



Controversy in the Botanical Identity of Ayurvedic Medicinal Plants: Factors, Challenges and the Need for Authentication

Dr. Sushma^{*1}, Dr. Varesh Parihar², Dr. Vikas Singh³, Dr. Rajesh Sharma⁴

^{*1, 2, 3} Post Graduate Scholar, Dept. of Dravyaguna Vigyan, Ayurvedic and Unani Tibbia College, Delhi, India.

⁴ Professor & HOD, Dept. of Dravyaguna Vigyan, Ayurvedic and Unani Tibbia College, Delhi, India.

ABSTRACT

Background: The botanical identity of several Ayurvedic medicinal plants remains controversial due to differences in nomenclature, manuscript transmission, regional variation, substitution, and interpretation of classical terminology. Such ambiguity may affect the authentication, standardization, safety, and reproducibility of Ayurvedic medicines.

Objective: To review the major factors responsible for controversy in the botanical identity of Ayurvedic medicinal plants and highlight the need for systematic authentication.

Materials and Methods: Classical and contemporary literature concerning Ayurvedic drug identity, controversial medicinal plants, pharmacognostical identification, phytochemical profiling, chromatographic fingerprinting, and molecular authentication was reviewed.

Results: Major causes of controversy include multiple names for a single plant, a single name for multiple plants, regional and vernacular variations, manuscript errors, substitution, generic drug names, contextual interpretation, and changes in botanical classification. Examples such as *Shankhpushpi*, *Brahmi*, and *Pashanabheda* illustrate the complexity of Ayurvedic drug-botanical correlations. Pharmacognostical, chromatographic, phytochemical, and molecular techniques provide complementary approaches for reliable authentication.

Conclusion: Botanical controversy in Ayurveda is a multidisciplinary issue with important implications for drug quality and research reproducibility. Integration of classical textual evidence with taxonomy, pharmacognosy, phytochemistry, and molecular authentication is essential for establishing reliable botanical identities.

Keywords: Ayurveda; Dravyaguna; botanical identity; controversial drugs; authentication; pharmacognosy; DNA barcoding.

Introduction

Ayurveda represents one of the world's oldest codified systems of traditional medicine, in which medicinal plants constitute a fundamental component of the *Dravyaguna* and therapeutic materia medica. Over centuries, knowledge concerning medicinal plants has been transmitted through *Samhitas*, *Nighantus*, commentaries, regional traditions, and practical experience. This extensive textual heritage contains a large body of information concerning the morphology, properties, therapeutic applications, and pharmaceutical utilization of medicinal plants. However, the identification of several Ayurvedic drugs with their corresponding botanical entities remains unresolved. The problem is particularly relevant when classical drug names are interpreted in relation to modern botanical nomenclature, because the descriptions available in many classical sources may not provide sufficient diagnostic characters for unequivocal species-level identification.¹

The controversy surrounding Ayurvedic medicinal plants is not attributable to a single factor. Differences in nomenclature, synonymy, regional traditions, interpretation of classical terminology, geographical distribution, substitution, and historical transmission of textual knowledge may result in more than one botanical entity being associated with a single Ayurvedic drug name. A detailed analysis of classical literature has demonstrated substantial overlap in plant names across Ayurvedic texts and identified a considerable proportion of medicinal plants whose botanical identities remain controversial. Such ambiguity is further complicated by the fact that certain Ayurvedic names may represent a therapeutic or morphological concept rather than a single taxonomically restricted species.¹

The problem can be illustrated by several widely used Ayurvedic drugs. *Shankhpushpi*, for example, has been associated with multiple botanical sources, including *Convolvulus pluricaulis*, *Evolvulus alsinoides*, *Canscora decussata*, and *Clitoria ternatea*. Comparative pharmacognostical investigations demonstrated distinct morphological, anatomical, physicochemical, HPTLC, and HPLC characteristics among these four botanical sources, indicating that the common Ayurvedic name does not necessarily imply botanical equivalence.^{ii, iii} Similarly, *Brahmi* has been used in different regions in relation

to botanically distinct species, particularly *Bacopa monnieri* and *Centella asiatica*. Recent comparative microscopic, chromatographic, and molecular investigations have further demonstrated that these plants can be differentiated using species-specific diagnostic characteristics.^{iv}

