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MORPHOLOGICAL CHARACTERS FOR AUTHENTICATION AND DIFFERENTIATION OF SEVEN MORPHOLOGICALLY SIMILAR BAUHINIA AND ALLIED TAXA: A COMPARATIVE REVIEW

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ABSTRACT

Correct botanical identification is fundamental to pharmacognosy, herbal drug authentication, conservation, and reproducible medicinal-plant research. Species of *Bauhinia* are particularly suitable for comparative morphological study because several taxa share conspicuously bilobed leaves, similar tree or shrub habits, and broadly comparable floral architecture. The present comparative review examines seven taxa: *Bauhinia purpurea* L., *B. variegata* L., *B. tomentosa* L., *B. racemosa* Lam., *B. malabarica* Roxb., *B. vahlii* Wight & Arn., and *B. acuminata* L. Comparative morphological characters were evaluated and checked against authoritative floristic and nomenclatural sources. Habit, leaf size and architecture, lobe depth, venation, indumentum, inflorescence, flower colour and markings, calyx, corolla, androecium, pod and seed characters, and flowering period were assessed for their diagnostic value. Most observations were consistent with published descriptions. However, two reproductive characters required important correction: *B. vahlii* is described in authoritative floristic sources with three fertile stamens rather than ten, while *B. malabarica* is not appropriately characterized as having five fertile and five sterile stamens; male flowers are described with ten fertile stamens and female flowers with reduced staminodes.

Current nomenclatural databases place B. malabarica and B. vahlii under Piliostigma malabaricum and Phanera vahlii, respectively; the traditional names are retained as the principal names in this review, with current names supplied parenthetically for taxonomic clarity. The review demonstrates that reliable identification should not depend on a single character. Instead, a hierarchical combination of habit, leaf architecture, floral characters, reproductive morphology, and pod features provides a more robust field-authentication strategy. The resulting comparative framework can support pharmacognostical standardization, herbarium authentication, teaching, and preliminary field identification of morphologically similar Bauhinia and allied taxa.

KEYWORDS: *Bauhinia;* comparative morphology; authentication; pharmacognosy; plant identification; leaf venation; reproductive morphology; medicinal plants.

1. INTRODUCTION

The genus *Bauhinia* is widely recognized for its characteristic simple, conspicuously bilobed leaves, commonly described as resembling a camel's foot. The genus has considerable ornamental, ecological, ethnobotanical and medicinal significance, and several species occur in the Indian subcontinent. Its members exhibit substantial variation in habit, leaf dimensions, lobe configuration, indumentum, inflorescence, floral colour, androecium and fruit morphology. This combination makes comparative morphology particularly useful for distinguishing taxa that may appear superficially similar in vegetative condition.

In pharmacognostical practice, authentication begins with the correct identity of the source plant. Substitution or misidentification at the raw-material stage can compromise pharmacopoeial quality, phytochemical interpretation, pharmacological reproducibility and clinical translation. Morphological examination remains especially valuable when material is available as a whole plant, fresh branch, herbarium specimen or partially intact crude drug. Although molecular and digital approaches can provide additional confirmation, they do not eliminate the need for a sound morphological baseline.

The present work integrates comparative morphological observations with authoritative botanical literature. Habit, vegetative morphology, reproductive characters and fruit characters were organized into a taxonomically informed authentication framework. External sources were used to verify taxonomic identity and morphological characters and to resolve discrepancies among published descriptions.

For nomenclatural continuity with Indian botanical literature, *Bauhinia malabarica* Roxb. and *Bauhinia vahlii* Wight & Arn. are retained as the principal names in the article, while current names are supplied parenthetically where appropriate. Thus, *B. malabarica* is linked to *Piliostigma malabaricum* and *B. vahlii* to *Phanera vahlii*. Current Kew Plants of the World Online treatment recognizes *P. malabaricum* and *P. vahlii* as accepted names. [1,2]

2. AIM AND OBJECTIVES

Aim: To develop a comparative morphological framework for the authentication and differentiation of seven morphologically similar *Bauhinia* taxa.

Objectives

• To compare habit, leaf morphology, venation, indumentum, inflorescence, flower, androecium, pod and seed characters.

