INTERNATIONAL JOURNAL OF INSTITUTIONAL PHARMACY AND LIFE SCIENCES

Pharmaceutical Sciences **Research Article……!!!**

Received; accepted

UNITIES AND DIVERSITIES AMONG POWDER CHARACTERISTICS OF THREE *VIBURNUM* LINN. SPECIES – AN EVALUATION

K Prabhu[1,*] and K Ponnudurai[2]

1. Department of Pharmacognosy, Nandini Nagar Mahavidyalaya College of Pharmacy, Nawabganj – 271303, Gonda, Uttar Pradesh, India.

2. Department of Pharmacology, Nandini Nagar Mahavidyalaya College of Pharmacy, Nawabganj – 271 303, Gonda, Uttar Pradesh, India.

Keywords:

Peltate scales, Druses, sclereids, Leaf hairs, Anomocytic stomata**,** Club shaped glands

For Correspondence:

K Prabhu

Nandini Nagar Mahavidyalaya College of Pharmacy, Nawabganj – 271303, Gonda, Uttar Pradesh, India.

E-mail:

prabhu.cognosy@gmail.com

ABSTRACT

Quality control of medicinal plants is to determine their identity, quality and purity. Although there are several methods of standardization in this regard, microscopic examination of medicinal plants, especially, in powder form is one of the reliable experimentations affording a finger print of the species. The main objective of the current study is to collect the leaves, stems and roots of some three species of *Viburnum* Linn species- *Viburnum punctatum* Buch.-Ham.ex D.Don, *Viburnum coriaceum* Blume. and *Viburnum erubescens* Wall.ex DC, belonging to Adoxaceae family, from Nilgiri hills of Tamilnadu, India and explore the powder characteristics of diagnostic values and report the unities and diversities among the species as a tool of their identity in powdered form.

Dried specimens were powdered separately in a mechanical grinder and passed through a series of sieves to retain and obtain coarse, fine and very fine powders respectively. The powdered samples were mounted in suitable chemical reagents and traced under microscope at various magnifications and very important components were micro-photographed. The leaves of all the three species showed anomocytic stomata, however, the trichomes were distinctly different in type and shape. The stems and the roots of all three species showed xylem fibres, vessels, starch grains, druses and sclereids as common diagnostic characters, however, their dimensions were quiet different among the species.

Introduction

The plant kingdom holds many species of plants containing chemical substances of medicinal values which have yet to be explored. A typical example of such as category is, *Viburnum* Linn. species, belonging to the family Caprifoliaceae (formerly) and Adoxaceae (currently) under the order Dipsacales[1-3]. The genus *Viburnum* Linn.has been surveyed to contain about 200 individual species distributed in Java, Korea, China and Japan, and about 17 species of them have been reported to survive in India (Himalaya, Nilgiri and Coimbatore hills). The leaves, stem barks and roots of many of these species have been recently investigated to posses various biological activities such as: cytotoxic, anti-microbial, anti-nociceptive[4], anti-spasmodic and uterine relaxant activities[5], which may be attributed to the presence of simple, poly-phenolic compounds and their glycosides[6-9], sesquiterpenoids[10], triterpenoids and iridoid glycosides as their chemical constituents.

The *Viburnum* species are extremely variable shrubs or medium sized trees which grow upto 3 – 5 m in height with an evergreen canopy. Identification of the individual species of *Viburnum* is still a difficult task for a taxonomist, botanist or for a pharmacognosy expert, because the morphological features of these species appear to be often identical, especially, when more than one species exist together at a single spot. This is why the taxonomical/botanical recognization and wild collection of *Viburnum* species is usually preferred during their flowering season (May-July) by the native plant vendors and the herbalist of the habitat.

As described above, a voluminous works on phyto-chemistry and pharmacology have been witnessed. However, pharmacognostical investigations (for identity) on these species are still very scant. The current study, so, is focussed on how the three species can be differentiated in powder form.

Materials and Methods

Powder Microscopy

The research specimens for the present study was collected from Nilgiri hills and taxonomically authenticated by Dr. Chelladurai, (Ex. Professor) Medicinal plants supply for siddha, Govt. of India, Tamilnadu as *Viburnum punctatum* Buch.-Ham.ex D.Don, *Viburnum coriaceum* Blume. and *Viburnum erubescens* Wall.ex DC. Herbarium of the specimens (labeled V181, VC131 and VE131 for *V.punctatum*, *V.coriaceum* and *V.erubescens* respectively) was submitted to the museum of the department of Pharmacognosy, Nandini Nagar Mahavidyalaya College of Pharmacy. The specimens dried in the sun and in the shade for about 15 days were finely powdered separately in a mechanical grinder and screened for the presence of foreign matters with aid of a dissection microscope (other than the organ selected for the research studies). The powders were passed through a sieve No.125 and a sieve No.180 separately to obtain fine and very fine powder respectively, and then subjected for microscopic examination. Significant microscopic features were drawn with an aid of Ives'swift Camera Lucida and dimensions of the isolated components were recorded, and some also micro-photographed. The samples were treated with following reagents and studied for their components of diagnostic value[11,12] :

50% w/v glycerin as temporary mountant; 2% w/v phloroglucinol in a mixture of 92% ethanol and conc. HCl (1:1) for lignin; 5% w/v alcoholic ferric chloride for phenolic compounds; 2 % iodine solution for starch grains; and 0.08% ruthenium red in 10% w/v lead acetate for mucilage[13].

