

**KAMALA (*NELUMBO NUCIFERA* GAERTN.) THROUGH THE LENS OF
PHARMACOGNOSY: CORRELATING CLASSICAL AYURVEDIC LITERATURE WITH
ANATOMICAL EVIDENCE****Dr. Sweta R. Yadav^{*1}, Dr. Bhavin V. Dhanavade²**¹²nd Year PG Scholar, Department of Dravyaguna Vigyana, Parul Institute of Ayurved and Research, Parul University, Vadodara, Gujarat; ORCID ID:0009-0002-0465-2885.²Associate Professor, Department of Dravyaguna Vigyana, Parul Institute of Ayurved and Research, Parul University, Vadodara, Gujarat; ORCID ID:0000-0003-0587-9985.***Corresponding Author: Dr. Sweta R. Yadav**²nd Year PG Scholar, Department of Dravyaguna Vigyana, Parul Institute of Ayurved and Research, Parul University, Vadodara, Gujarat; ORCID ID:0009-0002-0465-2885.**DOI:** <https://doi.org/10.5281/zenodo.23116770>**How to cite this Article:** Dr. Sweta R. Yadav^{*1}, Dr. Bhavin V. Dhanavade² (2026). Kamala (*Nelumbo Nucifera* Gaertn.) Through the lens of Pharmacognosy: Correlating Classical Ayurvedic Literature with Anatomical Evidence. World Journal of Pharmaceutical and Medical Research, 12(10), 317–323.

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ABSTRACT

Nelumbo nucifera Gaertn. (Kamala), a member of the family Nelumbonaceae, is a perennial aquatic herb extensively documented in classical Ayurvedic literature, including the works of *Acharya Charaka*, *Acharya Sushruta*, and *Bhavaprakasha Nighantu*, where its flowers, seeds, rhizome, and stalk are recognized for diverse therapeutic applications. The present study was undertaken to characterize the macroscopic and microscopic anatomical features of the peduncle of *N. nucifera*, generating reliable diagnostic markers for its standardization. Fresh, healthy peduncle samples were collected from natural aquatic habitats and evaluated organoleptically. Thin transverse sections were hand-cut using sharp blades, stained with 1% aqueous safranin, and examined microscopically at 10x and 40x magnification. Macroscopic assessment showed a green to greyish-green, cylindrical, rough-surfaced peduncle with a characteristic odour and mildly astringent taste. Anatomical examination revealed a compact single-layered epidermis covered by cuticle, an underlying parenchymatous hypodermis, and a broad ground tissue dominated by prominent aerenchyma comprising large, rounded to irregular air cavities separated by parenchymatous septa. Numerous vascular bundles containing xylem and phloem elements were distributed throughout the ground tissue, along with sclerenchymatous fibres and a central parenchymatous pith. The extensive aerenchymatous system was identified as a key structural adaptation facilitating internal aeration and buoyancy in the aquatic environment. These findings establish anatomical evaluation as a dependable tool for authenticating *Nelumbo nucifera*, particularly when morphological identification is limited by processing. Further molecular approaches, such as DNA barcoding, are recommended to complement these findings for comprehensive drug standardization.

KEYWORDS: Aerenchyma, Xylem, Peduncle, Microscopy, *Kamala***INTRODUCTION**

Lotus- *Kamala*, which beautifies the water mentioned by *Bhavaprakash Nighantu* in the context of *Kamala* (*Nelumbo nucifera* Gaertn.). It occurs in hot regions of India.^[1] It is a widespread aquatic plant found in ponds. They bloom during the summer and rainy season. The stem is rich in fibres. The cotyledon is sponge- like and grey, called as kamalagatta.^[2]

Botanical description^[3]Scientific Name: *Nelumbo nucifera* Gaertn.
Family- Nelumbonaceae**Physical Characteristics and Description**