• To identify characters with high practical value for field and herbarium authentication.

• To identify and correct characters that are inconsistent with the verified literature.

• To develop a revised comparative table and a practical identification key.

• To discuss the relevance of morphological authentication to pharmacognosy and medicinal-plant quality control.

• To verify the original comparative observations against authoritative floristic and nomenclatural sources.

3. REVIEW METHODOLOGY

Botanical information was cross-checked against Plants of the World Online (Kew), Flora of China/eFloras, eFlora of India, Botanical Survey of India floristic publications, and other standard taxonomic resources. The literature strategy included the terms Bauhinia, Bauhinia morphology, Bauhinia identification, Bauhinia taxonomy, Bauhinia stamens, Bauhinia leaf venation, Bauhinia fruit morphology, and the individual species name. This manuscript is a comparative botanical review rather than a systematic review; therefore, database-search counts and PRISMA-style screening were not applied.

Characters were grouped into habit, leaf, inflorescence, flower, androecium, fruit/seed and phenology. Each character was assessed as either retained, refined, or corrected. Exact measurements are presented as reported ranges rather than absolute constants because morphological dimensions vary with age, locality, ecological conditions and the source used. Flowering periods are likewise treated as regional observations rather than universal species-level constants.

The nomenclatural framework was checked against current Kew POWO records while retaining the traditional names used in Indian botanical literature. The family is Fabaceae; older literature frequently treated these taxa within Caesalpinioideae, whereas modern legume classifications place Bauhinia and allied genera within Cercidoideae. This distinction is noted to maintain taxonomic clarity without obscuring practical identification.

4. Taxonomic and Nomenclatural Framework.

Taxon used in this review	Current nomenclatural note	Habit in the comparative set	Principal diagnostic emphasis
Bauhinia purpurea L.	Accepted Bauhinia name	Tree	Pink–purple flower; 3 fertile stamens; bilobed leaf
Bauhinia variegata L.	Accepted Bauhinia name	Tree	Pink/variegated flower; 5 fertile stamens
Bauhinia tomentosa L.	Accepted Bauhinia name	Shrub/small tree	Yellow flower with dark blotch; 10 stamens; tomentose underside
Bauhinia racemosa Lam.	Accepted Bauhinia name	Small/bushy tree	Small leaves; 9-veined; 10 stamens
Bauhinia malabarica Roxb.	Current name: Piliostigma malabaricum	Tree	Broad bilobed leaves; 10 stamens in male flowers/staminodes in female flowers
Bauhinia vahlii Wight & Arn.	Current name: Phanera vahlii	Large woody climber/liana	Very large leaves; white flowers becoming buff; 3 fertile stamens
Bauhinia acuminata L.	Accepted Bauhinia name	Shrub/small tree	Acuminate/pointed lobes; white flowers; 10 stamens

The retention of *B. malabarica* and *B. vahlii* as the principal names facilitates continuity with traditional Indian botanical and pharmacognostical literature. Current names are supplied parenthetically because nomenclatural databases place these taxa in allied genera. [1,2]

5. Comparative Morphology

5.1 Habit and Growth Form

Habit is one of the most useful first observations because it can separate the large woody climber from the erect trees and shrubs before reproductive characters are examined. In the original comparative set, *B. purpurea* and *B. variegata* are medium-sized to large trees; *B. tomentosa* is a shrub or small tree; *B. racemosa* is a small, bushy tree; *B. malabarica* is a tree; *B. vahlii* is a large woody climber; and *B. acuminata* is a smaller shrub or ornamental plant. The distinction of *B. vahlii* is particularly strong because tendrils and a climbing habit provide an immediate vegetative clue. Botanical Survey of India descriptions likewise characterize *B. vahlii* as a large woody climber with tendrils. [3,4]

Taxon	Habit/growth form	Authentication value
B. purpurea	Medium to large tree; spreading crown	Moderate
B. variegata	Deciduous tree; flowering commonly before full leafing	High when combined with flower colour
B. tomentosa	Shrub or small tree; bushy/pendent branches	High
B. racemosa	Small, bushy tree	High when combined with very small leaves
B. malabarica	Small to medium tree	Moderate
B. vahlii	Large woody climber/liana, often with tendrils	Very high
B. acuminata	Shrub/small ornamental tree	Moderate

