

Intraspecific Morpho-Anatomical Study of *Piper betle* L. from South West Bengal, India: A Systematic Approach

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ABSTRACT

Piper betle L. is an economically noteworthy species from West Bengal. A bunch of its varieties are cultivated throughout the southern part of West Bengal for their commercial and medicinal values. This study aspires to establish a systematic interrelationship among these taxa for better understanding in the future. Characterization based on morpho-anatomical attributes was performed to realize the correlation among them. The necessity of scientific identification and classification of this species at the intraspecific level is understood. This study has revealed *P. betle* var. *calcuttia bangla* and *P. betle* var. *kali bangla* share maximum similarity between them based on the morpho-anatomical features. On the other hand, *P. betle* var. *meetha* and *P. betle* var. *sanchi* has shown a lot of parity between them, especially in having stronger laminar aroma and floral traits.

Highlights:

- The family Piperaceae belongs to the clade Magnoliid and is distributed pan-tropically, with the most abundance in South East Asia and the Neotropics.
- Leaves of *Piper betle* L. is one of the important commercial crops of India, which is used as refreshments medicine and also in religious and traditional rituals as an oblation.
- Many varieties of *P. betle* L. have been cultivated throughout India including the southern part of West Bengal.
- To reveal the medicinal values of these varieties, scientific identification and classification of them at an intraspecific level is very important.
- Morpho-anatomical traits can be used as markers in identifying and classifying varieties of betel.
- Taxonomic identification and classification of betel vine will guide future researchers in unveiling the phytochemistry and medicinal aspects of these varieties.

Keywords: *Piper betle*, morpho-anatomical, characterization, intraspecific, interrelationship

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INTRODUCTION

The family Piperaceae belongs to the clade Magnoliid, which contains approximately 3600 species and is distributed pantropically with the most abundance in South East Asia and Neotropics (Jaramillo and Cajellas, 2004). *Piper* is a well-recognized commercial plant that is often found in the low-land forest bed (Jaramillo and Manos, 2001). In India, members of *Piper* are observed mainly in the North-Eastern provinces of India and the Deccan region (Gajurel *et al.*, 2008; Chanchal *et al.*, 2014).

Piper betle L. is one of the important commercial crops of India with medicinal aspects. Leaves of the betel plant are used as refreshments and also used in religious and traditional rituals as an oblation (Shethi *et al.*, 2019). *Piper betle* L. is one of the important commercial crops of India with medicinal aspects. Leaves of the betel plant is used as refreshments and also used in religious and traditional rituals as an oblation. *P. betle* L. has South and Central Asian origin, especially in Indo-Burmese and Indo-Malayan regions (Parthasarathy *et al.*, 2006) and was found in the Eastern tropics as a wild plant (Dassanayake *et al.*, 1987). Habit, growth pattern, nodal traits, and spike alignment were recognized as taxonomic markers for *Piper* (Chanchal *et al.*, 2014). Typification, identification, nomenclature and distribution of eighty-four species of *Piper* from India were reported (Mukherjee, 2016, 2018 and 2020). Nine species of *Piper* were addressed from the Northern part of West Bengal.

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Bhattacharjee and Ansari (2020) in 'Flora of West Bengal (Vol. IV)' have mentioned fourteen wild and three cultivated species of *Piper* species throughout West Bengal. Singh (1994) has mentioned about five betel varieties from India, including Bangla, Kapoori, Sanchi, Desawari and Meetha. Foliar anatomy of six varieties of *Piper* was studied (Begam *et al.*, 2023).

Varieties of *P. betle* L. observed by the authors from the districts of southern West Bengal include- (i) Calcuttia bangla, (ii) Kali bangla, (iii) Kodi bangla, (iv) Desi bangla, (v) Meetha, (vi) Sanchi. This research work focuses on understanding the interrelationship among varieties of betel and determining the

importance of morpho-anatomical features that can be used as markers in identifying and classifying varieties of betel. This research work focuses on understanding the interrelationship among varieties of betel and determining the importance of morpho-anatomical features that can be used as markers in identifying and classifying varieties of betel.

MATERIAL AND METHODS

extensive surveys through the districts from the southwestern part of West Bengal (Fig. 1), India (selected study area), were executed to study *Piper betle* L. Many accessions of each variety were collected (Table 1) and analyzed (Prain, 1963).