Powdered samples of different parts were cleared with 10% aqueous NaOH solution and mounted in glycerine. The slides containing powdered samples were also stained with saffranin, fast green and iodine in potassium iodide (IKI), wherever required[14]. With the aid of a compound microscope (Focus (ISI), JPM-1, India) and an eye-piece micrometer

calibrated with a stage micrometer, the individual character of each specimen was studied under both low-power (10X × 10X) and high-power (10X × 45X) magnifications. The sclereids and starch grains, which were present in stems and roots, were subjected to lycopodium spore method[15] to enumerate their number per milligram of respective samples.

Photomicrography

Photomicrographs were taken to better describe the histological features during microscopic examination, wherever necessary, at different magnifications using a Nikon Labphot 2 microscopic unit. For normal observations, a bright field was used while for the study of calcium oxalate crystals, starch grains and lignified cells, polarized light was employed. Since these structures have birefringent properties under polarized light, they appear bright against dark background. Magnifications of the figures were indicated by scale-bars. The anatomical features were described taking botanical terminology in to account[16].

Result and Discussion

The organoleptic features mentioned here with experienced a change in colour and taste after a couple of month on storage. A photograph of all the samples together is supplemented in (Figure 1).

Leaf Powder of *V.punctatum*

Organoleptic Features: Colour-green powder with pale greenish spots; Odour- leaf characteristic; Taste-slightly bitter; Texture- smooth and slippery; With water-mucilaginous nature absent; Dilute $FeCl_3$ treatment- powder turned brownish; Particle size-passing through Sieve No: 40, 60 and 90; and for tracing grains and druses, No: 125 and 180.

Microscopical Features (Figure 2)

Stomata: Abaxial epidermis shows the presence of anamocytic stomata (irregular celled stomata); epidermis appears with wavy anti-clinal walls.

Trichomes (Peltate scale type): Circular in shape and frequent enough to show atleast about 5 in 1 mm square area. The central region posses a brown glassy mass surrounded by yellow colour cells scattered laterally and radially connected. The diameter of trichomes is in average ranging from 80 to 100 µm[17].

Adaxial epidermis: An adaxial epidermis; which is of apostomatic. The cells are thick walled, lobed with anticlinal walls.

Druses: The calcium oxalate crystals were of druses ranging from 17 – 24 µm in diameter; often appear with broken edges.

Stem Powder of *V.punctatum*

Organoleptic Features: Colour -Yellowish brown; Odour-woods characteristic; Taste-slightly bitter followed by astringent; Texture- hard & fibrous; With water-mucilaginous nature absent; Dilute $FeCl_3$ treatment- powder turned black; Phloroglucinol-HCl (1:1) treatment- powder turned pinkish.

Microscopical Features

Vessels: Thin walled xylem vessel with pitted thickening (rarely) and annular thickening (frequent) and up to 70 µm in width.

Lignified xylem fibre: The fibres are cylindrical in shape and occurring as bundles (3 to 6 fibres combined); thick walled lignified fibres showing a narrow lumen, central to its full length and showing blunt edges and were up to 1650 µm long.

Starch grains: Starch grains were single and rarely compound of 3 – 4; oval and circular in shape with eccentric hilum and concentric; a single grain, 6 – 17 µm in size and compound grain being, 15 – 55 µm.

Sclereids: Sclereids, were extremely thickened by lignifications and leaving a narrow lumen at the centre. In average, they were 25 – 45 µm thick.

Root Powder of *V.punctatum*

Organoleptic Features: Colour-yellowish brown; Odour-root characteristics; Taste-slightly bitter; Texture-fibrous; With water-mucilaginous nature absent; Dilute $FeCl_3$ treatment- powder turned black; Phloroglucinol-HCl (1:1) treatment- powder turned pinkish; Particle size-passing through No. 40, 60 and 90 sieves.

Microscopical Features

Xylem fibre: Wide and thick walled; leaving a thin central lumen with no striations. The shape and width were similar to that of the stem fibres and were as long as 1 mm.

Vessels: Vessels, showing annular thickening and were from 70 – 140 µm in width.

Starch grains: Starch grains were circular and oval in shape containing central hilum with eccentric; single grain is 3.4 – 17 µm diameter.

Leaf Powder of *V.coriaceum*

Organoleptic Features: Colour-greenish black; Odour- leaf characteristic; Taste-slightly bitter; Texture-rough at the bottom; With water-mucilaginous nature absent; Dilute $FeCl_3$ treatment-powder turned black.

Microscopic examination (Figure 3)

Adaxial epidermis: wavy walled rectangular, and thickened cells (40 µm thick); apostomatic; often found with palisade cells.

Stomata: Anamocytic stoma, observed on the abaxial side.

Glandular trichomes: 7 – 8 cells radially. Laterally bound together to form a subsessile circular plates or peltate scales. The dimension in verage was 70 µm in diameter[18].

Leaf hairs: It is one of its peculiar characteristics, multicellular, uniseriate, curved or slightly bent bodies with septed cytoplasm measured randomly to be 480 – 902 – 1279 µm in length and the base, 15 – 25µm in diameter with sharp or blunt apex. A few among them gave pale pink colour on addition of phloroglucinol-HCl (1:1).

Stem Powder of *V.coriaceum*

Organoleptic Features: Colour-brown; Odour-woods characteristic;Taste-slightly bitter and saline; Texture-extremely hard & fibrous; With water-mucilaginous nature absent; Dilute $FeCl_3$ treatment-powder turned black; Phloroglucinol-HCl (1:1) treatment- powder turned pinkish; Particle size-passing through No. 40, 60 and 90 sieves; and for crystals, grains and stone cells, No: 125 and 180.