5.2 Leaf Morphology

Leaf architecture is the most consistently useful vegetative character across the seven taxa. Important attributes include lamina size, relative length and breadth, base, depth of the apical cleft, lobe shape, apex, number of primary veins, texture and indumentum. Within the comparative set, *B. racemosa* is the small-leaved member, whereas *B. vahlii* is the large-leaved climber. The latter is especially distinctive: Botanical Survey of India descriptions report leaves approaching 30–40 cm across, densely tomentose beneath and 11–13-nerved. [3,4] Representative leaf characters are illustrated in Figure 1.

Taxon	Leaf size/outline	Base and lobes	Venation/surface
B. purpurea	Medium to large; approximately 10–18 cm long in published descriptions	Shallow to moderately deeply cordate; cleft about 1/3–1/2	About 9–11 primary veins; glabrous to nearly glabrous
B. variegata	About 7–15 cm long and 10–15 cm broad; often broader than long	Cordate; cleft about 1/3; lobes rounded/obtuse	Multiple basal veins; generally glabrous
B. tomentosa	Small, broader than long; approximately 3–8 cm	Cordate; cleft variable, commonly about 1/3–1/2	7–9 veins; lower surface tomentose
B. racemosa	Smallest in this set; about 3–6 cm	Cordate to rounded; bilobed	About 9 veins; generally glabrous
B. malabarica	Medium; broader than long	Cordate; cleft approximately 1/4	About 9 or more basal veins; surface characters variable by source
B. vahlii	Very large, commonly 10–40+ cm across	Deeply cordate; deeply bilobed	About 11–15 veins; densely tomentose beneath
B. acuminata	Medium; about 6–15 cm in the original comparison	Cordate; lobes acute/acuminate; cleft up to about 1/3	Published descriptions may give 9–11 primary veins; glabrous above, hairy along margins/underside

For *B. acuminata*, published descriptions give approximately 9–11 primary veins. [5] Because venation can vary with specimen maturity and counting convention, we express this character as an approximate range rather than a fixed number.