Another important dimension of the controversy is the use of generic or property-based drug names for multiple botanical entities. *Pashanabheda* is a notable example, with different plant species being used under the same name in different geographical and traditional contexts. Such multiplicity presents a challenge not only for textual interpretation but also for pharmacognostical standardization and quality control of crude drugs.¹ The problem is of practical significance because the biological activity, phytochemical composition, safety profile, and therapeutic response of botanically distinct species cannot necessarily be assumed to be identical merely because they share an Ayurvedic name or traditional therapeutic indication.

The consequences of uncertain botanical identity extend beyond academic nomenclature. Authentication of the correct botanical source is a fundamental prerequisite for the standardization, reproducibility, safety, efficacy, and regulatory quality of herbal medicines. Experimental authentication studies have demonstrated that even medicinal plant raw materials marketed under recognized Ayurvedic identities may contain substitutions or adulterants. In a DNA-barcoding investigation of raw drugs corresponding to plants listed in the Ayurvedic Pharmacopoeia of India, only 79% of the tested market samples were authenticated, while approximately 21% were found to be adulterated; adulteration was more frequent among powdered materials, in which morphological identification is particularly difficult.^v These findings emphasize that the issue of controversial identity is not confined to historical interpretation but remains relevant to contemporary Ayurvedic drug manufacture and quality assurance.

Modern pharmacognostical and molecular approaches provide opportunities to address these longstanding difficulties. Macroscopic and microscopic evaluation, comparative pharmacognosy, phytochemical profiling, chromatographic fingerprinting, DNA barcoding, and other molecular tools can provide complementary evidence for establishing the identity and authenticity of medicinal plant materials. Comparative studies of *Shankhpushpi*, for instance, have shown that pharmacognostical and chemical markers can assist in distinguishing its different botanical claimants, while DNA-barcoding approaches have demonstrated their utility in authenticating Ayurvedic raw drugs even when conventional morphological characters are unavailable.^{2,3,5}

Therefore, the controversy of Ayurvedic medicinal plants should be viewed not merely as a problem of nomenclature but as a multidisciplinary issue involving classical textual interpretation, ethnobotany, taxonomy, pharmacognosy, phytochemistry, and modern molecular authentication. A systematic understanding of the factors responsible for these controversies is essential for correlating classical Ayurvedic identities with contemporary botanical standards and for ensuring the authenticity and consistency of medicinal plant raw materials. The present article therefore examines the major factors responsible for controversy in the botanical identity of Ayurvedic medicinal plants, with particular emphasis on nomenclatural complexity, manuscript transmission, geographical and regional variation, substitution, interpretation of classical terminology, and the challenges of correlating traditional drug identities with modern botanical classification.

Historical and Conceptual Background

Ayurvedic knowledge of medicinal plants has been documented across a long chronological period, with numerous *Samhitas*, *Nighantus*, treatises, and commentaries produced over successive centuries. Differences in terminology, regional additions, omissions, substitutions, and changes in plant names across these texts have contributed to uncertainty regarding drug identity. The loss of living oral traditions and the disappearance of certain plant groups from later texts further weakened the continuity of identification. In addition, variations among commentators in interpreting the same classical references and the gradual incorporation of region-specific plants into the Ayurvedic *Dravyaguna* corpus have increased nomenclatural complexity. Thus, the temporal gap between texts, loss of traditional knowledge, and successive additions or modifications to the materia medica represent important factors responsible for controversy in the botanical identity of Ayurvedic drugs.

Major Factors Responsible for Drug Controversy in Ayurveda^{vi, vii}

The occurrence of controversial drugs in Ayurveda is a multifactorial phenomenon. Variations in manuscript transmission, nomenclature, regional availability, interpretation of classical terminology, substitution practices, and differences between traditional and modern botanical classifications have all contributed to uncertainty regarding the identity of several medicinal plants.