Nelumbo nucifera is a large aquatic rhizomatous herb consisting of a slender, elongated, creeping stem with nodal roots. Lotus is a perennial plant with both aerial and floating orbicular leaves. Aerial leaves are cupped-shaped, and floating leaves have a flat shape. Its

peduncles are considerably long and rough with distinct prickles.^[3] Flowers are pink in colour and are pleasantly sweet-scented, solitary, and hermaphrodite. The average diameter is 10-25 cm, and it is ovoid and glabrous. Fruits, which contain seeds, are black in colour, and are hard and ovoid, and are arranged in whorls; seeds ripened and were released as a result of bending down of the pod to the water. Tuberous roots are 8 inches long and 2 inches in diameter. The smooth outer skin of the lotus root is green in colour; however, the inner part possesses numerous big air pockets running throughout the length of the tuber, assisting in floating in the aquatic system.^[1]

According to literature, Acharya Charaka mentioned under *Mutraviranjaniya Varga*^[4], Acharya Sushruta mentions under *Utpaladi Varga*^[5], and Bhavprakash Nighantu mentioned it under *Pushpavarga*.^[1]

Synonymous words *Nalinam* are used by various lexicons, such as *Dhanvantari Nighantu*, *Rajanighantu*, and *Bhavprakash Nighantu*, which mean hollow stalk; *Mrunali*, which means fibres attached to the lotus stalk; and *Vanakandha*, which means long stalk.

Chemical Composition: resin, glucose, metarbin, tannin, and nelumbine are found in tubers and seeds. To prevent adulteration and promote correct usage, there is a detailed pharmacognostical analysis, particularly by studying their T.S. (transverse section) features, as it provides reliable diagnostic microscopic markers.

MATERIALS AND METHODS

Plant Collection: Fresh, healthy peduncle of *Nelumbo nucifera* Gaertn. (*Kamala*) were collected from its natural aquatic habitat during morning hours.

Macroscopic Evaluation



“Fig 1”: Collection and temporary preservation of *Nelumbo nucifera* Gaertn. flowers by immersion of the peduncles in water.



“Fig 2”: Freshly cut peduncle of *Nelumbo nucifera* Gaertn. showing the extrusion of characteristic transparent, thread-like strands from the cut surface.

Sample Preparation: The collected peduncle sample was thoroughly washed with water to remove adhering mud, algae, and organic debris.

A clean, uniform middle section of the peduncle measuring 2 to 3 cm was selected and preserved in distilled water to prevent tissue desiccation prior to sectioning.

Instruments and Reagents

Equipment and Tools: Binocular Compound microscope, sharp razor blades/scalpel, glass slides, Cover slips, fine hairbrush, watch glasses.

Reagents and Stains: Safranin (1% aqueous solution), Distilled water.

Preparation of T S of peduncle of *Nelumbo nucifera*

Hold the peduncle sample vertically between the thumb and forefinger.

Keep both the sample and the blade wet with distilled water in a watch glass.

Cut several thin transverse sections using a fine hairbrush.

Staining with Safranin

Select 2-3 of the thinnest, complete transverse sections using the hairbrush,

Transfer the selected sections into a watch glass containing Safranin stain solution.

Allow the tissue to stain for 1 to 2 minutes so lignified cell walls (xylem and sclerenchyma) absorb the stain.

Wash off excess stain thoroughly by transferring the sections back into a watch glass with fresh distilled water.

Microscopic Examination

The prepared slide is focused under 10x to observe the overall structural arrangement and large air cavities.

Switch to 40x to examine individual vascular bundles, epidermal cells and cell wall thickenings.

Thin hand-cut and microscopic sections of fresh petiole examined include cortex, vascular bundles, ground

tissue, aerenchyma cells, sclerenchyma cells, and parenchymatous cells.

RESULT

Macroscopic Features

Table 1: Macroscopic and organoleptic characteristics of peduncle of *Nelumbo nucifera* Gaertn.

This table explains the external and sensory features of *Nelumbo nucifera* Gaertn. (Kamala), including their colour, odour, taste, and shape, aiding in preliminary identification.

Parameter	<i>Nelumbo nucifera</i> Gaertn.
Colour	Green to greyish- green externally, with a pale interior
Odour	Characteristic
Taste	Slightly astringent
Touch	Rough or prickly on outer surface due to small prickles, inner fibres – thread-like ^[6]
Shape	Long and cylindrical

Table 2: T.S. of peduncle of *Nelumbo nucifera* Gaertn. Detailed Anatomical Description.