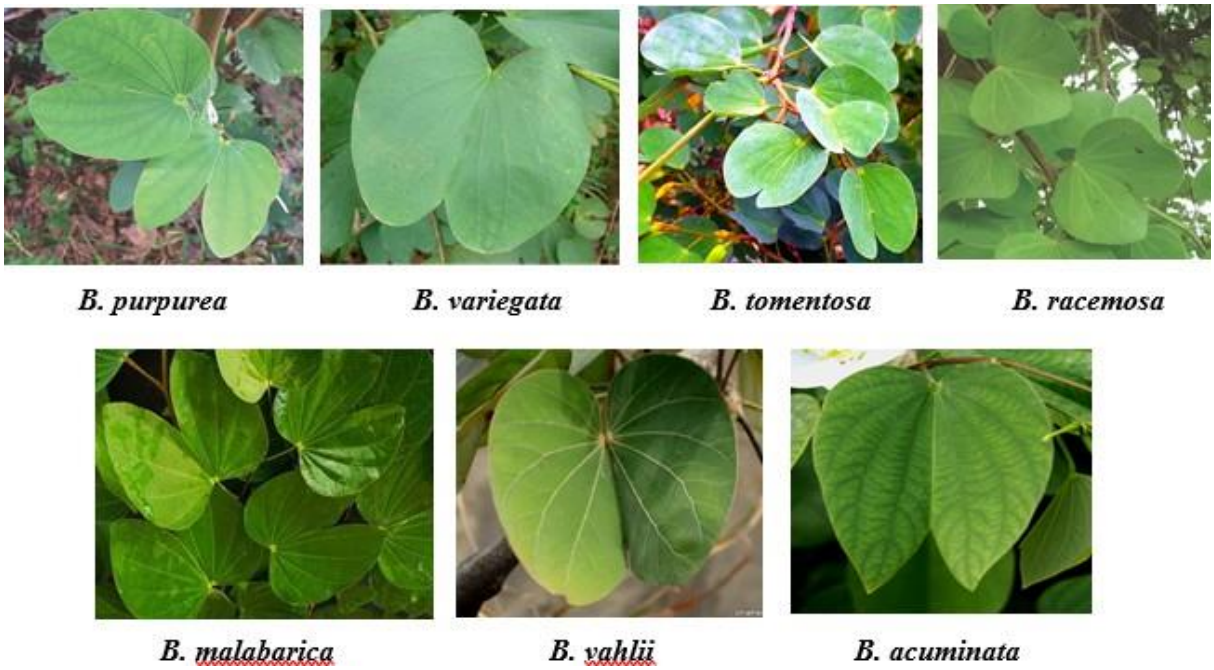


Figure 1. Comparative leaf morphology of the seven taxa. Representative leaves illustrating differences in lamina size, bilobing, lobe depth, venation and surface characters.

5.3 Inflorescence and Flower Characters

Floral colour and markings provide conspicuous field characters but should be used in combination with structural features. *B. purpurea* is characterized by pink to purple flowers; *B. variegata* commonly bears white to pink flowers with darker purplish markings and a darker upper petal; *B. tomentosa* bears yellow flowers with a contrasting dark blotch; *B. racemosa* has small pale flowers; *B. malabarica* has pale flowers; *B. vahlii* has white flowers that become buff with age; and *B. acuminata* has conspicuously white flowers. Published descriptions support the diagnostic value of the yellow flower and dark blotch in *B. tomentosa* and the white-to-buff colour change in B. vahlii. [6,7] Representative floral differences are illustrated in Figure 2.

Taxon	Inflorescence	Flower characters of diagnostic value
B. purpurea	Short racemes; sometimes paniculate	Pink to deep rose/purple; large, showy
B. variegata	Short racemes	White to pink with purplish veins; upper petal darker
B. tomentosa	Lateral/axillary short racemes	Yellow; one petal with a dark blotch
B. racemosa	Short racemes / axillary-terminal clusters	Small pale/white flowers
B. malabarica	Short racemes/corymbose clusters	Pale/white to yellowish flowers
B. vahlii	Terminal corymbose/subcorymbose hairy racemes	White, becoming buff with age
B. acuminata	Axillary racemes	Pure white, large and conspicuous

5.4 Calyx and Corolla

Calyx architecture is an underused but valuable taxonomic character. Bauhinia sensu stricto generally exhibits a spathaceous calyx, while allied taxa may show differences in the manner of splitting and in the degree of lobing. *B. purpurea* has a calyx opening into two lobes; *B. variegata* has a 5-toothed calyx; *B. tomentosa* has a spathaceous calyx at anthesis; *B. acuminata* has a spathaceous calyx; and *B. vahlii* has a distinctly hairy, lobed calyx. These features are best used

as confirmatory characters in herbarium or detailed field examination rather than as the sole first-step characters.

