

Petiolar Anatomy as an Aid to the Identification of *Mangifera indica* L. Varieties

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Abstract

Petiole anatomy of eight varieties of *Mangifera indica* L., namely 'Alphonso', 'Badshahpasand', 'Cowasji', 'Jhumakhiya', 'Khodi', 'Ladvo', 'Pai' and 'Sindoria', growing in Gujarat were carried out. The evaluated characters were found to be useful in differentiating individual varieties. On the basis of significant characters, such as shape of petiole, cross-sectional area of petiole, vascular arc, shape of vascular strands, total visual count of vessels and radial multiples of vessels in main arc, number of resin canals and their diameter, thickness of cuticle and shape and size of epidermal cell and layers of hypodermal cell the varieties were investigated. Number of resin canal was highest in 'Jhumakhiya' (18), followed by 'Khodi' and 'Cowasji' (15), 'Pai' and 'Ladvo' (14), 'Alphonso' 'Badshahpasand' 'Sindoria' (13) respectively. Thickness of cuticle was maximum in 'Pai' (12 μm), 'Khodi' (10 μm), 'Alphonso' (8.5 μm), followed by 'Jhumakhiya' (6.24 μm), 'Ladvo' (7 μm), 'Badshahpasand' (6 μm), 'Cowasji' (5 μm) and 'Sindoria' (5 μm). Shape of petiole on adaxial side was circular in all the varieties except 'Alphonso' and 'Badshahpasand', which had planoconvex shape and 'Sindoria' with a highly convex shape. The evaluated petiole anatomical characteristic features proved to be a useful tool for the taxonomic discrimination of the eight studied varieties. An artificial synoptic key to the identification of the varieties has been formulated.

Keywords: anatomy, petiole, *Mangifera indica*, vascular arc

Introduction

The classification of plants is mainly based on morphological and anatomical concepts. The application of anatomical characters in plant classification dates back to Bureau (1864), who for the first time used anatomical features for the determination of taxa with *Bignoniaceae*. Leaf anatomical features have been proved to be useful for species grouping and identification (Metcalf and Chalk, 1950; Ogundipe, 2002; Nwachukwu and Mbagwu, 2006) and it has been of great taxonomic significance (Dehgan, 1982; Ogundipe and Olatunji, 1991). Ingole and Patil (2003) studied the pattern of some *Verrbenaceae* family member's vasculature where they found petiolar anatomy to be taxon specific and useful in identification of different taxa. Petiolar anatomy of *Cinnamomum* species has been used as an aid for taxonomic discrimination (Baruah, 2007). Petiolar anatomy of *Thottea* genus has been use for interpretation of numerical taxonomic methods. Mango is commonly known as King of fruits because of its excellent flavor, delicious taste, attractive appearance, high nutritive value, richness in varieties and popularity among masses. The present study was aimed to identify the characteristic anatomical features of petiole on eight mango varieties available in Gujarat.

Materials and methods

The material for the present study was obtained from the orchard of Junagadh Agriculture University, Gujarat. (India). The varieties included 'Alphonso', 'Badshahpasand', 'Cowasji', 'Jhumakhiya', 'Khodi', 'Ladvo', 'Pai' and 'Sindoria'. Leaf petioles were fixed in formalin (40%): acetic acid: ethyl alcohol (70%) 5:5:90 (v/v) FAA fixatives. Fixed samples were dehydrated in graded series (20, 35, 55, 75, 95 and 100%) of TBA (tertiary-butyl-alcohol) and embedded in paraffin wax (Johansen, 1940). Single staining with toluidine blue and double staining with Safranin and fast green (Saas, 1958) were done for cross section. Serial sections of the petiole for each variety were observed and micro photographed to visualize the cuticle, resin canals, arrangement of vascular strands and other anatomical features.