Herbarium sheets of specimens were deposited and

Table 1: Collection sites of *P. betle* varieties with latitude and longitude

SN	Plant taxa	Site of collection	Latitude and longitude
1.	<i>P. betle</i> var. <i>calcuttia bangla</i>	Itaberia, Purba Medinipur	21°59'8.15"N, 87°39'27.2"E
		Sujalpur, Contai, Purba Medinipur	21°45'16.5"N, 87°38'52.7"E
		Padima, Patashpur, Purba Medinipur	22°0'44.5"N, 87°28'27.54"E
		Mohanpur, Paschim Medinipur	21°49'47.9"N, 87°26'46.15"E
		Khakurda, Paschim Medinipur	21°58'31"N, 87°25'47.57"E
		Balai Panda, Moyna, Paschim Medinipur	22°11'34.6"N, 87°46'12.2"E
		Ismalichak, Moyna, Paschim Medinipur	22°12'54.36"N, 87°44'39"E
		Nachipur, Keshiary, Paschim Medinipur	22°5'35.2"N, 87°12'44.5"E
		Churamanipur, Bankura	23°4'57.83"N, 87°17'58.87"E
2.	<i>P. betle</i> var. <i>kali bangla</i>	Porachingra, Bhagawanpur, Purba Medinipur	22°1'56.5"N, 87°51'5.85"E
		Naipur, Patashpur, Purba Medinipur	22°1'21.6"N, 87°29'43.4"E
		Banamalichatta, Contai, Purba Medinipur	21°51'22.9"N, 87°43'34"E
		Khanchi, Tamluk, Purba Medinipur	22°13'6.7"N, 87°54'31"E
		Narikelda, Tamluk, Purba Medinipur	22°15'27.85"N, 87°52'59.3"E
		Jamirapal, Jhargram	21°58'54.5"N, 87°12'12.25"E
		Taldangra, Bankura	23°2'8.25"N, 87°6'32.6"E
		Padima, Patashpur, Purba Medinipur	22°1'7.05"N, 87°28'11.9"E
		Mustafapur, Patashpur, Purba Medinipur	21°58'34"N, 87°29'46"E
3.	<i>P. betle</i> var. <i>desi bangla</i>	Agarbar, Belda, Paschim Medinipur	22°0'18.15"N, 87°27'53"E
		Jahalda, Paschim Medinipur	21°55'41.9"N, 87°2'20.5"E
		Sirshi, Jhargram	22°22'41.67"N, 87°2'23"E
		Kaktya, Purba Medinipur	22°21'57.67"N, 87°54'20"E
		Nandakumar, Purba Medinipur	22°10'53.7"N, 87°53'38.5"E
4.	<i>P. betle</i> var. <i>kodi bangla</i>	Tangrakhali, Purba Medinipur	22°12'12.75"N, 87°50'58.3"E
		Hanschara, Nandigram, Purba Medinipur	22°7'39.05"N, 87°54'19.81"E
		Hoglaberya, Purba Medinipur	22°22'1"N, 87°52'25"E
		Deshduttabar, Contai, Purba Medinipur	21°44'12.5"N, 87°46'28.15"E
		Kaktya, Purba Medinipur	22°21'40.87"N, 87°54'7.2"E
5.	<i>P. betle</i> var. <i>meetha</i>	Narikelda, Tamluk, Purba Medinipur	22°15'11.7"N, 87°54'20"E
		Demari, Tamluk, Purba Medinipur	22°21'0.5"N, 87°55'22"E
		Picchaboni, Purba Medinipur	21°42'59.4"N, 87°40'11"E
		Balpai, Purba Medinipur	22°12'53"N, 87°37'15"E
		Thekua, Purba Medinipur	22°13'10.5"N, 87°51'42.7"E
6.	<i>P. betle</i> var. <i>sanchi</i>	Radhaballavpur, Purba Medinipur	22°18'49"N, 87°54'49"E
		Barkalu, Purba Medinipur	22°17'22.17"N, 87°52'34.2"E
		Tengunia, Contai, Purba Medinipur	21°46'22.58"N, 87°42'10.56"E
		Ekarukhi, Dantan, Paschim Medinipur	21°58'40"N, 87°26'36.5"E