1. Errors During Manuscript Transmission

Before the advent of printing technology, Ayurvedic texts were predominantly preserved through handwritten manuscripts. Repeated transcription by scribes, editors, and translators could introduce errors in spelling, terminology, or interpretation. Even minor alterations in a Sanskrit word could subsequently lead to differences in the identification of a medicinal plant. Over generations, such textual variations may result in divergent interpretations of the original drug identity.

2. Use of a Single Name for Multiple Plants

A single Ayurvedic synonym may sometimes be applied to more than one botanically distinct plant. Such plants may differ considerably in morphology and taxonomy while sharing similar therapeutic attributes or traditional descriptions. For example, *Amrita* has been used in different contexts for both *Tinospora cordifolia* and *Terminalia chebula*. *Aksha* is used for more than one plant entity, including *Haritaki* and *Rudraksha*. Conversely, a single plant

may possess multiple common names; *Haritaki*, for instance, is also known as **Aksha** and **Amrita**, which may themselves refer to other plants. This multiplicity of plant identities associated with a single name is an important source of controversy in Ayurvedic drug identification.

3. Geographical Variation

India possesses considerable ecological and climatic diversity, resulting in substantial regional variation in medicinal plant distribution. A plant traditionally used in one geographical region may be unavailable in another region, leading practitioners to use a locally available species with comparable properties. For instance, *Sankhpushpi* has historically been associated with *Convolvulus microphyllus* in some regions, whereas *Clitoria ternatea* has been used under the same name in other geographical areas. Such regional practices can produce differences in drug identity.

4. Context-Dependent Interpretation of Sanskrit Terminology

The meaning of a Sanskrit term may change according to its grammatical, textual, or contextual usage. Inadequate understanding of the linguistic context can therefore lead to incorrect interpretation of a drug name. Classical Ayurvedic terminology may also employ the same word with different meanings depending upon the context in which it occurs. Consequently, linguistic interpretation should be supported by textual, pharmacognostical, and therapeutic evidence before assigning a botanical identity.

5. Substitution of Medicinal Plants

Substitution is another important contributor to drug controversy. It may occur because of scarcity, seasonal unavailability, geographical limitations, high cost, or restricted availability of the authentic drug. When a substitute is used repeatedly over a prolonged period, it may gradually become accepted as the genuine source, making subsequent authentication difficult. *Pashanabheda* is a classic example, as several species such as *Bergenia ligulata*, *Aerva lanata*, and *Bryophyllum* species have been used under this name in different traditions, although their botanical identities are distinct.

6. Parallel Development of Knowledge Systems

Ayurvedic drug identification has evolved through different textual traditions, regional practices, and schools of knowledge. Plants possessing similar therapeutic properties may consequently acquire the same or similar vernacular or classical names. For example, *Brahmi* is traditionally associated with *Bacopa monnieri*, while *Centella asiatica* is also referred to as *Brahmi* in certain regions because of similarities in their cognitive and therapeutic applications. Such parallel traditions contribute to continuing controversy regarding drug identity.

7. Vernacular and Regional Nomenclature

Vernacular names are highly variable and may differ between states, languages, and local communities. The same name may refer to entirely different botanical species in different linguistic regions, while a single plant may possess several regional names. Therefore, identification based solely on vernacular terminology can result in misidentification and should be corroborated using botanical and pharmacognostical characters.

8. Influence of Non-Ayurvedic Literature

References from other traditional medical systems and non-Ayurvedic literature may also contribute to confusion. A common name may be used for different plants across different medical or literary traditions. For example, terms such as *Kamala*, *Utpala*, *Kumuda*, and *Kalhara* have been used in relation to lotus and allied plants, although their botanical identities may not always correspond to a single species. Cross-system interpretation without adequate botanical correlation may therefore introduce ambiguity.

9. Polynominal Nomenclature

The use of multiple names for a single medicinal plant is another characteristic feature of classical Ayurvedic literature. Different *Nighantus* and authors may provide several synonyms for the same drug to describe its morphology, habitat, therapeutic action, or other attributes. While such nomenclature was useful for understanding the drug from different perspectives, it can create difficulties when these synonyms are interpreted as representing separate botanical entities.