Microscopic examination

Calcium oxalate druses: Druses measuring 10 – 15 µm in diameter, found to be abundant.

Xylem vessels: Annular thickenings were evident, lignified, measuring 40 – 60 µm in diameter.

Fibres: Cylindrical, solitary, sometimes with vessels, lacking lignifications, thick walled-thin lumen, thin walled-thick lumen blunt, narrowing tips and broader at mid part, measuring 218 – 651 – 1248 µm in length and 15 – 20 µm in width.

Brachio-sclereids: Brachio-sclereids with uniformly thickened walls; the lumen, narrow, a few are elongated slightly.

Starch grains: Abundant, oval, and some circular, measuring 7 – 9.8 – 14 µm in diameter; eccentric hilum; compound grains, rarely seen.

Root Powder of *V.coriaceum*

Organoleptic Features: Colour-light brown; Odour-valarian root characteristics; Taste-slightly bitter; Texture-rough and fibrous; With water-mucilaginous nature absent; Dilute $FeCl_3$ treatment-powder turned black; Phloroglucinol-HCl (1:1) treatment-powder turned pinkish; Particle size-passing through No. 40, 60 and 90 sieves; and for crystals and grains, No: 125 and 180.

Microscopic examination

Starch grains: Abundant, solitary, simple with eccentric hilum, oval and, a fewwere circular, measuring 7 – 14 – 21 µm in diameter.

Cortical parenchyma: Fragments of parenchymatous tissue stained to dilute ferric chloride solution, showing the presence of tanniniferous content.

Fibres and Vessels: Thick walled fibres and vessels were lignified. The vessels showed annular thickening, the dimension of fibres in average, 760 – 924 – 1076 µm inlength and 15 – 20 µm in width. The vessels, 80 – 120 µm wide.

Calcium oxalate crystals: Druses, 35 – 40 µm in diameter; and the rosettes being 50 – 55 µm in diameter were evident.

Leaf Powder of *V.erubescens*

Organoleptic Features: Colour-brownish green; Odour-leaf characteristic; Taste-slightly bitter; Texture-rough at the bottom; With water-mucilaginous nature absent; Dilute $FeCl_3$ treatment-powder turned dark brown.

Microscopic examination (Figure 4)

Glandular trichome: Scattered on the surface of the lamina are seen club shaped multicellular stalked glands. They have unicellular, rectangular stack cell and bi-seriate, wider body cells. The glands are 60 µm in height and 25 µm thick. Their distribution on the lamina is random.

The cells of the epidermis from which the glandular trichomes arise are not modified in anyway[19].

*Nonglandular trichomes***:** These trichomes occur both on the veins and along the epidermal surface. They are multicellular, three or four celled, uni-seriate and unbranched. The cells are narrow, long, and thin, and smooth walled; the trichome is slender and mostly lopsided. They are up to 500 µm long and 10 µm thick.

*Stomata and epidermal cells***:** Fragments of abaxial epidermis are seen in the powder. They are stomatiferous. The epidermal cells have thin wavy anticlinal walls rendering the cells amoeboid outline. The stomata are anomocytic type. The guard cells are elliptic, wide and thin walled.

Stem Powder of *V.erubescens*

Organoleptic Features: Colour-reddish brown; Odour-woods characteristic; Taste-no specific taste; Texture-hard, rough and fibrous; With water-mucilaginous nature absent; Dilute $FeCl_3$ treatment-powder turned black; Phloroglucinol-HCl (1:1) treatment-powder turned pinkish; Particle size-passing through No. 40, 60 and 90 sieves; 125 and 180 for crystals and grains, if any.

Microscopic examination

The stem powder contains fibres, vessel elements and xylem parenchyma cells.The fibres are libri-form type having thick lignified walls and uni-seriate slit like pits. The fibres are 300-500 µm long and 20 µm thick.

Vessel Elements: Vessel elements are unique in being long, narrow and thin walled. They resemble the fibres in length and width. However, the vessels have uni-seriate scalariform lateral wall pits and long, much oblique scalariform perforation plate. The vessel elements are 800-900 µm long and 40 µm wide.

*Stem bark powder***:** The bark powder contains abundance of sclereids. They are brachysclereids (stone cells) and vary in shape. Some of them are isodiametric and others are rectangular with unequal sides. The sclereids have thick walls and wide lumen. The walls have wide equal like simple pits. Libriform fibres are also occasionally seen in the powder. They resemble the fibres in the stem. The bark fibres are 1.1 mm long, fairly thick walled and have single vertical row of pits.

Root Powder of *V.erubescens*

Organoleptic Features: Colour-yellowish brown; Odour-slightly aromatic; Taste-no specific taste; Texture-extremely hard, rough and fibrous; With water-mucilaginous nature absent; Dilute $FeCl_3$ treatment-powder turned black; Phloroglucinol-HCl (1:1) treatment-powder turned pinkish; Particle size- passing through No. 40, 60 and 90 sieves, and 125 and 180 for crystals and grains.

Microscopic examination

Starch grains: Simple and rarely compound; circular, spherical and sub-spherical in shape with a central hilum; size ranges from 6 – 12.5 µm.

Druses: A few with a distinct hilum; size ranges from 12 – 18 µm.

Fibres: Thick walled lignified fibres; libriform and associated with vessels; narrowing tips with blunt ends; a thin lumen with no pits measuring from 250 - 1280 µm length and 6 – 15 µm width.

Stone cells (sclereids): The root powder contains abundance of sclereids. They are brachysclereids (stone cells) and vary in shape. The sclereids have thick walls and wide lumen. The walls have wide equal like simple pits.