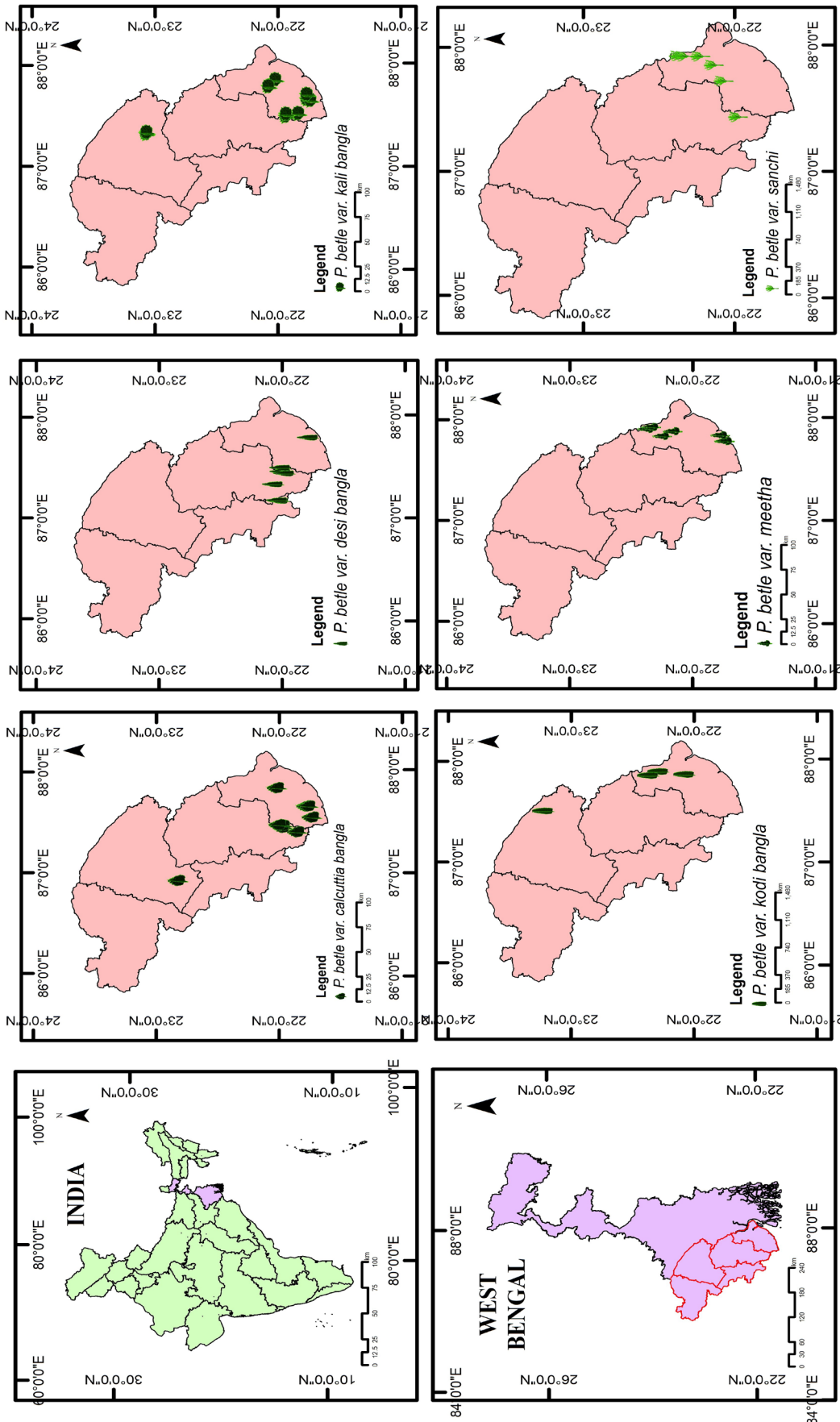


Fig. 1: Distribution map of the studied varieties of *P. betle* L. in the study area

authenticated in Central National Herbarium (CNH), BSI, Kolkata (CAL). Specimens (both vegetative and reproductive parts) were observed under Stereo Microscopes for morphological scrutiny (Leica M125C and Leica DM3000).

Specimens (internode, lamina and petiole) were preserved in FAA solution (Johansen, 1940; Raman *et al.*, 2012) and were cross-sectioned by razor blade and in cryomicrotome (Leica Cryomicrotome: CM1950). Sections were dehydrated in ethanol's graded series (30, 50, 70, 90 and 100%). Then, sections were subjected to staining in 1% safranin solution and mounted in Canada balsam (Ruzin, 1999; Nugroho *et al.*, 2019). A minimum of ten slides for each specimen were observed under a compound microscope (Olympus CH20i BIMU). Stained slides were measured by using a Zeiss-primo star microscope under E10, E20 and E40 and oil immersion (E100, 1.25) by using a 10X eyepiece. Photomicrographs were captured using a camera (Axiocam 105 color) equipped with this microscope.

Observations have revealed sixty morpho-anatomical traits that were used to construct a data matrix (Chopra *et al.*, 1956). Two variables of each trait were marked as 0 and 1, respectively. Based on this data matrix, principal component analysis (PCA) and multivariate cluster analysis (UPGMA) were performed through PAST3 software using the biplot graphic system (Gabriel, 1971; Jolliffe, 2002).

RESULTS AND DISCUSSION

Morphological account of *Piper betle* L.