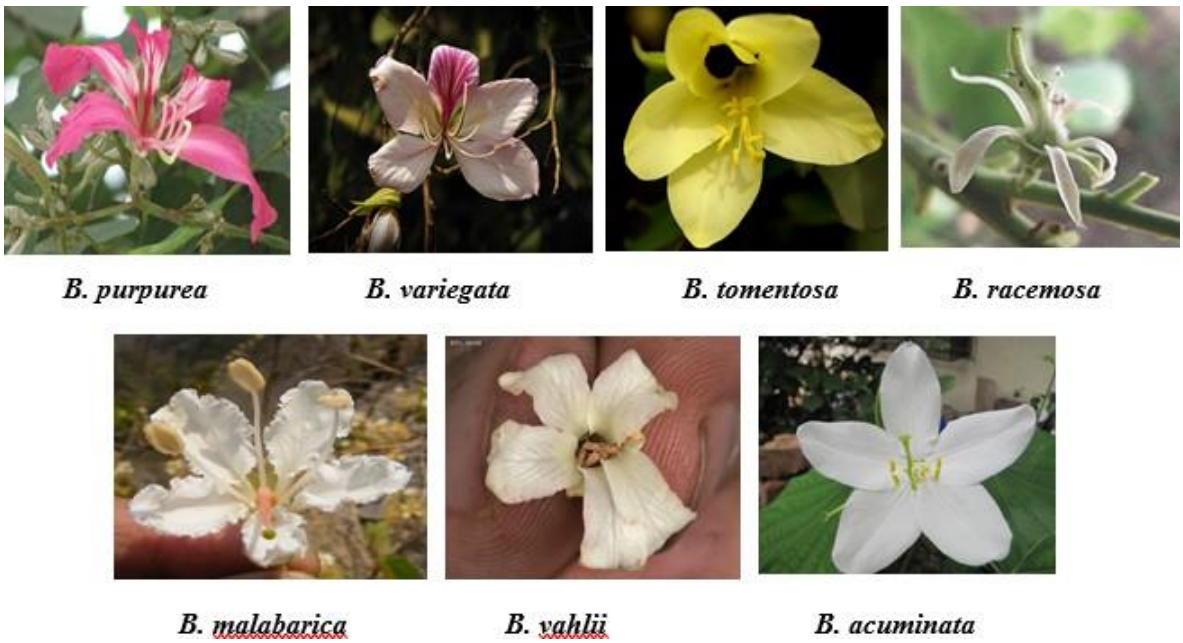


Figure 2. Comparative floral morphology of the seven taxa. Representative flowers illustrating differences in colour, petal patterning and general floral architecture.

5.5 Androecium: A Major Diagnostic Character Requiring Careful Interpretation

Stamen number is highly useful in Bauhinia identification, but it should not be used as a universal first-step character across the seven taxa. Flora of China gives three fertile stamens for *B. purpurea*, five for *B. variegata*, ten for *B. tomentosa*, and ten for *B. acuminata*. [5–7] *B. racemosa* is also described with ten stamens in floristic treatments. [8]

Two taxa require special treatment. For *B. malabarica*, a Botanical Survey of India flora describes ten stamens, all fertile, whereas current nomenclatural and comparative sources indicate reproductive differentiation between male and female flowers in the allied Piliostigma treatment. [9,10] Consequently, the original statement '5 fertile + 5 sterile stamens' should not be retained as a universal character. For *B. vahlii*, authoritative Botanical Survey of India sources report three fertile stamens, not ten. [3,4] This correction is essential because it changes the structure of the identification key.

Taxon	Verified androecial character	Use in identification
B. purpurea	3 fertile stamens; staminodes present	Very high
B. variegata	5 fertile stamens; staminodes may occur	Very high
B. tomentosa	10 fertile stamens, unequal	High
B. racemosa	10 stamens; anther/filament characters may aid confirmation	High
B. malabarica	10 stamens reported in male flowers; female flowers may have reduced staminodes	High, but reproductive sex must be recorded
B. vahlii	3 fertile stamens reported by BSI sources	Very high
B. acuminata	10 fertile stamens	High

5.6 Fruit and Seed Characters

Pod morphology provides an important second-stage confirmation because fruit characters are

generally less affected by transient environmental conditions than flower colour or flowering period. The original comparison identifies the large woody, rusty-velvety pod of *B. vahlii*, the flattened and pubescent pod of *B. malabarica*, and the distinctly stalked pod of *B. tomentosa* as useful clues. Botanical Survey of India sources support the large rusty-velvety pods of *B. vahlii.* [3,4] Flora of China describes the linear, flattened pod of *B. purpurea*; the linear pod of *B. tomentosa*; and the pod characters of *B. acuminata*. [5–7] Representative pod and seed characters are illustrated in Figure 3.

