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Micromorphological techniques in botanical standardization of closely related root drugs

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Abstract

Background / Objectives: The collection of raw phytodrugs by untrained personnel may lead to unintentional adulteration of drugs. Intentional adulteration or substitution is also a menace in the crude drug markets.
Methods / Statistical Analysis: To detect the adulterants from the original ones, the crude drugs are subjected for microscopic analysis including anatomical parameters. The microscopic observations on the gross anatomical features coupled with tissue disposition and cell inclusions are more reliable techniques in the crude samples of root drugs.
Findings: The present paper deals with two root drugs, popularly used in Indian System of Medicine, highlights the anatomical differences namely *Aerva lanata* (L.) Juss. ex Schultes and *Aerva persica* (Burm. f.) Merr.
Application / Improvements: The possible reasons for root drug similarities and differences are discussed. Such inquire may find use further in the pharmaceutical applications of these two species.

Key Words **:** *Aervalanata, Aervapersica*, Root drugs, Microscopic features, Diagnostic value.

1. Introduction

In the pharmacognostic science, anatomy occupies a significant place of time renowned recognition. The important practical application of root anatomy has been highlighted [1]. Amaranthaceae is an economically recognized family for its edible greens as well as pharmaceutical values [2]. It is popularly known as *Pig Weed Family*. It includes both cultivated and wild plants, mostly annual or perennial herbs (rarely shrubs), trees or vines. The family of 64 genera and about 800 species is most abundant in tropical regions. About 18 genera and over 50 species have been reported from India [2]. The present study deals with two similar species for pharmacognostical investigation [3] i.e, *Aerva lanata* and *Aerva persica*. The former is commonly called as mountain knot grass, woody prostrate or succulent, perennial herb in native to Asia, Africa and Australia. It is a common weed which grows wild everywhere in the plains of India. The root has camphor like aroma. The dried flowers which look like soft spikes are sold under the commercial names as *Buikallan* or *Boor*. The latter is commonly known as Desert cotton, native of Africa (including Madagascar), South West and South Asia.

2. Materials and Methods

The roots of two plants belonging to Amaranthaceae family were selected for the microscopic studies. 1. *Aervalanata* (L.) Juss. ex Schultes grows in common fields shady places in hedges and wastelands of most of the area. Flowering shoots were collected during August and fruits during October to February. 2. *Aervapersica* (Burm. f.) Merr. grows in plains even in poor, gravelly soil, scrub jungles, way side waste lands, optimum size by aerable lands. It occurs in almost all districts of tropical areas. The two plants were collected from Kollappakkam Reserve Forest, Vandaloor, Chennai. This forest maintained dry and very hot arid atmosphere. It is marked by dry winds during the noon hours. Rain fall is sparse and only occurs during the monsoon season. Botanical diagnosis of the plant was confirmed on the basis of flower, fruit and vegetative morphological features of the plant [4]. Twigs with tap root system of the plants were collected from healthy population. The plants, from which roots were studied, were authentically identified with the help of Gamble Flora [5]. The root drug materials were trimmed and fixed in FAA (Formalin Acetic Acid and Alcohol) in the field. Dehydration, paraffin wax infiltration and microtoming were carried

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out by customary procedures [6]. Sections ranging from 8 – 12 µm thick were stained with toluidine blue [7]. Microscopic descriptions were supplemented with photomicrographs taken with NIKON – Labphot – 2.

3. Observations

3.1. *Aerva lanata* (L.) Juss. ex Schultes (Syn. : *A. floribanda* Wt.) is an erect herb covered with white tomentum (Fig. 1A). The root system has branched thin or thick primary root. The lateral roots arise densely from different regions of the main root forming coiled wiry appearance (Fig. 1B).

Anatomical features of the root: The young roots of different thickness varying from 700 µm to 1.1 mm were studied. The thinnest root has broad homogeneous periderm, a central solid circular cylinder of first formed secondary xylem and a single ring of successive vascular cylinder. Old thick roots of 4 mm in diameter were studied. The root has wavy fissured, irregular periderm. The cortex is broad and consists of radially divided tangentially oblong parenchyma cells. The vascular cylinders are four to six in number and are broken and wavy. When the outer surface has ridges and furrows the secondary phloem occurs only on the outer part of the ridges. Secondary phloem consists of small polygonal sieve elements. In between each phloem zone and outer xylem zone a wide parenchymatous region is seen. When the root is viewed under polarized microscope Calcium oxalate crystals are seen in the cortex (Fig. 2). The crystals are mostly micro crystals or sand crystals.

3. 2. *Aerva persica* (Burm. f.) Merr. (Syn.: *A. Javanica* (Burm. f.) Juss. *A. tomentosa* Forssk.) is common in Deccan and Carnatic, a very white tomentose conspicuous undershrub. The male flowers seem to be very rare indeed, perianth lobes obtuse. The has mainly tap root and the lateral roots are few thin and wiry (Fig. 3). The main root is thick with deep irregular fissures, cylindrical and somewhat shiny. Lenticels are not seen. The root is light brown.

Anatomical features of the root: Thick tap root measuring more than 3 mm in diameter was studied. The root has a central core of solid lobed first formed secondary xylem and tetrarch less prominent primary xylem. There are five or six successive cylinders of vascular tissues comprising of alternate zones of secondary xylem and secondary phloem. The outer most zone has thick prominent periderm with deep irregular fissures. The vascular cylinders are continuous alternating with successive zones of secondary xylem and secondary phloem with phloem parenchyma. Calcium oxalate crystals are abundant in the cortex. The crystals are large druses. The druses are also found sparsely in the parenchyma cells in between the successive vascular cylinders (Fig. 4).