Perennial, climber, roots nodal, adventitious, enable climbing, leader monopodial, internode marked with vertical whitish streaks, crescentic leaf scar present on node, aerial branches sympodial, horizontal or drooping, stipules adnate, spatulate, deciduous, leaves simple, distichous, alternate, aromatic, coriaceous, venation acrodromous, dioecious, inflorescence axillary, opposite to leaf (Fig. 2), pendulous spike, male inflorescence cylindrical, flowers spirally arranged, sessile, bracts peltate, orbicular, stamens 2, filaments inconspicuous, anthers reniform, bithecos, extrose, female spike pendulous (Fig. 2), female flowers achlamydous, bracteate, bract peltate, monocarpellary, stigma 3 to 5 fid, ovary inferior, ovule anatropous (Fig. 2 and Table 2).

Anatomical account of *Piper betle* L.

Stem

A cross-section of the internode shows a wavy outline of a uni-layered epidermis with 1-3 celled non-glandular trichomes. The cortex beneath this has collenchymatous, chlorenchymatous, and parenchymatous layers successively from the outer to the inner side, along with scattered tiny patches of sclerenchyma (Fig. 3). A ring of sclerenchyma appears next to the cortex which embeds cortical vascular bundles on the outer side (Table 3). The mucilage canal is present centrally and vascular bundles encircle it. A ring of lysigenous mucilage canals surrounds medullary bundles alternately to the bundles (Fig. 3). Each vascular bundle is open, collateral and conjoint. Pith is parenchymatous and contains oil droplets (Fig. 3 and Table 3).

Table 2: Important morphological characters of *P. betle* varieties

Characters	<i>P. betle</i> var. <i>calcuttia bangla</i>	<i>P. betle</i> var. <i>kali bangla</i>	<i>P. betle</i> var. <i>kodi bangla</i>	<i>P. betle</i> var. <i>desi bangla</i>	<i>P. betle</i> var. <i>meetha</i>	<i>P. betle</i> var. <i>sanchi</i>
Orthotropic shoot	Shoot tip yellowish green, internode with light green striation	Shoot tip Dark green, internode with reddish green striation	Shoot tip Dark green, internode with reddish green striation	Shoot tip light green, internode with green/white striation	Shoot tip Dark green, internode with light green striation	Shoot tip Dark green, internode with whitish green striation
Nodal	Appears in 2 whorls	Appears in 2 whorls	Appears in 2 whorls	Appears in 2 whorls	Appears in 2 whorls	Appears in 1 whorl
Branching	Horizontal	Horizontal with semi-erect tip	Horizontal	Horizontal with erect tip	Drooping	Drooping
Trailer	Leafy	Dendroid	Dendroid	Leafy	Leafy	Dendroid
Stipule	Short (2-2.5 cm), green coloured	Short (2-2.5 cm), green coloured	Short (1.5-2 cm), green coloured	Short (2-2.5 cm), pale green coloured	Short (1.5-2 cm), pale green coloured	Long (3-5 cm), yellowish green coloured
Leaf	Cordate, acute, base cordate, entire	Cordate, acute, base cordate, entire	Cordate, acute, base cordate, undulate near base	Ovate, acuminate, base cordate, undulate near base	Lanceolate, acuminate, base truncate, undulate near base	Ovate, acuminate base truncate, entire
Bract	Peltate, orbicular, deeply entrenched	Peltate, orbicular, deeply entrenched	Peltate, orbicular, attached at surface	Peltate, orbicular, attached at surface	Peltate, orbicular, deeply entrenched	Peltate, orbicular, attached at surface
Peduncle	Curved, pubescent	Curved, pubescent	Straight, glabrous	Straight, glabrous	Curved, pubescent	Curved, glabrous



Fig. 2: (a-d) *P. betle* var. *calcuttia bangla* [(a) Habit, (b) Leaf, (c) Inflorescence, (d) Nodal root]; (e-g) *P. betle* var. *kali bangla* [(e) Habit and nodal root, (f) Leaf, (g) Inflorescence]; (h-j) *P. betle* var. *kodi bangla* [(h) Habit and nodal root, (i) Leaf, (j) Inflorescence]; (k-m) *P. betle* var. *desi bangla* [(k) Habit and nodal root, (l) Leaf, (m) Inflorescence]; (n-q) *P. betle* var. *meetha* [(n) Habit, (o) Leaf, (p) Inflorescence, (q) Nodal root]; (r-u) *P. betle* var. *sanchi* [(r) Habit, (s) Leaf, (t) Nodal root, (u) Inflorescence].