Taxon	Pod/fruit character	Diagnostic value
B. purpurea	Flat linear pod, about 12–25 cm long	High for mature material
B. variegata	Flat linear/oblong pod, approximately 15–25 cm	High
B. tomentosa	Flat linear pod, approximately 7–15 cm; often velutinous/hairy	High
B. racemosa	Oblong pod; comparatively small in relation to B. vahlii	Moderate-high
B. malabarica	Flattened, long-beaked pod in traditional Indian floras	High
B. vahlii	Large woody pod, about 20–30 cm, rusty-velvety, 6–12 seeds	Very high
B. acuminata	Linear-oblong, compressed pod; several seeds	High

5.7 Flowering Period

Phenology is useful for field planning and preliminary identification but should not be treated as a fixed taxonomic character. Reported flowering periods include September–February for *B. purpurea*, February–March for *B. variegata*, June–February for *B. tomentosa*, April–June for *B. racemosa*, July–December for *B. malabarica*, February–July for *B. vahlii* and two seasonal peaks for *B. acuminata.* Regional floras demonstrate that these periods can shift considerably. For example, Flora of China gives September–November for *B. purpurea*, while BSI descriptions give April–June for *B. vahlii* and October–May for *B. malabarica* in particular regions. [3,4,6] Therefore, phenology should be presented as a supportive, locality-dependent character.



Figure 3. Comparative fruit and pod morphology. Representative mature pods and seed/fruit details illustrating differences in size, shape, surface texture and seed characters.

6. Revised Master Identification Table

Taxon	Leaf clue	Flower clue	Androecium	Habit / key confirmation
B. purpurea	Bilobed, shallow–moderately deep cleft; ~9–11 veins	Pink to purple, large	3 fertile stamens	Tree; flat linear pod
B. variegata	Broad bilobed leaf; cleft ~1/3	White/pink, purplish veins; upper petal darker	5 fertile stamens	Deciduous tree; flowering often before leaves
B. tomentosa	Small, broad leaf; 7–9 veins; tomentose beneath	Yellow with dark blotch	10 fertile stamens	Shrub/small tree; hairy pod
B. racemosa	Smallest leaves in this set; ~9 veins	Small pale/white flowers	10 stamens	Small bushy tree
B. malabarica	Broadly bilobed; cleft ~1/4; ~9+ veins	Pale/white-yellowish	10 in male flowers; staminodes in female flowers	Tree; long-beaked pod
B. vahlii	Very large, deeply bilobed; 11–15 veins; tomentose beneath	White becoming buff	3 fertile stamens	Large climber with tendrils; rusty-velvety pod
B. acuminata	Cordate leaf with acute/acuminate lobes; ~9–11 veins	Pure white	10 fertile stamens	Shrub/small tree; compressed linear pod

7. Diagnostic Characters Ranked by Practical Use

Rank	Character	Reason for value
1	Habit/climbing vs erect	Immediately separates *B. vahlii* from most of the set
2	Leaf size and lobe architecture	Stable, visible in vegetative material
3	Leaf indumentum	Useful for *B. tomentosa* and *B. vahlii*
4	Flower colour and distinctive markings	Rapid field clue, especially *B. tomentosa* and *B. vahlii*
5	Fertile stamen number	Highly diagnostic when flowers are mature and reproductive condition is known
6	Calyx architecture	Strong confirmatory taxonomic character
7	Pod morphology	Excellent confirmation when fruits are present
8	Venation	Useful supporting character
9	Flowering period	Supportive but geographically variable
10	Common name	Not suitable as an authentication character

8. Species-wise Diagnostic Notes

B. purpurea: A medium to large tree with bilobed leaves and conspicuous pink to purple flowers. The most useful reproductive distinction is three fertile stamens, with staminodes also present. Mature flat linear pods provide additional confirmation. [6,7]

B. variegata: A deciduous tree with broad bilobed leaves, commonly flowering before complete leaf emergence. Flowers are white to pink with purplish venation and a darker upper petal. Five fertile stamens are diagnostic. [6,7]

B. tomentosa: A shrub or small tree with relatively small, broad leaves, 7–9 veins and a tomentose lower surface. Yellow flowers with a contrasting dark blotch and ten fertile stamens make it one of the easiest taxa to recognize when flowering. [6,7]

B. racemosa: A small bushy tree distinguished by comparatively small leaves, small pale flowers and ten stamens. Leaf size should be interpreted comparatively rather than as an absolute species boundary because dimensions vary with age and habitat. [8]

