,sometimes discoloured, glabrous to pubescent, lower surface paler,frequently grayish to whitish,nearly glabrous to pubescent; pubescence quite variable, sometimes present only over veins,sometimes dense) adulterated with *Isocoma veneta* formerly known as Aplopappus andHaplopappus discoideus (margins not revolute, apex acute, glandular dots black)

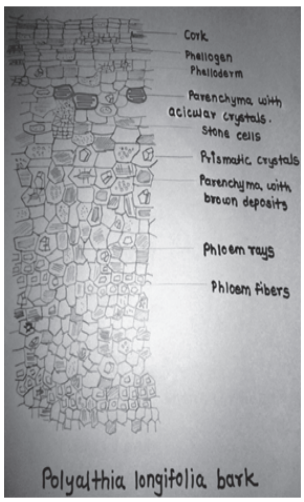
6. Hyoscyamus niger(It bears uniseriate 2–4 celled,conical covering trichomes about 100–300 u long,and glandular trichomes, about 100–500 u long,with uniseriate stalk of 2–6 cells and ovoid multicellular glandular head, and some clavate glandular trichomes adulterate with *Hyoscyamus albus* (the trichomes are rather narrow, about three cells long,and the numerous glandular ones have a small unicellular sub-spherical head)

Why Is Knowledge Of Adulterant Important?

Adulteration may be defined as mixing or substituting the original drug material with other spurious, inferior, defective, spoiled, useless other parts of same or different plant or harmful substances or drug which do not conform with the official standards. A drug shall be deemed to be adulterated if it consists, in whole or in part, of any filthy, putrid or decomposed substance.



Janosia Ashoka bark T.S



Polyalthia longifolia bark T.S

2. *ArnicaMontana*

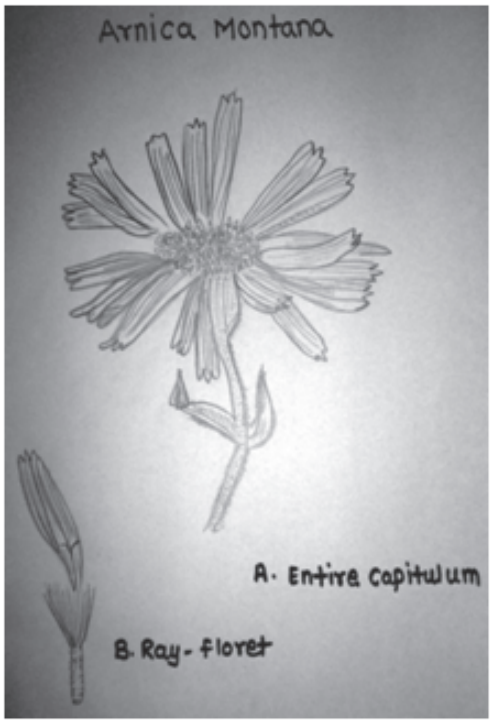
Identification

Ligulate florets in a single row of 16–20;calyxrepresented by a pappus of numerous bristles, each of which is4–5 cells in diameter and minutely denticulate on the surface;strap of the corolla about 2–3 cmlong and 3–5 mmwide,with 3 acute teeth at the apex and 7–9 veins.

Other substitutes of Arnica

1. *Anthemis tinctoria*;fruits without pappus
2. *Calendula officinalis*;ligulate corolla with four veins;fruit without pappus

3. *Inula britannica*;ligulate corolla with four veins; pappus not bristly
4. *Doronicum pardalianches*;ligulate corolla with four veins;no pappus
5. *Taraxacum* sp;all florets with five-toothed ligulate corollas