Results and discussion

A comparison of the petiole's structure in eight varieties of *Mangifera indica* shows that the petiole, in the cross section, is circular abaxially and adaxially in 'Pai', 'Ladvo', 'Khodi' 'Jhumakhiya', 'Cowasji', while it is round abaxially and planoconvex adaxially with invaginations in 'Sindoria',

'Badshahpasand' and 'Alphonso'. Epidermis was uniseriate and cuticularized in all varieties. It was barrel shaped and radially elongated compared to the the tangential wall; also the cells were papillate on the adaxial side in varieties 'Jhumakhiya', 'Pairi' and 'Alphonso'. The degree of cutinization varies amongst the varieties. Cuticle was found penetrating halfway along the radial walls if epidermis in 'Alphonso', 'Cowasji', and 'Badshahpasand' whereas in 'Ladvo', 'Sindoria' the penetration was all the way along the radial walls, in 'Khodi', 'Pairi' and 'Jhumakhiya' the cuticle was confined to the epidermal cell's surface. Thickness of the cuticle was measured using micrometry, presenting a maximum at 'Pairi' (12 μm), 'Khodi' (10 μm), 'Alphonso' (8.5 μm), followed by 'Jhumakhiya' (6.24 μm), 'Ladvo' (7 μm), 'Badshahpasand' (6 μm), 'Cowasji' (5 μm) and 'Sindoria' (5 μm) which showed the lowest. (Tab. 1).

Hypodermis in all the varieties is collenchymatous (3-4 layers), some patches (4-5 together) of stone cells are observed in the hypodermal region in varieties like 'Khodi', stone cells are in layers of 1-2 with some interrupted parenchyma in 'Alphonso' 'Jhumakhiya' and 'Sindoria' but in 'Cowasji' and 'Ladvo' it showed to be less, whereas in 'Pairi' the stone cells were absent. Below hypodermis the cortex was parenchymatous. Number of resin canal, diameter of resin canal, and shape of vasculature and pith characters showed variation.

Number of resin canal in 'Alphonso' (13), 'Badshahpasand' (13), 'Cowasji' (15), 'Jhumakhiya' (16), 'Khodi'

(15), 'Ladvo' (15) 'Pairi' (14) and 'Sindoria'(13) shape and diameter of resin canal was oval (88.53 μm) in 'Jhumakhiya', round (108.52 μm) in 'Pairi', round (119.95 μm) in 'Khodi', oval (114.24 μm) in 'Alphonso', oval(111.38 μm) in 'Cowasji', oval (88.53 μm) in 'Badshahpasand', oval (122.80 μm) in 'Sindoria' and round (88.53 μm) in 'Ladvo'.

Studies on the quantitative features of petiolar anatomy were undertaken for all the varieties. Cross-sectional area of the petiole was recorded highest in 'Pairi' followed by 'Jhumakhiya' and 'Cowasji' and lowest in 'Badshahpasand'. (Tab. 2). Total visual count of vessel in main vascular arc in median region presented the highest in 'Sindoria' (about 352-386) and the lowest in 'Ladvo' (about 125-140). Number of radial multiples of vessels in different varieties ranged from 60-65, as in 'Cowasji' (Fig. 1.C) to 52-55 to 34-38, while in 'Alphonso' and 'Khodi' (Fig. 1.A and E).

The present investigation has established that the petiole characters can be used as a tool for the taxonomic discrimination of eight varieties of *Mangifera indica*. An artificial synoptic key to the varieties, formulated on the basis of the petiolar anatomical characters, is presented below:

Key for identification

1. Outline circular abaxially and adaxially:- 'Pairi', 'Ladvo', 'Khodi', 'Jhumakhiya', 'Cowasji'

1.1. Outline smooth-'Cowasji', 'Ladvo'

Tab. 1. Anatomical features of the petiole of different varieties of *Mangifera indica*

Varieties	Thickness of cuticle (μm)	No. of Resin canal	Diameter of Resin canal(μm)	Crystal Sp Rh	Shape of the petiole on adaxial side.
'Alphonso'	8.5	13	114.24	+ +	Planoconvex
'Badshahpasand'	6	13	88.53	+ +	Planoconvex
'Cowasji'	5	15	111.38	+ +	Circular
'Jhumakhiya'	6.24	18	88.53	+ -	Circular
'Khodi'	10	15	119.95	+ +	Circular
'Ladvo'	7	14	88.53	+ +	Circular
'Pairi'	12	14	108.52	- +	Circular
'Sindoria'	5	13	122.80	- +	Highly convex