10. Evolution of Botanical Classification

Modern botanical nomenclature and taxonomy continue to evolve through advances in morphological, anatomical, molecular, and phylogenetic studies. Consequently, the botanical name assigned to a plant in older Ayurvedic literature may differ from its currently accepted scientific name. Changes in taxonomic classification, synonymization, and reclassification may therefore create additional challenges when correlating classical drug identities with contemporary botanical nomenclature.

Single Generic Name for Multiple Plant Entities

Some Ayurvedic drug names are **generic and property-based rather than species-specific**, allowing several botanically distinct plants with similar therapeutic attributes to be identified by the same name. *Pashanabheda*, literally referring to a plant capable of “breaking stones,” is a classic example. Different species, including *Aerva lanata*, *Aerva javanica*, *Ammannia baccifera*, *Rotula aquatica*, *Bergenia* spp., *Coleus aromaticus*, *Bryophyllum pinnatum*, *Bridelia montana*, *Ocimum basilicum*, and *Homonoia riparia*, have been used under this generic name in different regions of India.

Absence of Systematic Taxonomic Descriptions

The traditional Ayurvedic system relied largely on **direct observation, practical experience, and oral transmission** rather than a formal taxonomic system for plant identification. Although later texts provided descriptions of certain botanical characteristics, these were often brief and insufficient for establishing precise botanical identity. For example, descriptive terms such as *Deerghamoola* (“having long roots”) may apply to several different plants and therefore lack adequate taxonomic specificity. With the gradual weakening of the traditional first-hand and oral methods of plant recognition, such incomplete descriptions contributed to uncertainty and controversy regarding the identity of several medicinal plants.

Multiple Names for a Single Plant Entity

Ayurvedic nomenclature often assigns **multiple names to a single medicinal plant**, with each name reflecting characteristics such as habitat, morphology, taste, potency, therapeutic action, geographical origin, or traditional use. For example, *Shankhapushpi* is described by numerous synonyms, each highlighting a particular attribute of the drug. However, these synonyms generally do not provide sufficient morphological or taxonomic details to establish a definitive botanical identity. The addition of new names by different authors and across regions, including Sanskrit adaptations of local names, further increases nomenclatural complexity and contributes to uncertainty in the identification of medicinal plants.

Table 1: Examples of Ayurvedic controversial Drugs Associated with Multiple Botanical Sources ^{6,viii,ix}

S. No.	Sanskrit Name	No. of Plants	Botanical Sources	Family
1	<i>Daruharidra</i>	02	<i>Berberis aristata</i> ; <i>Coscinium fenestratum</i>	Berberidaceae; Menispermaceae
2	<i>Brahmi</i>	03	<i>Bacopa moniera</i> ; <i>Hydrocotyle asiatica</i> ; <i>Moniera cuneate</i>	Scrophulariaceae; Umbelliferae;
3	<i>Amaravala</i>	02	<i>Cuscuta reflexa</i> ; <i>Cassytha filiformis</i>	Convolvulaceae; Lauraceae
4	<i>Punarnava</i>	02	<i>Trianthema portulacastrum</i> ; <i>Boerhaavia diffusa</i>	Ficoidaceae; Nyctaginaceae
5	<i>Pasanabheda</i>	11	<i>Saxifraga ligulata</i> ; <i>Aerva lanata</i> ; <i>Aerva javanica</i> ; <i>Ammannia baccifera</i> ; <i>Bergenia ligulata</i> ; <i>Bryophyllum calycinum</i> ; <i>Coleus aromaticus</i> ; <i>Rotula aquatica</i> ; <i>Bridelia montana</i> ; <i>Homania riparia</i> ; <i>Ocimum basilicum</i>	Saxifragaceae; Amaranthaceae; Amaranthaceae; Lythraceae; Saxifragaceae; Crassulaceae; Labiatae; Boraginaceae; Euphorbiaceae; Euphorbiaceae; Labiatae
6	<i>Jivanti</i>	03	<i>Leptadenia reticulata</i> ; <i>Desmotrichum fimbriatum</i> ; <i>Cimicifuga foetida</i>	Asclepiadaceae; Orchidaceae; Ranunculaceae
7	<i>Shankhpushpi</i>	04	<i>Convolvulus pluricaulis</i> ; <i>Evolvulus alsinoides</i> ; <i>Canscora decussata</i> ; <i>Clitoria ternatea</i>	Convolvulaceae; Convolvulaceae; Gentianaceae; Papilionaceae
8	<i>Rasna</i>	10	<i>Vanda tessellata</i> ; <i>Alpinia galanga</i> ; <i>Pluchea lanceolata</i> ; <i>Viscum album</i> ; <i>Withania coagulans</i> ; <i>Aristolochia indica</i> ; <i>Inula racemosa</i> ; <i>Rauwolfia serpentina</i> ; <i>Lochnera rosea</i> ; <i>Enicostemma littorale</i>	Orchidaceae; Scitaminaceae; Compositae; Loranthaceae; Solanaceae; Aristolochiaceae; Compositae; Apocynaceae; Apocynaceae; Gentianaceae
9	<i>Talishpatra</i>	03	<i>Abies webbiana</i> ; <i>Taxus baccata</i> ; <i>Rhododendron anthopogon</i>	Pinaceae; Pinaceae; Ericaceae