Table 3: Important stem anatomical characters of *P. betle* varieties

Characters		<i>P. betle</i> var. <i>calcuttia bangla</i>	<i>P. betle</i> var. <i>kali bangla</i>	<i>P. betle</i> var. <i>kodi bangla</i>	<i>P. betle</i> var. <i>desi bangla</i>	<i>P. betle</i> var. <i>meetha</i>	<i>P. betle</i> var. <i>sanchi</i>
Trichome		Unicelled	With 2-3cells	Unicelled	With 2-3cells	With 2-3cells	With 2-3cells
Cortical Vascular Bundle	Number	20-25	20-25	30-35	15-20 in	30-35	35-40
	Length (µm.)	55-60	55-60	52-55	40-45	45-50	55-60
Medullary Vascular Bundle	Width (µm.)	30-35	30-35	45-50	25-30	25-30	40-45
	Number	10-15	10-15	10-15	05-10	08-10	08-10
Xylem (µm.)	Length (µm.)	75-80	85-90	85-90	85-90	70-75	70-75
	Width (µm.)	45-50	50-55	45-50	45-50	50-55	45-50
Cortical mucilage canal (µm.)	Protoxylem	10-15 long	20-25 long	10-15 long	20-25 long	22-30 long	20-25 long
	Metaxylem	20-25 long	20-25 long	20-25 long	30-35 long	30-35 long	30-35 long
Central mucilage canal (µm.)		20-25 wide	20-25 wide	28-30 wide	28-30 wide	20-25 wide	20-25 wide
Starch grain		Present, abundant	Absent	Present, scarce	Present, abundant	Absent	Absent
Oleoresins		Abundant	Abundant	Scarce	scarce	Abundant	Abundant

Leaf

Lamina appears semi-circular, dorsi-ventrally differentiable, and with an even surface in cross section. Adaxial epidermis is 1-3 layered, apostomatic, cells rectangular, abaxial epidermis is 1-2 layered, stomateferous, thinly cuticularised (Fig. 3). Both the epidermis bears uniseriate, 1-4 celled non-glandular trichomes (Table 4). Hypodermis on both sides is collenchymatous and abundant with idioblasts. Sub-epidermal cells are collenchymatous. Mesophyll tissue is bifacial, unilayered, and elongated. 1-2 layers of Palisade are succeeded by oval, 4-7 layers of spongy cells (Fig. 3). A conspicuous parenchyma-made bundle sheath with tinges of sclerenchymatous patches is observed. Each vascular bundle is conjoint, collateral and closed. The only mucilage canal was observed above the central vascular bundle (Fig. 3 and Table 4).

Petioles appear heart-shaped and deeply grooved in cross-section. 1-2 layered epidermis covered with thick cuticle and non-glandular trichomes appear on the surface. The cortex is

made up of interrupted patches of collenchyma, followed and invaginated by polygonal parenchymatous cells (Fig. 3). A thick band of multilayered collenchyma appears at the furrowed region beneath the epidermis. Two or more rings of vascular bundles are arranged successively. In 11 to 12 bundles in the inner ring and 3 to 5 in the outer ring with variable numbers of additional vascular bundles are noticed (Fig. 3). In some varieties, mucilage canals lie beneath the vascular bundle. Pith bears stone cells (Fig. 3 and Table 4).

Based on the contrasting features given in Table 2 (for morphological traits), Table 3 and Table 4 (for anatomical traits) PCA was executed and dendrogram was built. These are discussed below-

Principal Component Analysis

In PCA, based on morpho-anatomical characters, the calculated variance for PC 1 is 33.71%, PC 2 is 20.95%, PC 3 is 18.05%, PC 4 is 15.78% and PC 5 is 11.51%. In the scatter plot the close co-relation

Table 4: Important anatomical characters of leaf

Characters		<i>P. betle</i> var. <i>calcuttia bangla</i>	<i>P. betle</i> var. <i>kali bangla</i>	<i>P. betle</i> var. <i>Kodi bangla</i>	<i>P. betle</i> var. <i>desi bangla</i>	<i>P. betle</i> var. <i>meetha</i>	<i>P. betle</i> var. <i>sanchi</i>
Trichome		Unicelled	2-3-celled	Unicelled	2-3-celled	2-3-celled	2-3-celled
Lamina Mesophyll tissue (µm.)		65-70	75-80	75-80	60-70	65-70	60-65
	Vascular Bundle	Length (µm.)	180-200	180-230	120-150	180-200	120-150
Vascular Bundle	Width (µm.)	180-220	180-220	120-150	180-200	180-200	180-200
	Outer ring	8-10 in number	12-15 in number	8-10 in number	8-10 in number	5-8 in number	5-8 in number
Vascular Bundle	Inner ring	4-6 in number	8-10 in number	4-6 in number	8-9 in number	8-9 in number	8-9 in number
	Accessory bundle	Absent	Absent	Present	Absent	Present	Present
Petiole Mucilage canal beneath vascular bundle		Present	Present	Present	Absent	Absent	Absent