Figure 1. Aerva lanata (L.) Juss. ex Schultes (Amaranthaceae)

A. Flowering Shoot

B. Root system showing thick primary root and fibrous lateral root



Figure 2. *Aerva lanata* (L.) Juss. ex Schultes (Amaranthaceae) Anatomy of the old root
(Cr – Crystals ; Pe – Periderm; Sph – Secondary phloem; SX – Secondary xylem)

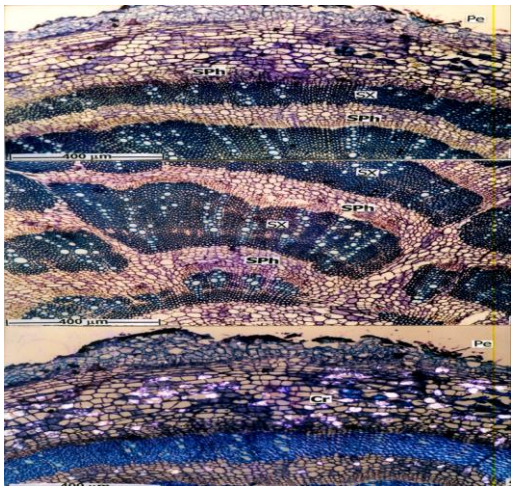
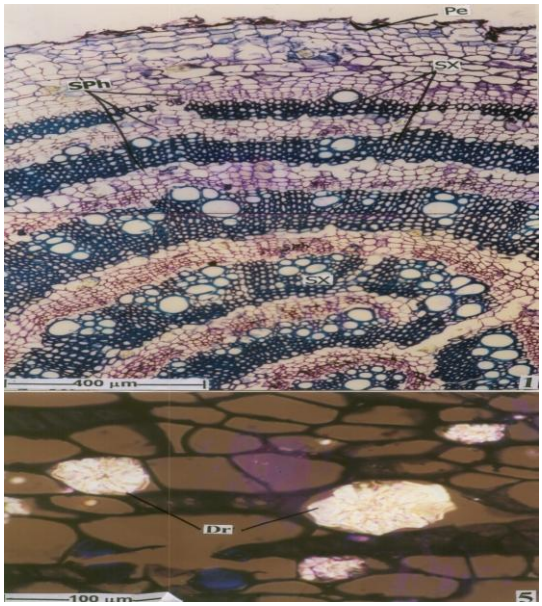


Figure 3. *Aerva persica* (Burm. f.) Merr. (Amaranthaceae) Shoot system with terminal compound spikes and tap root with a few lateral roots



Figure 4. *Aerva persica* (Burm. f.) Merr. (Amaranthaceae) Structural details of the old root
(Dr – Druses; Pe – Periderm; Sph – Secondary phloem; SX – Secondary xylem)



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4. Discussion

Anatomy of the root varies in much the same way as that from the aerial parts of a plant. These variations of root anatomy may be duly utilized for the diagnostic purpose of fragmentary root identification. Of different tissue systems of the root, periderm represents an important structural and functional unit. Anomalous or uncommon type of vascular structure occurs in both the species. Concentrically alternating xylem and phloem cylinders are another anomalous type of secondary growth found in these plants. In these root, there are several coaxial cylinders of xylem and phloem in the vascular bundle. Calcium oxalate crystals exhibit fascinating morphological spectrum and great range of distribution patterns. These two species are exactly similar to each other both morphological as well as anatomical profile but it differ only minute microscopic characters. These two species have anomalous type of secondary growth with successive coaxial cylinders of vascular tissues. The medicinal values of two identical root drugs can be analyzed easily with the help of microtechnique, without spending high cost and labour. These roots though uniform in gross anatomical manifestation, exhibit strikingly great deal of variation in crystal distribution, starch grains prevalence and gelatinous fibre expression in the vascular tissues. The another group of investigators contend that it is by a single self perpetuating unidirectional cambium [8], [9]. This type of anomalous secondary growth is reported in several families including Amaranthaceae [10]. For diagnostic purpose of the roots, it is enough to consider the mature structure without going into the developmental aspects. Cell inclusions especially the ergastic substances, have been much useful in the diagnostic studies of fragmentary plant specimens. These substances include mostly crystals of calcium oxalate calcium carbonate, starch grains and silica bodies and other inclusions like tannin, gum, mucilage, latex etc. The microscopic studies of the periderm have specific structural profile with special reference to phloem elements, crystals and other secondary metabolites. The in depth microscopic studies of root drugs, a thrust area in pharmacological arena. The results of the study provide a ready reckoner for detecting the adulteration and determining the genuineness of the root sample. Both the species are corpus lingnosumvellatusm (coaxial successive vascular cylinder) an anomalous type of secondary growth. But it differs in microscopical examination. *Aerva lanata* possess sandy crystals abundant in the cortex, but it is scanty in the phloem, thin shallow fissured periderm, vessels in long radial chains. Whereas, *Aerva persica* possess druses or sphaero crystals, wide and deep fissured periderm with solidary and scanty vessels. Based on the present investigations the structure of the root is highly variable at different taxonomical levels and it is specific for each plant species. It can be effectively employed for botanical identity of fragmentary root drugs.

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