This table explains the detailed microscopic structures of *Nelumbo nucifera* Gaertn. ^{[7],[8]}

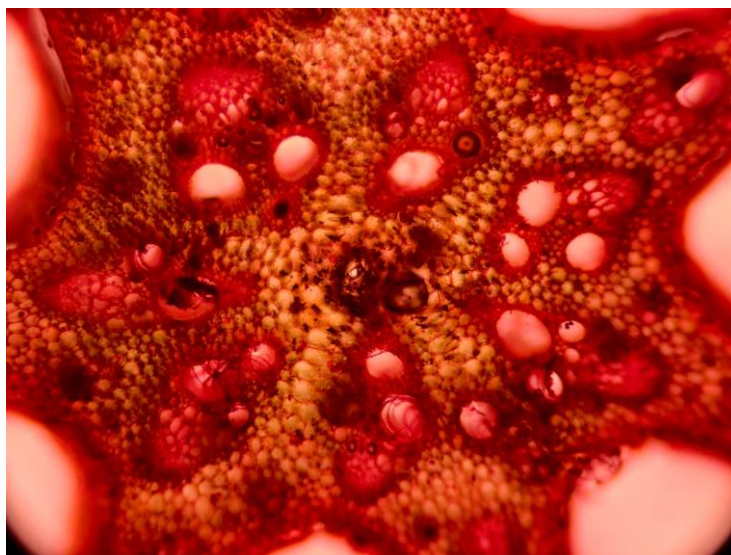
Sr. No.	Anatomical Feature	Description	Function
1.	Epidermis	Outermost single layer of compactly arranged cells covered externally by a cuticle.	Reduces water loss and provides protection to internal tissues.
2.	Hypodermis	Distinct layer located directly below the epidermis, composed of parenchymatous cells.	Provides mechanical support to the outer structure.
3.	Ground Tissue	Predominantly parenchymatous cells differentiated with large air spaces.	Forms the matrix air spaces (aerenchyma) characteristic of aquatic plants.
4.	Aerenchyma	Prominent feature consisting of numerous large, circular to oval air chambers surrounded by parenchyma and interconnected by small spaces.	Facilitates internal aeration of submerged tissues. Aids gas (O ₂) diffusion. Provides buoyancy and reduces plant density.
5.	Vascular Bundles	Numerous circular or oval groups of conducting tissues distributed throughout the ground tissue.	Responsible for transporting water and nutrients embedded within the surrounding parenchymatous tissue.
6.	Xylem	Composed of conducting elements, including vessel elements and tracheary elements.	Responsible for conducting water and dissolved minerals.
7.	Phloem	Located on the outer side of the vascular bundle relative to the xylem.	Responsible for translocating photosynthates and organic nutrients.
8.	Sclerenchyma	Thick-walled supporting	Provides

		fibers.	mechanical strength and structural reinforcement.
9.	Pith	The central region composed largely of parenchymatous tissue.	Serves as the central ground tissue.

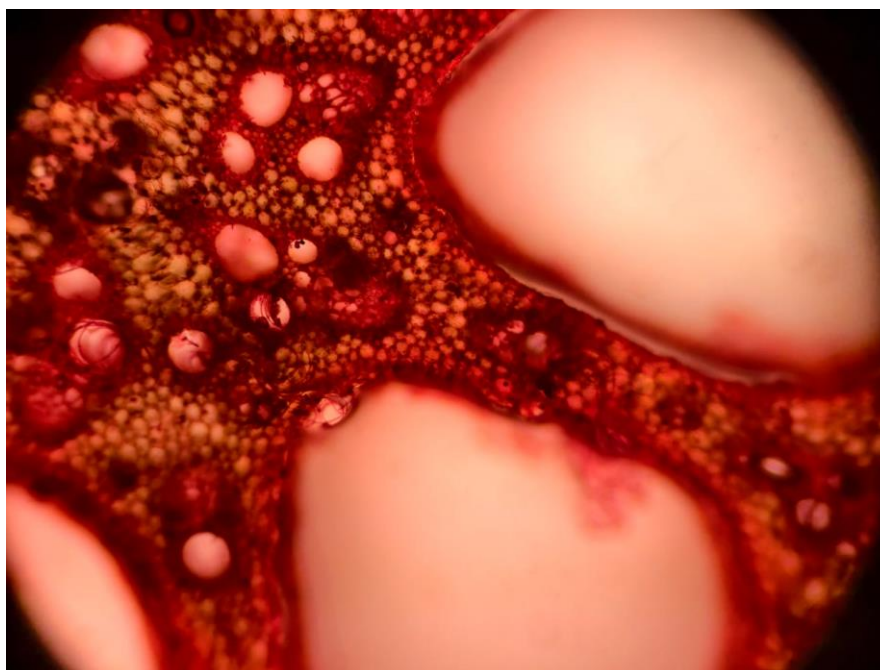
Microscopic Transverse Sections (t.s.) of Peduncle