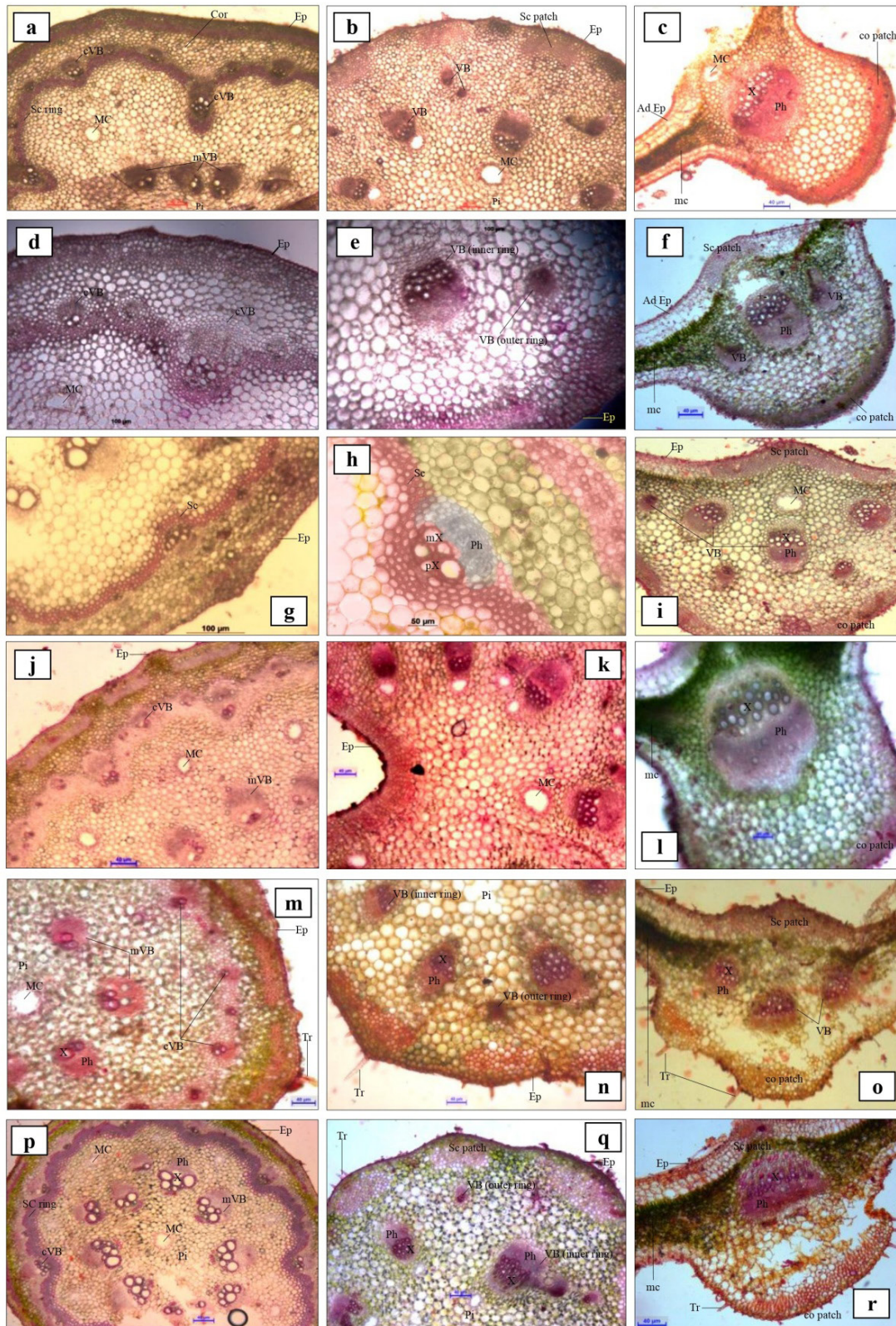


Fig. 3: (a-c) *P. betle* var. *calcuttia bangla* [T.S. of (a) Stem, (b) Petiole, (c) Lamina]; (d-f) *P. betle* var. *kali bangla* [T.S. of (d) Stem, (e) Petiole, (f) Lamina]; (g-i) *P. betle* var. *kodi bangla* [T.S. of (g) Stem, (h) Petiole, (i) Lamina]; (j-l) *P. betle* var. *desi bangla* [T.S. of (j) Stem, (k) Petiole, (l) Lamina]; (m-o) *P. betle* var. *meetha* [T.S. of (m) Stem, (n) Petiole, (o) Lamina]; (p-r) *P. betle* var. *sanchi* [T.S. of (p) Stem, (q) Petiole, (r) Lamina] (Ep- Epidermis, Tr- Trichome, MC- Mucilage canal, VB- Vascular Bundle, Pi- Pith, X- Xylem, Ph- Phloem, co- Collenchyma, c- cortex, mVB- medullary bundle, cVB- cortical bundle Ad- Adaxial, Ab- Abaxial, Sc- Sclerenchyma, mc- Mesophyll cell).