UNITIES

Leaf Powders

Leaf powders of all the species when collected and shade dried for a couple of week, were greenish to pale green in colour. However, on storage, the powders darkened and appeared greenish brown to brown in colour (it may be due to the presence of phyto-constituents such as iridoid glycosides[20])

Stomata: The leaves of all the three species were apostomatic on their adaxial side and stomatiferous with anamocytic stomata on their abaxial side, where the epidermal cells appear with wavy anticlinal walls.

Trichomes: The presence of trichomes are witnessed in case of all the three species.

Druses: V.punctatum and *V.coriaceum* represent the presence of druses.

Starch grains: The leaves of all the species are devoid of starch grains.

Stem Powders

Xylem vessels with annular thickening; presence of starch grains; lignified fibres; brachy-sclereids; and druses are commonly found with all the stem powders of all the three species. The grains are simple, and compound (very rarely) in all the species

Root Powders

Presence of xylem vessels, starch grains; lignified xylem fibres; brachy-sclereids; and druses are commonly appearing diagnostic features with the root powders of all the three species. However, there were several diversities among the commonly found in the stem and root components, which deserve a discussion. The grains are simple, and compound (very rarely).

DIVERSITIES

Apart from being slightly bitter both the root and stem powders are astringent in taste which may be due to the presence of phenolics such as tannins.

Leaf Powders

The leaf powder of *V.punctatum* contains peltate scale type of trichomes ranging from 65 – 90 µm in size; whereas *V.coriaceum* leaf shows rosette type glandular trichomes measuring from 46.8 – 109.2 µm in diameter, in addition to enormous number of leaf hairs measuring up to 800 µm long. But in case of the leaves of *V.erubescens*, club shaped, short stalked multicellular glandular trichomes, in addition to unicellular, unbranched, curved covering trichomes are evident which are up to 500 µm in length in average. The druses in *V.punctatum* are as big as 9 µm in diameter whereas in *V.coriaceum*, they are up to 25 µm in diameter. The epidermis (adaxial) in *V.erubescens* is papillate, beneath this arranged are vertically elongated palisade cells. But, in case of *V.punctatum* and *V.coriaceum*, the palisade cells are cylindrical and undulate respectively. The sclerenchyma is seen only with *V.coriaceum* powder (rarely). An amoeboid outlined abaxial epidermis is seen with the powder of *V.erubescens* leaf.

Stem Powders

Xylem fibre in *V.punctatum* are as long as 930 µm and 600 µm in *V.erubescens*, whereas in *V.coriaceum* the fibres are up to 1.2 mm; xylem vessels in *V.punctatum* are up to 70 µm wide, while in *V.coriaceum* and *V.erubescens*, up to 55 µm wide, in case of *V.punctatum* and *V.coriaceum* the sclereids are up to 45 µm wide, whereas in *V.erubescens*, 60 µm in size. As far as druses sizes are concerned, the powder of *V.coriaceum* shows up to 25 µm in diameter, while in rest of the species show up to a maximum of 15 µm in diameter.

From the above observation, it has been concluded to conduct a quantitative analysis (as an additional support) employing lycopodium spore method for enumerating number of starch grains and sclereids/mg of the stem powder resulting 920 and 210; 570 and 535; and 850 and 750 for *V.punctatum*, *V.coriaceum* and *V.erubescens* respectively.

Root Powders

The lignified, thick walled xylem fibres in the roots of *V.punctatum* and *V.coriaceum* are as long as 1 – 1.3 mm whereas in *V.erubescens*, measures up to 650 µm in length which are cylindrical with narrow tips. The xylem vessels randomly measure are up to 140, 120 and 45 µm in width in *V.punctatum*, *V.coriaceum* and *V.erubescens* respectively. In case of *V.punctatum* and *V.coriaceum*, the sclereids are of 20 – 45 µm wide, but in *V.erubescens*, found are the two types of slereids (stone cells) and elongated sclereids, measuring 55 µm and 45 – 105 µm wide respectively. The starch grains in *V.punctatum*, *V.coriaceum* and *V.erubescens* roots are as big as 17, 21 and 12 µm in diameter. Scalariform thickening, apart from annular thickening, is rarely seen with xylem vessels in the roots of *V.erubescens.*

As performed with the stem powders of *V.punctatum*, *V.coriaceum* and *V.erubescens*, a quantitative analysis on stach grains and sclereids were employed using lycopodium spore method resulting 1300 and 125; 1200 and 420; and 1700 and 340/mg of powder of *V.punctatum*, *V.coriaceum* and *V.erubescens* respectively.

Conclusion

Some three species were collected from Nilgiri hills, authentificated and subjected to powder microscopy to divulge unities and diversities among the species based on the core of the topic selected. This study and its results may be useful to differentiate these species, one from the other as well as from their other co-species in future.