B. malabarica: A tree with broad bilobed leaves and pale flowers. The androecium must be interpreted with reproductive condition: Indian floristic sources report ten stamens, while current

allied-genus treatments distinguish male and female flowers. The original '5 fertile + 5 sterile' formulation is therefore not retained. [1,9,10]

B. vahlii: A large woody climber with tendrils, exceptionally large deeply bilobed leaves, dense lower-surface indumentum and white flowers that become buff. The authoritative BSI descriptions report three fertile stamens and large rusty-velvety pods. [3,4]

B. acuminata: A shrub or small tree with cordate leaves whose lobes terminate in acute to acuminate tips. Large pure-white flowers and ten fertile stamens provide strong reproductive confirmation. Published venation ranges differ slightly, so the character is best stated as approximately 9–11 primary veins. [5]

9. Misidentification Risks

Several pairs or groups are potentially confused when only a single vegetative character is available. *B. purpurea* and *B. variegata* can overlap in general tree habit and flower size, but fertile stamen number and floral colour/marking provide separation. *B. tomentosa* and *B. racemosa* may both be small trees, but the yellow blotched flowers of *B. tomentosa* contrast strongly with the small pale flowers and smaller leaves of *B. racemosa. B. malabarica* and *B. racemosa* can overlap in general leaf architecture, making calyx, pod and reproductive characters useful. *B. vahlii* is least likely to be confused when the climbing habit and very large leaves are observed.

A further source of confusion is nomenclature. Older Indian literature may use *Bauhinia* for taxa now placed in allied genera. For pharmacognostical work, the name on a specimen label should therefore be linked to an author citation and, where possible, a current nomenclatural identifier. This prevents apparent disagreement between older floras and current databases from being mistaken for biological difference.

10. Pharmacognostical Significance

Morphological authentication is the first layer of quality assurance for medicinal plants. In a crude-drug context, a combination of macromorphological characters can establish identity before microscopy, physicochemical testing, chromatographic profiling or DNA-based authentication is undertaken. The present comparison is particularly relevant because leaf architecture is conspicuous in *Bauhinia* and can remain useful when flowers are absent.

For pharmacognostical standardization, diagnostic characters should be converted into a voucher-based checklist: accepted/working taxon name, author citation, collection locality, habit, leaf dimensions, lobe depth, venation, indumentum, inflorescence, floral colour, calyx, fertile-stamen count, fruit morphology, seed characters, phenological state and voucher number. A herbarium voucher should accompany any pharmacological or phytochemical study so that the biological material can be traced back to a verified specimen.

The distinction between a diagnostic character and a supportive character is important. Flower colour may be highly conspicuous but can vary with age and environmental conditions. Stamen number may be highly diagnostic but requires an open, mature flower and correct interpretation of fertile stamens versus staminodes. Pod morphology can be highly informative but is unavailable during the vegetative or flowering stage. Authentication therefore benefits from character combination rather than reliance on one feature.

11. Herbarium and Voucher Authentication

For future experimental studies involving these taxa, field identification should be followed by voucher preparation and expert confirmation. The specimen should include a representative leafy branch, flowers when available, and fruit when available. The collection label should record locality, date, habitat, habit, collector, collection number and phenological condition. Photographs of the habit, leaf surface, flower, calyx, androecium and fruit should be linked to the same collection number.

Where taxonomic uncertainty persists, the specimen should be compared with authenticated herbarium material or submitted to a recognized herbarium or botanical expert. This is particularly important for *B. malabarica* and *B. vahlii* because historical literature and current nomenclatural databases may use different generic placements.

12. Digital Identification and Molecular Confirmation

Digital plant-identification systems, image-based classification and computer vision can complement conventional morphology by documenting leaf outline, lobe depth, venation and flower colour. However, automated image recognition should be trained on correctly identified, voucher-linked specimens. A model trained on misidentified images may reproduce the original taxonomic error.

DNA barcoding can provide an independent line of evidence where closely related taxa remain difficult to distinguish morphologically. For medicinal-plant authentication, a practical future workflow would combine voucher-confirmed morphology, standardized digital images and selected DNA barcode loci, followed by chemical fingerprinting where required. Molecular data should complement rather than replace morphological and herbarium-based authentication.