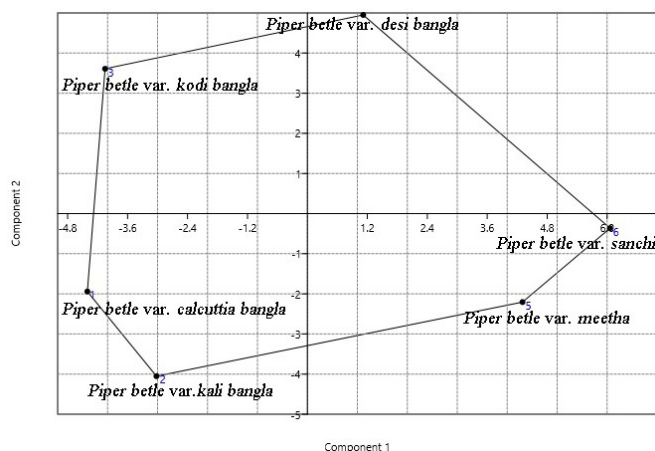


Fig. 4: Scatter Plot showing the distribution of varieties of *Piper betle* L. among principal components

between *P. betle* var. meetha and *P. betle* var. sanchi (Fig. 4), as well as between *P. betle* var. calcuttia bangla and *P. betle* var. kali bangla was revealed (Fig. 4). Characters that played a key role in PC 1 include shoot tip colour, branch appearance, and stipular characters. Lamina shape, apex, dimorphism, aroma, and taste were the important characters involved in PC 2. Floral characters, bracteal characters, appearance, and texture of peduncles were influential in PC 3. PC 4, together with PC 5 depends upon anatomical characteristics, such as features of trichome, sclerenchymatous pericycle, appearance of vascular bundles at cortex and stele, abundance of oil droplets and starch grains, presence and positioning of mucilage canals in petiole.

Cluster Analysis

The cluster analysis (UPGMA Hierarchical Clustering) has separated the investigated taxa into two clusters, viz. –

Cluster I

This cluster includes taxa with cordate lamina, dark green coloured stipule, presence of mucilage canal beneath petiolar vascular bundles and higher numbers of internodal medullary bundle. It includes *Piper betle* var. calcuttia bangla, *P. betle* var. kali bangla and *P. betle* var. kodi bangla (Fig. 4).

Cluster II

This cluster includes taxa with elliptic-lanceolate lamina, white-yellowish green coloured stipule, absence of mucilage canal beneath petiolar vascular bundles and lesser numbers of internodal medullary bundles. It includes *P. betle* var. desi bangla, *P. betle* var. meetha, and *P. betle* var. sanchi (Fig. 5).

In cluster I (Fig. 5), *P. betle* var. calcuttia bangla and *P. betle* var. kali bangla are kept in the same sub-cluster and separated from *P. betle* var. kodi bangla based on characters like- lamina area, appearance of peduncle, vascular bundles' number in cortex of stem. *P. betle* var. calcuttia bangla and *P. betle* var. kali bangla later differentiated based on features which include leaf apex, size of carpel, presence of starch grains and trichomatous density in the lamina abaxial surface. In Cluster II (Fig. 5), *P. betle* var. desi bangla stayed separated from the other two taxa, viz., - *P. betle* var. meetha and *P. betle* var. sanchi (Fig. 5). Features like the intensity of aroma in leaves, appearance of branches, length