References

1. Gamble JS. Flora of the Presidency of Madras, Vol. I, II & III. Botanical Survey of India, Calcutta, India, 1935.
2. The Wealth of India. A Dictionary of Indian Raw materials and Industrial Products – Raw Material Series, Publication and Information Directorate, CSIR, New Delhi, 2003, 10, 437 – 446.
3. Chester EW, Wofford BE and Kral K. Atlas of Tennessee vascular plats, Angiosperms: Dicots. Misc. Publ., 1997, 2(13).
4. Altun ML , Saltan CG , Sever YB and Ozbek H, Antinociceptive and anti-inflammatory activities of *Viburnum opulus*. *Pharm Biol*, 2009; 47(7): 653-658.
5. Nadkarni KM, Indian Materia Medica, 2nd ed, Popular Prakashan, Bombay, India, 2002, 1, 1271 – 1272.
6. Fukuyama Y, Kubo M, Minami H, Yuasa H, Matsuo A, Fujii T, Morisaki M and Harada K, Rearranged vibsane type diterpenes from *Viburnum awabuki* and photochemical reaction of vibsanin-B, *Chem Pharm Bull*, 2005; 53(1): 72 - 80.
7. Hoerhammer L., Wagner H and Reinhardt H. Isolation of flavonoids from the barks of *Viburnum prunifolium* Dent, *Apothekerzer*, 1965; 105(40)**:** 1371.
8. Tomassini L., Dejan B., Sebastiano F. and Nicoletti M, Iridoid glucosides from *Viburnum rhytidophyllum*, *Phytochemistry*, 1997; Vol. 44, No. 4: 751-753.
9. Tomassini L., Gao J., Foddai S., Serafini M., Ventrone A. and Nicoleti, Iridoid glycosides from *Viburnum chinshanense*, *Nat Prod Res,* 2006; 20(8): 697 - 700.
10. Khosa RL, Wahi AK, Mohan Y and Ray AB, Isolation of Bergenin from roots of *Viburnum nervosum* Hook, *Ind J Pharm*, 1979; 41(3): 120.
11. World Health Organization, Quality control methods for medicinal plant materials, WHO/PHARM/92.559, 1992, 11 – 36.
12. Wallis TE, Text Book of Pharmacognosy, 5th ed., CBS Publishers and Distributors, New Delhi, India, 2005, 559 – 618.
13. Wallis TE, Practical Pharmacognosy, Churchill Ltd., 1952, 178 – 179.
14. O'Brien TP, Feder N and Mc Cull ME, Polychromatic staining of plant cell walls by toluidine blue-O, *Protoplasma*, 1964; 59: 364 - 373.
15. Lala PK, Practical Pharmacognosy, Lina Guha Publication, India, 1981, Vol. 1, 136-153.
16. Easu K, Plant Anatomy, John Wiley and Sons, New York, 1964, 767.

17. Prabhu K, Karar PK, Ponnudurai K and Hemalatha S, Pharmacognostic and Preliminary Phytochemical Investigations on the Leaves of *Viburnum punctatum* Buch.-Ham.ex D.Don, *J Pharm Sci Res*, 2009; 1: 43.

18. Prabhu K, Ponnudurai K, Hemalatha S and Karar PK, Pharmacognostic investigations on the leaves of *Viburnum coriaceum* Blume, *Nat Prod Rad*, 2009; 8: 520.

19. Prabhu K,. Karar PK, Ponnudurai K and Hemalatha S, Pharmacognostic Investigation of the Leaves and Stems of *Viburnum erubescens* Wall.ex DC, *Trop J Pharm Res*, 2009; 8: 557.

20. Harborne JB. Phytochemical methods, 3rd ed, London, Chapman and Hall, 2005, 49-244.

Figure 1. Powders of Leaf, stem and Root of three *Viburnum* Linn. species

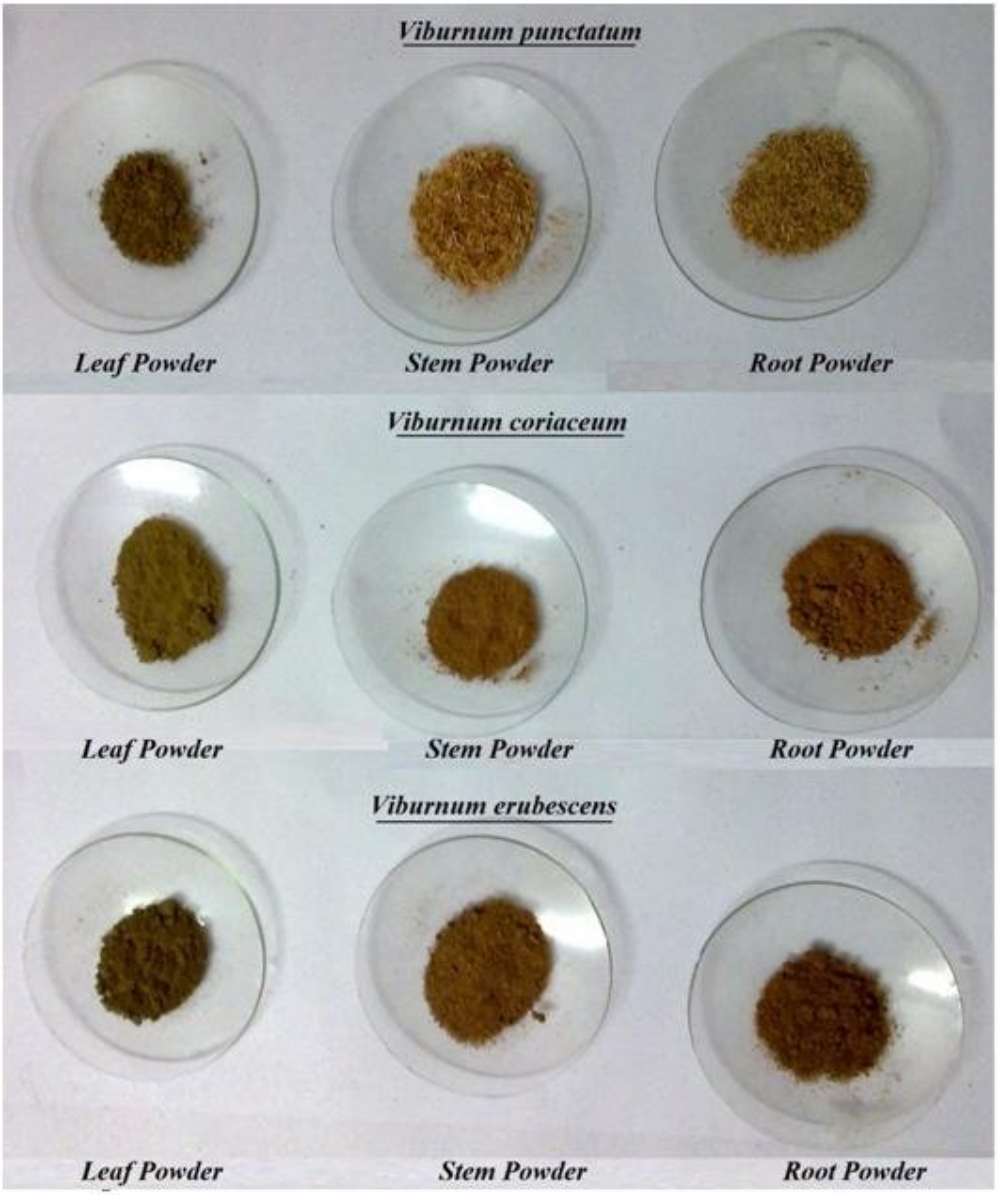
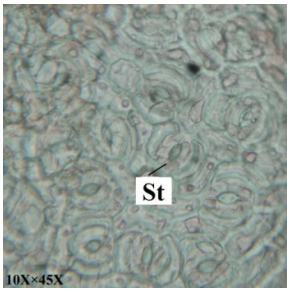
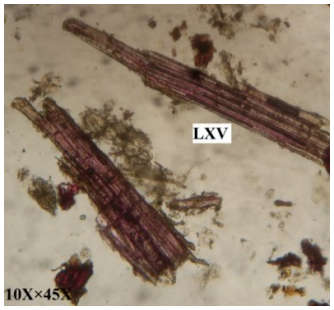