3. Chamomilla and other adulterants

Features	*Matrucaria chamomila*	*Anthemis cotula*	*Anthemis nobilis*
Common names	German Or Hungarian chamomile	Foetid chamomile	Englosh Or Roman chmomile
Receptacle	Hollow	Solid	Solid
Flower head		Decidedly conical to oblong	Conical
Peduncle	Unicellular non-glandular hairs absent	Numerous unicellular non-glandular hairs	Numerous unicellular Non-glandular hairs
Paleae (scales on receptacle)	Absent	Present, Broad and membranous	Present, Broad and bristly acuminate
Ligulate florets	Pistillate, 3 toothed and 4 veined; 10-30 in one series	Neutral, mostly 3 toothed; 10-18 in one series	Pistillate, 3 toothed, 3 to 6 veined; 12-18 in one series
Bracts	Entire, lanceolate	Fimbriated, obovate	Obtuse, pubescent, with scarious margins
Achenes	Smooth, 3-5 ribbed	Rough, 10-ribbed	Oblong, obtusely 3-angled
Pappus	Absent or as toothed membrane	Absent	Absent

Good Collection (Harvesting) Practices

The WHO has published guidelines on good collection practices for medicinal plants.The main objectives of these guidelines are:

1. Contribute to the quality assurance of medicinal plant material used as a source of herbal medicine to improve the quality, safety and efficacy of different products.
2. It also mentions the harvesting time, method of drying and its proper processing.

For example:Digitalis

The leaves are collected in dry weather and are dried as rapidly as possible at a fairly low temperature. The drying should be done in darkness and two methods are used.By one common method the leaves are spread on trays with a fairly fine wire netting bottom and stacked on runner in a well-closed, dark, drying-shed heated by hot air from a furnace in the basement and ventilated above,or a tunnel driermay be used;the temperature should not exceed 55p to 60p Cand the process takes from 4 to 10 days.A second method of drying is to put the leaves on the heated shelves of a vacuum drying-oven when the whole operation is completed in a few hours.The dried leaves are stored in the drying rooms till needed for distribution, when they are packed in well-filled,air-tight containers such as well-closed tins or the powder may be put into small bottles or ampoules and protected from the light .When the leaves are packed, the moisture present should not exceed 5 percent.

SUMMARY

An accurate authentication of plant material is one of the most difficulttasks. For this, botanist and chemist have to work together in co-ordination. Quality control of herbal drugs can be conducted by various methods, as discussed in this article. In homoeopathy, we do not authenticate the plant by testing of single phytochemical.

For example,reserpine is present in *Rauvolfia serpatina* and in *Raovolfia vomitoria*.The reserpine content of *Rauvolfia vomitoria* is more than twice that of *Rauvolfia serpatina* but we cannot use this particular plant. Keeping this in view, one has to perform all the parameters as mentioned in the article to standardize the plant material.

Analysis of the plant material is more challenging and difficult than the chemical analysis of minerals. Several problems not applicable to synthetic drugs often influence the quality of herbal drugs.For instance:

1. Herbal drugs are usually a mixture of many constituents.
2. The active principle(s) is (are)in most cases unknown.
3. Selective analytical method or reference compoundsmay not be available commercially.
4. Variation in phytochemical in the plant material due to various factors.

References

HPI,HPUS, GHP, FHP, BHP, JHP, Current Microscopy contributions to Advances in science and Technology (A. Méndez-Vilas, Ed), Textbook of pharmacognocy by Wallis, Trease and Evans pharmacognosy (W.C. Evans), Plant Drug Analysis by H.Wagner, S.Bladt & E.M.Zgainski, Gaedche F, Steinhoff B, Blasius H. Herbal Medicinal Products, Scientific and Regulatory Basis for Developement, quality Assurance and marketing Authorisation by wissenschftfliche, stuttgart, CRC press; Boca Raton,USA; 2003;37-52,Yadav NP,Dixit VK.Recent approaches in herbal drug standardization.International Journal of Integrative Biology.2008;2;195-203.,Smillie TJ,Khan IA.A Comprehensive Approach to identifying and Authenticating Botanicakl Products.Clinical pharmacology and Therapeutics.2010;87:175-186.