The following figures illustrate the transverse sections of the *Nelumbo nucifera* Gaertn. Highlighting diagnostic

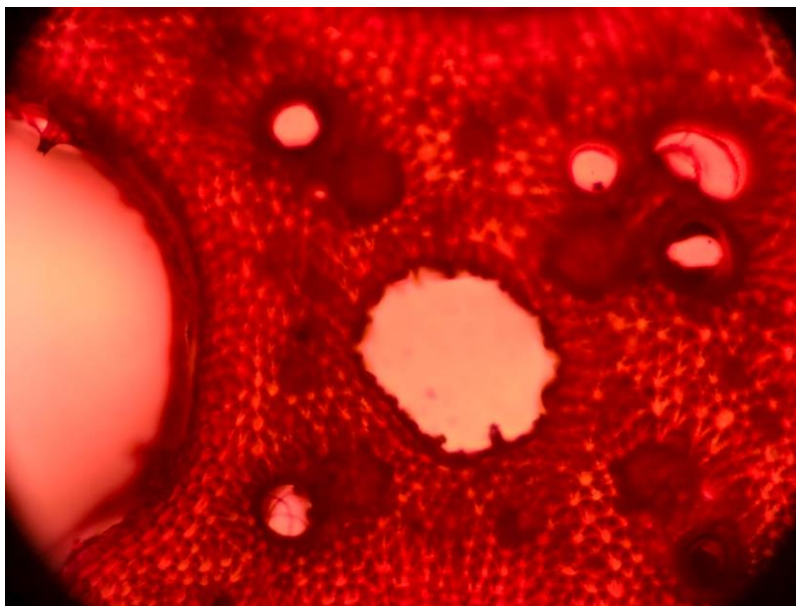
microscopic features such as ground tissue, vascular bundles, protoxylem, aerenchyma cells.



“Fig 3”: Transverse section (T.S.) of the petiole of *Nelumbo nucifera* Gaertn. showing numerous vascular bundles embedded in parenchymatous aerenchymatous tissue with prominent air cavities.



“Fig 4”: Transverse section (T.S.) of the petiole of *Nelumbo nucifera* Gaertn. showing prominent air cavities surrounded by aerenchymatous parenchyma, with scattered vascular bundles embedded within the ground tissue.



“Fig 5”. Transverse section of the petiole of *Nelumbo nucifera* Gaertn. showing prominent aerenchymatous air chambers separated by parenchymatous septa, with vascular bundles embedded within the intervening ground tissue.

DISCUSSION

Nelumbo nucifera Gaertn., commonly known as *Kamala* is an important aquatic medicinal plant belonging to the family Nelumbonaceae. Its attractive flowers and aquatic habit have been recognized in *Ayurvedic* literature, where the plant is described under different classical classifications. *Bhavaprakasha Nighantu* describes *Kamala* (*Nelumbo nucifera* Gaertn.) in the context of *Pushpavarga* and highlights its characteristic beauty associated with aquatic habitats.^[1] References to *Kamala* (*Nelumbo nucifera* Gaertn.) are also found in the classical works of *Acharya Charaka*^[4] and *Acharya Sushruta*^[5], where it is included in specific medicinal groups. The continued presence of *Nelumbo nucifera* Gaertn. in *Ayurvedic* literature indicates its longstanding importance as both a medicinal and culturally significant plant.