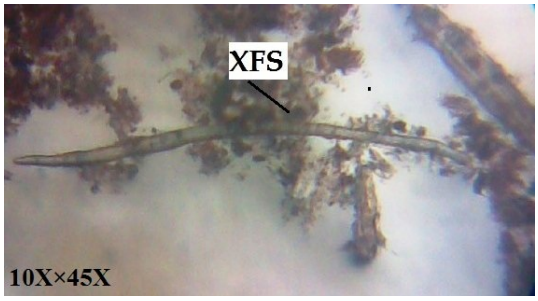
Figure 2. Powder Characteristics of Leaves, Stem and roots of *V.punctatum*

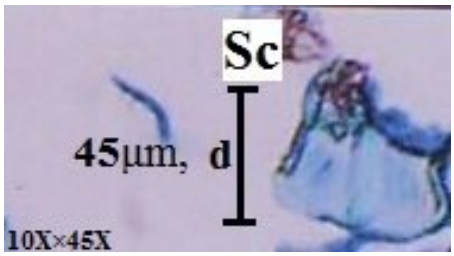
Leaf powder



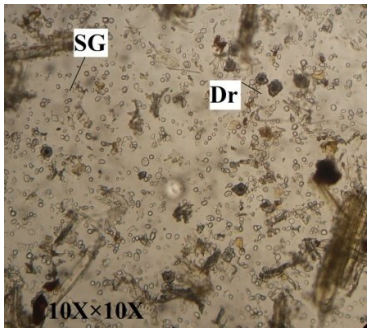
Stem Powder







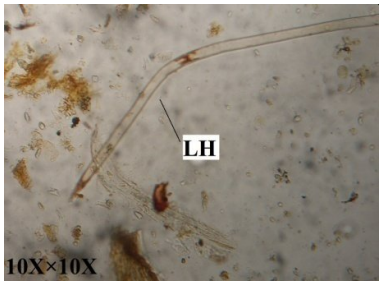
Root Powder



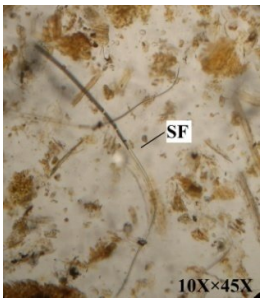
Dr – Druses, LXV – Lignified vessel and fibres sheath, SG – Starch grains, St – Abaxial epidermis showing stomata, XFS – Xylem fibre, Sc–Sclereid

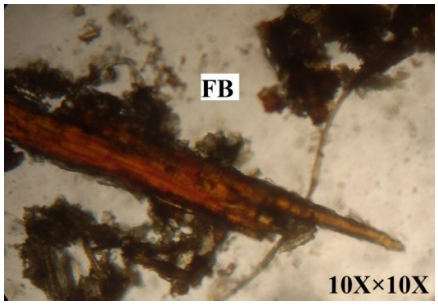
Figure 3. Powder Characteristics of Leaves, Stem and roots of *V.coriaceum*