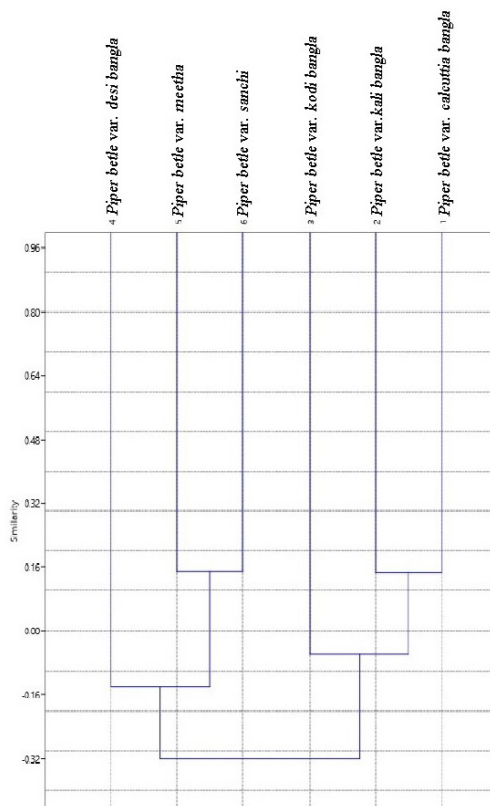


Fig. 5: UPGMA Dendrogram showing phenetic interrelation among varieties of *Piper betle* L.

of lamina vascular bundles, presence of oleoresins and pearl glands have ensured this segregation. Characters that played an important role in separating *P. betle* var. meetha and *P. betle* var. sanchi include the number of nodal root whorl, stipular size, floral arrangement, sclerenchyma beneath vascular bundles.

Key to the varieties

1. Lamina cordate, stipule dark green, medullary vascular bundle more than 10, mucilage canal beneath vascular bundles in petiole present..... (2)
1. Lamina elliptic-lanceolate, stipule white-yellow, medullary vascular bundle less than 10, mucilage canal beneath vascular bundle in petiole absent (4)
2. Lamina longer (>15 cm), margin entire, cortical vascular bundles more than 25 (3)
2. Lamina shorter (<15 cm), margin undulate at base, cortical vascular bundle less than 25 *P. betle* var. kodi bangla
3. Carpel < 1.5 μm, trailer leafy, trichomes unicelled, starch grains present, density of trichomes is low
..... *P. betle* var. calcuttia bangla
3. Carpel > 1.5 μm, trailer dendroid, trichomes 2-3 celled, starch grains absent, trichomatous density is high
..... *P. betle* var. kali bangla
4. Leaves less aromatic, non-dimorphic, branches drooping, peduncle <1.5 μm in length, oleoresins scarce.....
..... *P. betle* var. desi bangla
4. Leaves strongly aromatic, show dimorphism, branches

- horizontal, peduncle more than 1.5 µm in length, oleoresins abundant (5)
5. Nodal roots appear in two whorls, stipules shorter (< 2.5 cm) floral arrangement dense, sclerenchyma beneath vascular bundle absent *P. betle* var. *meetha*
5. Nodal roots appear in one whorl, stipules shorter (> 2.5 cm), floral arrangement sparse, sclerenchyma beneath vascular bundle present *P. betle* var. *sanchi*

CONCLUSION

The potential of *Piper betle* L. as an important crop in South West Bengal is well established. Its commercial roles, medicinal utilities, and religious aspects have enhanced its value. Taxonomic identification and classification of this species is essential to determine the comparative commercial and medicinal prospects of the varieties under *P. betle* L.

Based on the PCA and dendrogram analysis (Fig. 4 and Fig. 5) of the studied, a close relationship between *P. betle* var. *calcuttia bangla* and *P. betle* var. *kali bangla* was established. The possession of a higher laminar area than others has kept them nearby in the index of interrelationship (Table 2, 3 & 4). Closeness was found between *P. betle* var. *meetha* and *P. betle* var. *sanchi*. Such an interrelationship was set up based on uniqueness related to their laminar morpho-anatomy (Fig. 4 and Fig. 5). *P. betle* var. *kodi bangla* is the least abundant among all varieties in the districts of South West Bengal. It bears the shortest internodes among all the studied varieties. *P. betle* var. *kali bangla* and *P. betle* var. *Calcuttia bangla* possesses higher commercial aspects as they bear large-sized leaves.

On the other hand, *P. betle* var. *sanchi* and *P. betle* var. *meetha* have a specific leaf aroma and taste. These features make them valuable commercially within India and abroad. Due to the dioeciousness, unavailability of both flowers nearby in nature and cultivation through vegetative propagation, this species has a limited opportunity for evolutionary divergence. This taxonomic identification and classification of betel vine will guide future workers in the biochemical study of these taxa at an interspecific level for better revelation of the medicinal aspects of this species.

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AUTHORS' CONTRIBUTION

SD conducted field visits, collection of specimens, photography, and macroscopic analysis. Microscopic study; and making of photo-plates were executed by SD & ST. Analysis and interpretation of data were performed by SD & AKM. The original manuscript has been written down by SD & ST. The authors have gone through and finally validated the manuscript.

CONFLICT OF INTEREST

There is no conflict of interest among the authors.

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