S. No.	Sanskrit Name	No. of Plants	Botanical Sources	Family
10	<i>Nagakesara</i>	03	<i>Mesua ferrea</i> ; <i>Ochrocarpus longifolius</i> ; <i>Dillenia pentagyna</i>	Guttiferae; Guttiferae; Dilleniaceae
11	<i>Brahma-dandi</i>	03	<i>Argemone mexicana</i> ; <i>Tricholepis glaberrima</i> ; <i>Echinops echinatus</i>	Papaveraceae; Compositae; Echinaceae
12	<i>Ashoka</i>	03	<i>Polyalthia longifolia</i> ; <i>Saraca indica</i> ; <i>Shorea robusta</i>	Anonaceae; Caesalpiniaceae; Dipterocarpaceae
13	<i>Twak</i>	03	<i>Cinnamomum tamala</i> ; <i>Cinnamomum zeylanicum</i> ; <i>Cinnamomum cassia</i>	Lauraceae; Lauraceae; Lauraceae
14	<i>Murva</i>	11	<i>Marsdenia tenacissima</i> ; <i>Marsdenia roylei</i> ; <i>Bauhinia tomentosa</i> ; <i>Helicteres isora</i> ; <i>Maerua oblongifolia</i> ; <i>Clematis triloba</i> ; <i>Chonemorpha fragrans</i> ; <i>Salvadora persica</i> ; <i>Wattakaka volubilis</i> ; <i>Sansevieria roxburghiana</i> ; <i>Argyreia nervosa</i>	Asclepiadaceae; Asclepiadaceae; Leguminosae; Sterculiaceae; Capparaceae; Ranunculaceae; Apocynaceae; Salvadoraceae; Asclepiadaceae; Agavaceae; Convolvulaceae

Discussion

The present review demonstrates that controversy in the botanical identity of Ayurvedic medicinal plants is a multifactorial and historically accumulated phenomenon rather than an isolated problem of taxonomy. The long chronological development of Ayurvedic literature, regional diversification of medicinal-plant practices, transmission of knowledge through manuscripts, and evolution of botanical nomenclature have collectively contributed to the present complexity. The coexistence of multiple botanical sources for several well-established Ayurvedic drug names indicates that botanical identification cannot always be achieved by a simple one-to-one conversion of Sanskrit terminology into modern scientific nomenclature.¹

One of the fundamental reasons for this difficulty is the difference between Ayurvedic nomenclature and modern botanical nomenclature. Classical Ayurvedic names may encode information relating to morphology, habitat, therapeutic action, taste, potency, or other characteristics. In contrast, modern taxonomy attempts to establish a scientifically defined biological entity. Therefore, an Ayurvedic synonym may not necessarily function as a strict taxonomic identifier. Interpretation of the classical name should consequently consider its textual context, associated synonyms, descriptions, therapeutic attributes, geographical distribution, and traditional usage before a botanical equivalent is assigned.