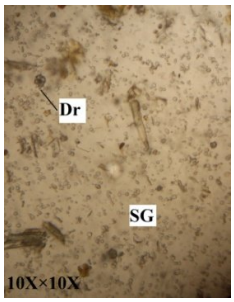
Leaf Powder

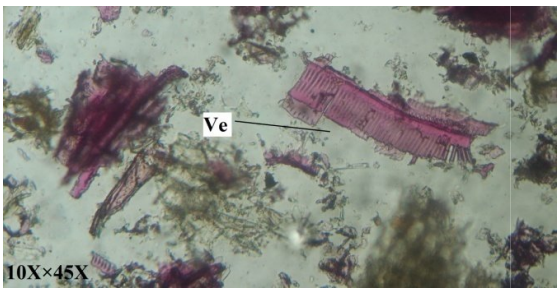


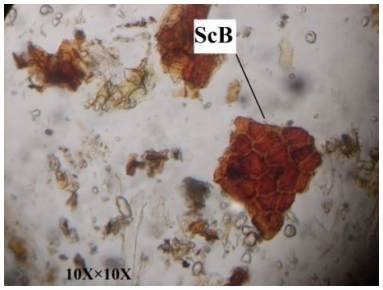
Stem Powder



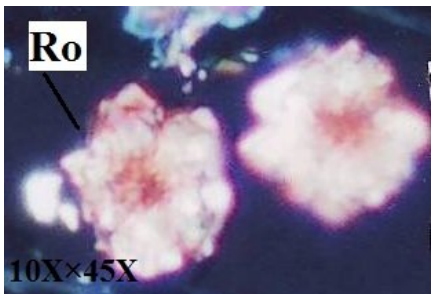


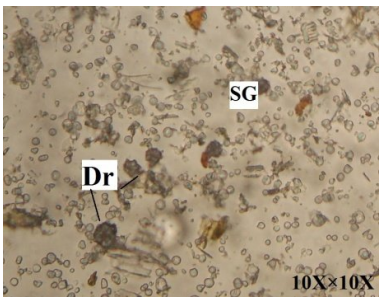


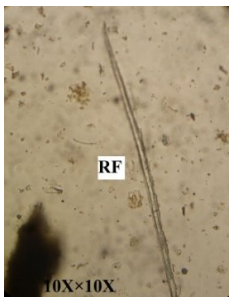




Root Powder



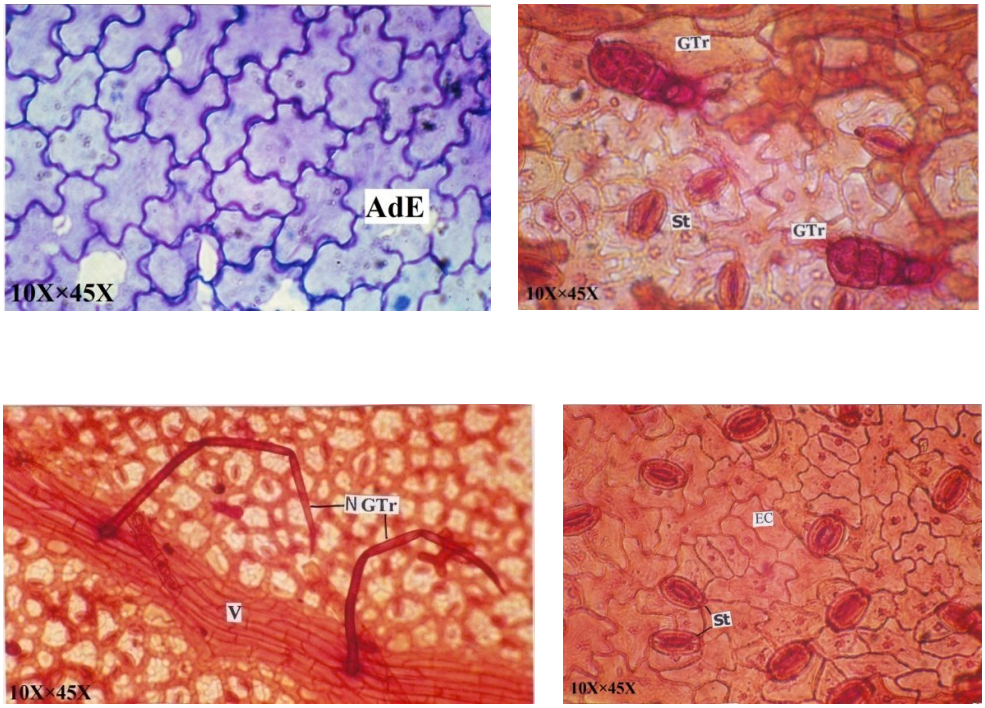




Dr - Druses; FB – Fibre Bundles; LH – Leaf Hairs; RF – Root Fibre; Ro – Rosettes; ScB – Sclereid bundles or group of sclereids; SG – Starch Grains; SF – Stem Fibre; Ve – Vessels annular thickening (magnified).

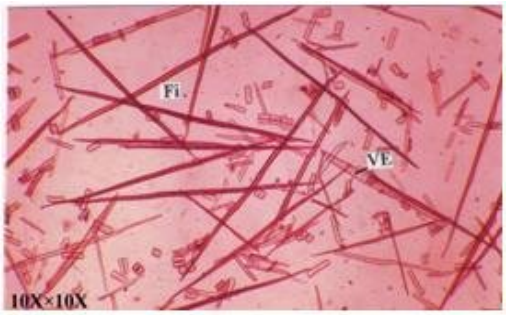
Figure 4. Powder Characteristics of Leaves, Stem and roots of *V.erubescens*