Sp-Sphaeraphides, Rh-Rhomboidal crystal, + Present,-Absent

Tab. 2. Quantitative Features of petiole anatomy of different varieties of *Mangifera indica*

Name of Varieties	Cross-sectional area (μm)	Cross-sectional area of vascular arc (μm)	Distance between sides to arc		Total visual count of vessels in main arc	Radial multiples of vessels in main arc	Cross-sectional area of vessels		Distance between two ends of arc (μm)
			Adaxial (μm)	Abaxial (μm)			Tangential (μm)	Radial (μm)	
'Alphonso'	1928x1958	1506x1524	282	194	169-179	52-55	46	74	1572
'Badshahpasand'	1706x1800	1460x1572	214	178	146-172	53-62	38	52	1640
'Cowasji'	2542x2440	2116x2090	280	230	205-225	60-65	57	74	1946
'Jhumakhiya'	2670x2800	1902x1942	540	456	140-176	45-55	47	47	1948
'Khodi'	2050x2052	1496x1538	222	288	162-190	34-38	37	41	1654
'Ladvo'	1726x1976	1162x1552	272	313	125-140	41-52	50	63	1490
'Pairi'	3006x3618	1822x3528	740	508	181-220	54-73	35	40	2396
'Sindoria'	1988x1894	1738x1710	170	132	352-386	55-59	43	46	1630