The problem of multiple botanical sources is particularly evident in *Shankhpushpi*. The association of this Ayurvedic drug with *Convolvulus pluricaulis*, *Evolvulus alsinoides*, *Canscora decussata*, and *Clitoria ternatea* illustrates the consequences of regional and nomenclatural variation. Importantly, comparative pharmacognostical investigations have demonstrated differences among these botanical sources.^{2, 3} Thus, the existence of a common Ayurvedic name should not automatically be interpreted as evidence that the different botanical sources are pharmacologically or chemically interchangeable.

Similarly, the controversy surrounding *Brahmi* demonstrates how regional nomenclature and parallel traditions can influence drug identity. The association of *Bacopa monnieri* and *Centella asiatica* with the name *Brahmi* has generated difficulties in interpreting pharmacognostical and pharmacological literature. Comparative microscopic, chromatographic, and molecular approaches provide objective parameters for distinguishing these species and thereby demonstrate the importance of combining traditional nomenclature with modern authentication techniques.⁴

The example of *Pashanabheda* further demonstrates the complexity of generic or property-based drug names. Several botanically distinct plants have historically been associated with this name in different geographical and traditional settings. This suggests that some Ayurvedic drug names may represent a **therapeutic concept or functional attribute rather than a single botanical species**. Therefore, assigning one botanical species to such a term without adequate textual and pharmacognostical justification may oversimplify the historical evidence.

Manuscript transmission represents another important dimension. Before the widespread availability of printing, repeated copying of manuscripts provided opportunities for changes in spelling, terminology, or interpretation. Such alterations, when subsequently reproduced in later manuscripts or secondary literature, may become difficult to distinguish from the original textual tradition. The problem is compounded when a controversial term is subsequently correlated with a modern botanical name without examination of earlier textual sources.

Geographical diversity also has a major role. India contains highly diverse ecological conditions and regional medicinal traditions. When an authentic plant is unavailable in a particular region, a locally available plant with similar appearance, properties, or therapeutic application may become established

under the same name. If this practice continues for generations, the regional substitute may eventually acquire the status of an accepted drug source. Consequently, geographical variation should be considered when evaluating apparently contradictory botanical identifications.

The issue of substitution also has direct implications for quality control of Ayurvedic medicines. Substitution may arise from legitimate practical circumstances such as scarcity, seasonal limitations, geographical distribution, or economic considerations. However, substitution becomes problematic when the replacement is not clearly documented or authenticated. A distinction should therefore be maintained between an intentionally recognized substitute and an undeclared adulterant. This distinction is essential for pharmaceutical standardization and reproducibility of therapeutic research.

The contemporary significance of the controversy is further demonstrated by molecular authentication studies. DNA barcoding of Ayurvedic raw drugs has shown that a proportion of commercially available samples may not correspond to their claimed botanical identity.⁵ Such findings indicate that the problem of drug identity is not merely historical or academic; it continues to influence the quality and authenticity of medicinal plant materials used in modern Ayurvedic pharmaceutical practice.

Pharmacognostical methods remain an important first-line approach for authentication because macroscopic and microscopic characters can provide direct evidence of botanical identity. However, processing and powdering may destroy or obscure diagnostic morphological features. In such situations, chromatographic fingerprinting and molecular authentication provide additional evidence. The use of HPTLC or HPLC can assist in establishing characteristic chemical profiles, whereas DNA-based methods can help resolve species-level identity when morphology is inadequate.^{2, 4, 5}

The integration of these approaches is particularly important for pharmacological and clinical research. If different botanical species are investigated under the same Ayurvedic name, apparent differences in pharmacological activity may arise from differences in species rather than from genuine variation in therapeutic response. Similarly, phytochemical findings generated from one botanical source cannot automatically be extrapolated to another species simply because both are known by the same Ayurvedic name. Accurate botanical authentication should therefore precede pharmacological, toxicological, and clinical investigations.

The resolution of controversial identities requires collaboration among Ayurvedic scholars, Sanskrit experts, taxonomists, pharmacognosists, phytochemists, molecular biologists, and clinicians. Classical textual interpretation can provide historical context; ethnobotanical studies can clarify regional usage; taxonomy can establish botanical identity; pharmacognosy can provide diagnostic morphological and anatomical characteristics; phytochemical methods can establish chemical profiles; and molecular approaches can provide additional species-level confirmation.