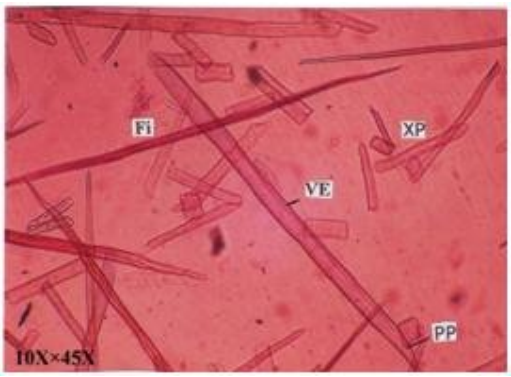
Leaf Powder



AdE – Adaxial Epidermis; EC – Epidermal cells; GTr - Glandular Trichomes; NGTr - Nonglandular trichomes; St – Stomata; V – Vein

Stem Powder of *V.erubescens*

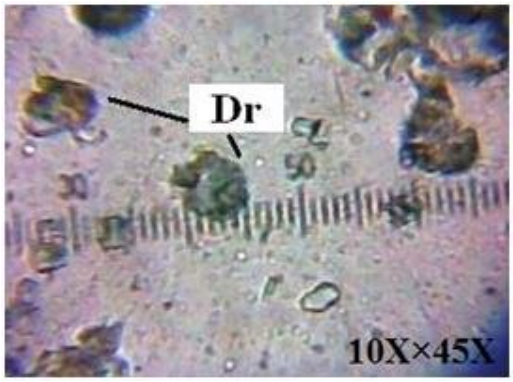


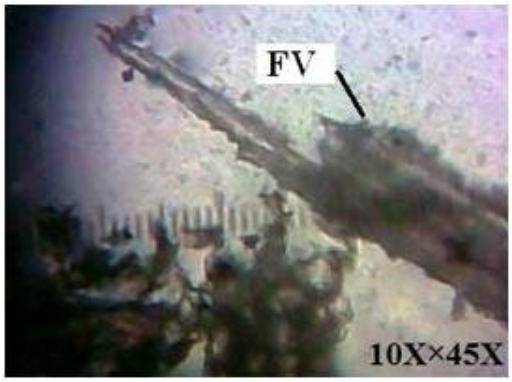


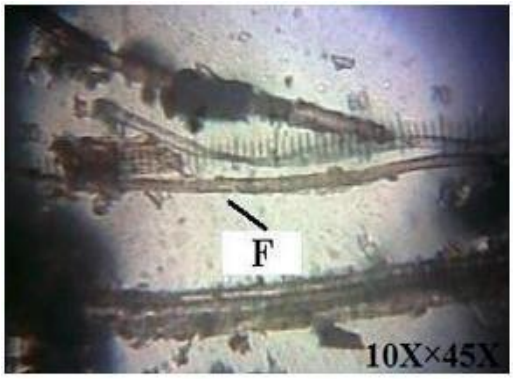
Stem Bark Powder of *V.erubescens*

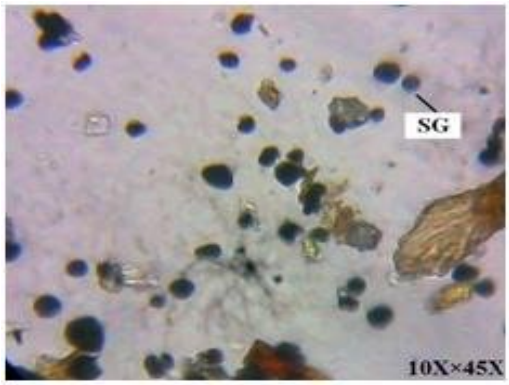
Fi - Fibres; PP - Perforation Plate (Scalariform) ; Parenchyma; Sc – Sclereid; VE - Vessel Element; XP – Xylem.

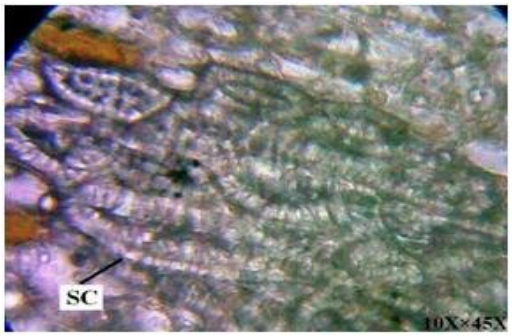
Root Powder of *V.erubescens*











Dr – Druses; F – Fibre; FV – Fibre with Vessels; SC – Stone Cells (elongated); SG – Starch grains.

LIST OF FIGURES

Figure 1. Powders of Leaf, stem and Root of three *Viburnum* Linn. species

Figure 2. Powder Characteristics of Leaves, Stem and roots of *V.punctatum*

Figure 3. Powder Characteristics of Leaves, Stem and roots of *V.coriaceum*

Figure 4. Powder Characteristics of Leaves, Stem and roots of *V.erubescens*

LEGEND FOR FIGURES

Figure 2 Dr – Druses, LXV – Lignified vessel and fibres sheath, SG – Starch grains, St – Abaxial epidermis showing stomata, XFS – Xylem fibre, Sc–Sclereid

Figure 3. Dr - Druses; FB – Fibre Bundles; LH – Leaf Hairs; RF – Root Fibre; Ro – Rosettes; ScB – Sclereid bundles or group of sclereids; SG – Starch Grains; SF – Stem Fibre; Ve – Vessels annular thickening (magnified).

Figure 4. AdE – Adaxial Epidermis; EC – Epidermal cells; GTr - Glandular Trichomes; NGTr - Nonglandular trichomes; St – Stomata; V – Vein

Fi - Fibres; PP - Perforation Plate (Scalariform) ; Parenchyma; Sc – Sclereid; VE - Vessel Element; XP – Xylem.

Dr – Druses; F – Fibre; FV – Fibre with Vessels; SC – Stone Cells (elongated); SG – Starch grains.