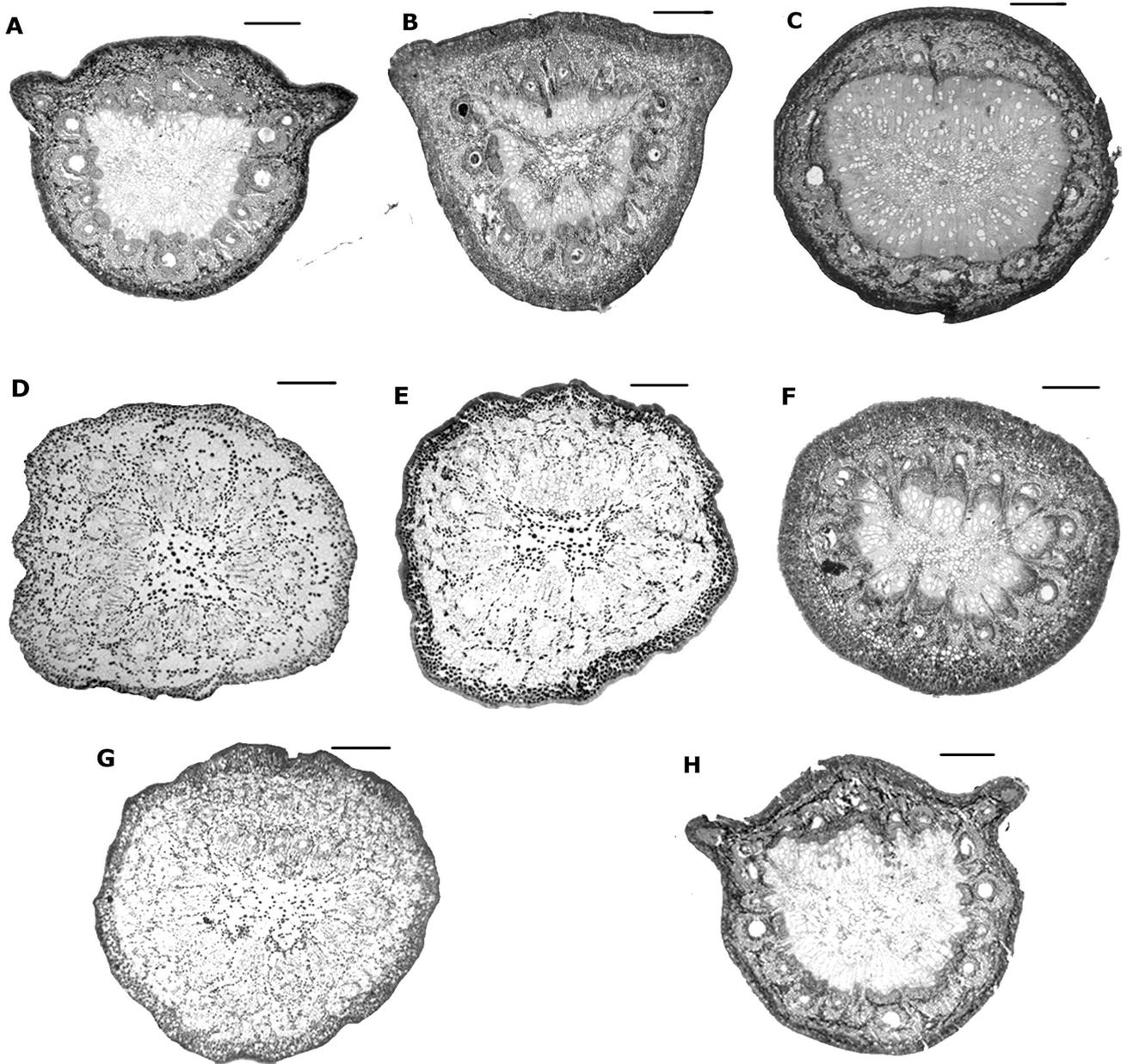


Fig. 1. A-H Transection of Petiole. A. 'Alphonso'; B. 'Badshahpasand'; C. 'Cowasji'; D. 'Jhumakhiya'; E. 'Khodi'; F. 'Ladoo'; G. 'Pairi'; H. 'Sindoria'. (Bar A-H = 10mm)

1.1.1. Vascular bundles arranged to form a closed continuous crescentric cylinder.

Epidermal cells broad, cuticle penetrates halfway in between epidermal cell-'Cowasji'

1.1.2. Vascular bundles widely spaced and arranged to form discontinuous crescentric cylinder.

Epidermal cell narrow elongated and appears in pairs, cuticle penetrates between pairs of epidermal cell-'Ladvo'

1.2. Outline Wavy-'Jhumakhiya', 'Khodi', 'Pairi'

Epidermal cell elongated. Cuticle confined to outer surface of epidermal cell.

1.2.1. Thick layer of cuticle, epidermal cell squarish-'Pairi'

1.2.2. Thick layer of cuticle, epidermal cell elongated-'Jhumakhiya', 'Khodi'

1.2.2.1. Radial multiple of vessel in main arc 45-55. Distance between epidermis and the vascular arc on adaxial side is 8-14-'Jhumakhiya'

1.2.2.2. Radial multiple of vessel in main arc 34-38. Distance between epidermis and the vascular arc on adaxial side is 24-29-'Khodi'

2. Outline roundish abaxially and adaxially planoconvex and invaginated-'Sindoria', 'Badshahpasand', 'Alphonso'

2.1. Adaxial surface circular. Vascular bundles arranged in a closed crescentric arc and pith large-'Alphonso', 'Sindoria'