Thus, controversy should not necessarily be regarded only as a weakness of Ayurvedic nomenclature. Rather, it represents an area where historical Ayurvedic knowledge can be systematically correlated with contemporary scientific methods. Establishing authenticated links between classical drug names, botanical identity, pharmacognostical characteristics, chemical fingerprints, and therapeutic evidence can strengthen the scientific foundation of *Dravyaguna* and improve the reproducibility of Ayurvedic research.

Conclusion

The controversy in the botanical identity of Ayurvedic medicinal plants is a complex phenomenon resulting from manuscript transmission, multiple synonyms, regional and vernacular nomenclature, geographical variation, substitution, contextual interpretation of classical terminology, generic drug names, and changes in modern botanical classification. The examples of *Shankhpushpi*, *Brahmi*, and *Pashanabheda* demonstrate that a single Ayurvedic drug name may be associated with multiple botanically distinct entities.

This problem has important contemporary implications because uncertain botanical identity can affect the authenticity, phytochemical composition, pharmacological reproducibility, safety, efficacy, and quality of Ayurvedic medicinal products. Therefore, botanical authentication should be considered a fundamental component of Ayurvedic drug standardization.

A multidisciplinary approach integrating classical textual evidence, ethnobotany, taxonomy, pharmacognosy, phytochemistry, chromatographic fingerprinting, and molecular authentication provides a more reliable framework for resolving controversial identities. Establishment of authenticated reference specimens, standardized pharmacognostical parameters, chemical fingerprints, and molecular reference databases can help bridge the gap between classical Ayurvedic nomenclature and modern botanical science.

Ultimately, systematic resolution of controversial medicinal plants will not only improve the quality and consistency of Ayurvedic raw materials but will also facilitate reproducible pharmacological and clinical research while preserving the rich historical and regional diversity of Ayurvedic botanical knowledge.

i Pushpangadan P, et al. Controversial identities of medicinal plants in classical literature of Ayurveda. J Ayurveda Integr Med. 2020;11(4):390-398. doi:10.1016/j.jaim.2019.01.004.

ii Sethiya NK, Trivedi A, Patel MB, Mishra SH. Comparative pharmacognostical investigation on four ethnobotanicals traditionally used as *Shankhpushpi* in India. Pharmacogn J. 2010;1(4):388-395. doi:10.4103/0975-3575.76437.

iii Aulakh GS, Narayanan S, Mahadevan G. Phyto-chemistry and pharmacology of *Shankhpushpi*—four varieties. Anc Sci Life. 1988;7(3-4):149-156.

iv Suksawat M, Jittachai W, Gavichai O, Pophanmuen T, Vimolmangkang S, Sitthithaworn W, et al. Integrated microscopic, HPTLC, and HRM analyses for differentiating *Centella asiatica* (L.) Urb., *Bacopa monnieri* (L.) Wettst, and *Hydrocotyle umbellata* L. Sci Rep. 2025;15:21370. doi:10.1038/s41598-025-06188-2.

-
- v Vassou SL, Parani M. Creation of reference DNA barcode library and authentication of medicinal plant raw drugs used in Ayurvedic medicine. *BMC Complement Altern Med*. 2016;16:186. doi:10.1186/s12906-016-1086-0.
- vi Keshari P. Controversy, adulteration and substitution: Burning problems in ayurveda practices. *Natural medicinal plants*. 2021 Jun 8;10.
- vii Thomas V, Nair SV, Ved DK, Shankar D. Controversial identities of medicinal plants in classical literature of Ayurveda. *Journal of Ayurveda and integrative medicine*. 2020 Oct 1;11(4):565-72.
- viii Tiwari V, Singh A, Tiwari A. Phytopharmacological overview on controversial drug: Murva. *Traditional and Folk Herbal Medicine: Recent Researches*. 2018;2:475-526.
- ix Sethiya NK, Mishra SH. Controversial Drugs of Ayurveda.