13. DISCUSSION

The comparative analysis demonstrates that the seven taxa can be differentiated effectively through a hierarchy of macromorphological characters. The strongest first-stage distinction is growth form: B. vahlii is a large woody climber with tendrils, whereas the other taxa are primarily erect shrubs or trees. Leaf architecture then provides a second level of separation through lamina size, depth of bilobing, lobe apex, venation and indumentum.

Floral characters provide particularly strong confirmation. The dark blotch on the yellow flower of *B. tomentosa*, the pink/variegated flower of *B. variegata*, the pink-purple flowers and three fertile stamens of *B. purpurea*, and the white-to-buff flowers of *B. vahlii* are conspicuous combinations. Androecial characters are also highly valuable, but only when reproductive morphology is interpreted correctly. The correction of *B. vahlii* from ten to three fertile stamens is therefore not a minor editorial change; it materially affects the diagnostic key.

The analysis also demonstrates why taxonomic authentication cannot be reduced to a single numerical character. Leaf dimensions overlap among taxa, flowering periods vary geographically, and reproductive structures may differ with sex or maturity. A robust identification should therefore be based on a character suite. This is consistent with classical taxonomic practice in which habit, leaves, calyx, corolla, androecium and fruit are evaluated together.

For Dravyaguna and pharmacognostical teaching, the comparative table can serve as a practical bridge between classical plant recognition and modern botanical authentication. The framework can also be expanded to include microscopic leaf anatomy, powder microscopy, histochemical characters, physicochemical parameters, chromatographic fingerprints and DNA barcoding.

14. LIMITATIONS

The present review is limited to seven selected taxa and does not constitute a comprehensive revision of the genus Bauhinia or its allied taxa. Variations in reported morphological measurements may arise from geographical differences, specimen maturity, ecological conditions and measurement conventions, while flowering periods remain locality-dependent and should not be considered fixed species-level characteristics. Certain traditional names have undergone changes in their taxonomic placement; therefore, the original names have been retained for continuity with earlier literature, with currently accepted names provided parenthetically. Furthermore, photographic materials require appropriate documentation of ownership, permission or applicable open licences before journal submission. The revised identification key is intended primarily as a field and teaching aid and should be supplemented by herbarium verification when specimens exhibit ambiguous or overlapping morphological characters.

15. Future Perspectives

Future work should establish voucher-linked regional populations of the seven taxa and quantify diagnostic variation in leaf size, lobe depth, venation and reproductive morphology. High-resolution imaging can be standardized for machine-learning applications, while molecular barcoding can be used to test morphologically ambiguous specimens. Integrating morphology, anatomy, phytochemistry and DNA data would provide an evidence-based authentication platform suitable for medicinal-plant quality control.

A particularly useful next step would be the creation of a digital *Bauhinia* identification atlas containing authenticated herbarium vouchers, standardized photographs of leaves and flowers, pod images, floral dissections, stamen counts and georeferenced collection metadata. Such a resource would reduce dependence on common names and visually similar internet images and would provide a reproducible reference for students, researchers and pharmacognostical laboratories.

16. CONCLUSION

Morphological examination remains a practical and scientifically valuable method for differentiating morphologically similar Bauhinia taxa. In the seven-taxon comparison examined here, the most informative characters are growth form, leaf size and architecture, lobe depth and apex, venation, indumentum, flower colour and markings, calyx structure, fertile-stamen number and pod morphology. The original comparative framework is broadly useful, but two reproductive characters require correction: B. vahlii should not be characterized as having ten fertile stamens, and B. malabarica should not be universally characterized as having five fertile and five sterile stamens. A revised hierarchical identification key that combines habit, leaves, flowers, androecium and fruits is therefore more reliable than a single-character key.

The review supports the use of comparative morphology as the first stage of authentication, followed where necessary by herbarium verification, microscopy, chemical profiling and molecular

methods. Retaining the traditional names *B. malabarica* and *B. vahlii* while supplying their current nomenclatural equivalents allows continuity with Indian botanical and pharmacognostical literature without sacrificing taxonomic clarity.

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