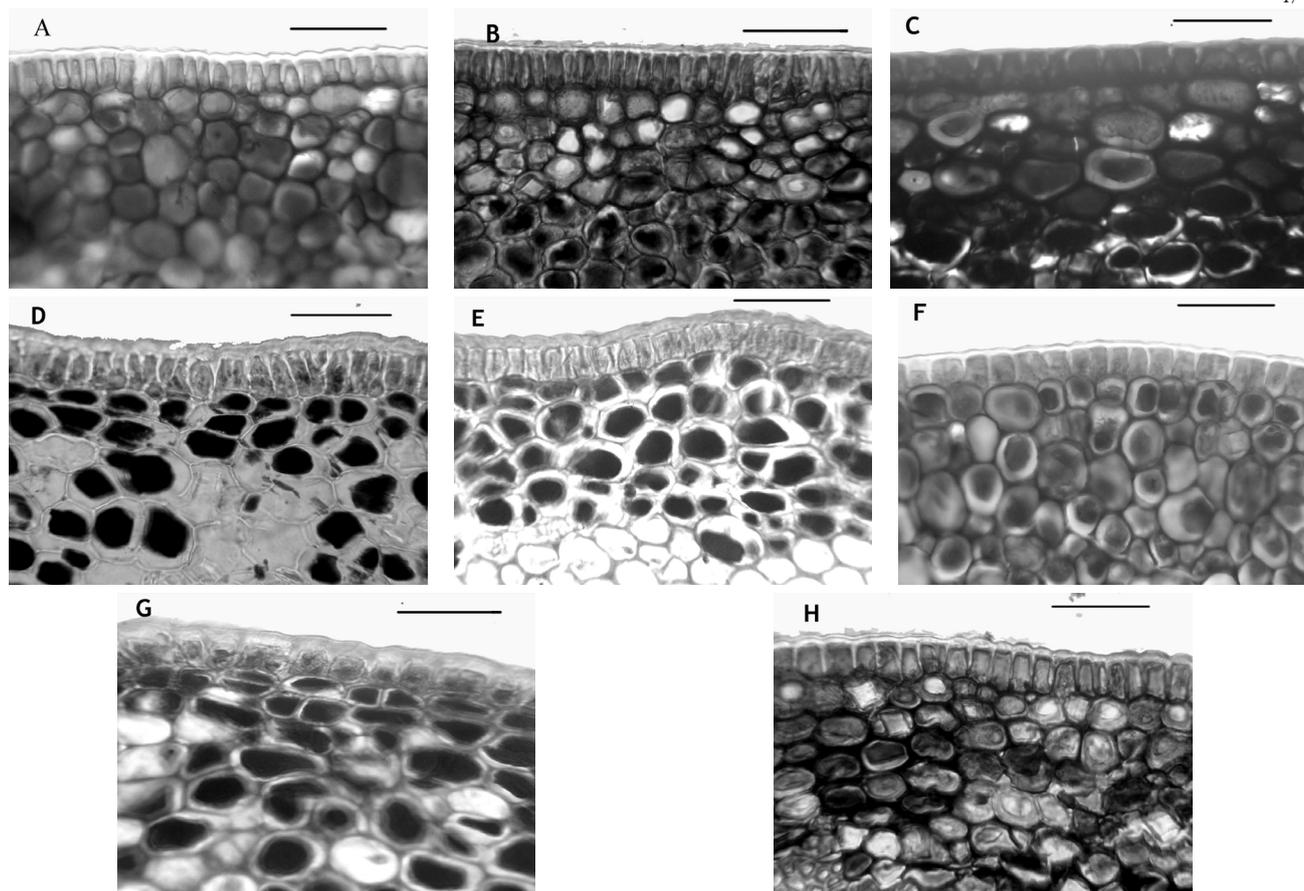


Fig. 2. A-H Epidermal and sub-epidermal regions of the Petiole in the different varieties of *Mangifera indica*. A. 'Alphonso'-Cuticle, epidermal cell and rhomboidal crystal; B. 'Badshahpasand'-Fibre cell and rhomboidal crystal in hypodermis; C. 'Cowasji'-Fibre cell and rhomboidal crystals in hypodermis; D. 'Jhumakhiya'-Cuticle penetrating halfway between epidermal cells; E. 'Khodi'-Cuticle covering the epidermal cell; F. 'Ladvo'-Fibre cell and rhomboidal crystal in hypodermis; G. 'Pairi'-Epidermis with thick cuticle; H. 'Sindoria'-Fibre cell and rhomboidal crystals in hypodermal region. (Bar A-H = 20mm)

2.1.1. Adaxial surface convex and slightly flattened. Cuticle penetrating half way between epidermal cell- 'Alphonso'

2.1.2. Adaxial surface highly convex. Cuticle deeply penetrated- 'Sindoria'

2.2. Adaxial surface elongated. Vascular bundles elongated deeply and arranged in a closed crescentric arc, Pith highly reduced.

Hypodermis with rhomboidal crystal and fibre cells- 'Badshahpasand'

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