From a pharmacognostical perspective, correct identification of *Nelumbo nucifera* Gaertn. is essential for preventing substitution and adulteration of crude drug material. Morphological characteristics are useful during preliminary identification, but they may become difficult to evaluate when the drug is dried, fragmented or powdered. In such situations, transverse-section studies provide more reliable diagnostic information because anatomical structures remain useful even when external morphological characters are no longer apparent.

The fresh flower-bearing stalk showed a green, elongated structure with a firm yet flexible appearance. On cutting the stalk, transparent thread-like strands were observed emerging from the cut surface. This observation indicates the presence of elongated conducting or supporting elements within the tissue and represents a characteristic macroscopic feature that may be useful during preliminary identification of fresh material. However,

microscopic examination is required for definitive identification of the individual tissue components.

The transverse sections of the petiole revealed a prominent system of large, rounded to irregular air cavities distributed throughout the parenchymatous ground tissue. These cavities, together with the surrounding cellular tissue, form a well-developed aerenchymatous system. The large air spaces were separated by cellular partitions or parenchymatous septa, which maintained the structural continuity of the petiole. The abundance and conspicuous nature of these air chambers are particularly noteworthy in *N. nucifera*, an aquatic plant in which efficient internal aeration is important.^[9]

The parenchymatous tissue surrounding the air chambers consisted predominantly of numerous small, closely arranged cells. Vascular bundles were observed within the intervening ground tissue, occurring in association with the parenchymatous regions. The distribution of vascular tissue within the aerenchymatous framework reflects the specialized anatomical organization of the lotus petiole.^{[8],[9]}

The prominent aerenchyma observed in the sections can be interpreted as an adaptation to the aquatic environment.^[10] Large internal air spaces can facilitate movement and distribution of gases within submerged or partially submerged plant organs. This arrangement is particularly advantageous for maintaining aeration of tissues that are not directly exposed to atmospheric air. The presence of extensive air chambers also reduces the proportion of dense tissue in the petiole, contributing to its buoyant and flexible nature.^{[9],[11]}

These features can serve as supporting diagnostic characters in pharmacognostical standardization and authentication of the plant material. The observations

also demonstrate the close relationship between the petiole's anatomical organisation and its adaptation to an aquatic mode of growth.

Therapeutic Significance and Usage

Table 3: Therapeutic significance and usage of *Nelumbo nucifera* Gaertn.^{[12],[13],[14]}

Plant part	Key dosha Action	Therapeutic indications	Matra (Dose)
Flower petals	Pitta	<i>Raktapitta</i> (bleeding disorders), <i>Jwara</i> (Fever), <i>Mutrakrucha</i> (Dysuria), <i>Atisara</i> (Diarrhoea)	12-24gm
Petiole/Rhizome/stalk	Pitta	<i>Arsha</i> (piles), <i>Rakta Atisara</i> (Diarrhoea), <i>Charma roga</i> (skin disease)	5-10gm
Seeds powder	Kapha- Pitta	<i>Trushna</i> (Thirst), <i>Raktavikar</i> (diseases of blood)	3-6gm

Additional Traditional Uses^{[12],[13],[14]}

- Stalk of kamala (*Nelumbo nucifera* Gaertn.) acts as a galactagogue and aphrodisiac.
- Peya made from the rhizomes of kamala (*Nelumbo nucifera* Gaertn.) used in conditions of Diarrhoea and weak -digestion issues.
- Lepa prepared from the powder of rhizomes of kamala (*Nelumbo nucifera* Gaertn.) applied in skin diseases.

CONCLUSIONS

The present pharmacognostical study of *Nelumbo nucifera* Gaertn. demonstrated characteristic morphological and anatomical features useful for its identification and authentication. The prominent aerenchymatous air cavities, parenchymatous tissue and vascular bundles observed in the transverse sections represent important diagnostic characters. These findings support the use of anatomical evaluation as a reliable tool for standardization and prevention of adulteration of *Nelumbo nucifera* Gaertn. used in *Ayurvedic* practice. This study is also traditionally described as having cooling, astringent, soothing and haemostatic properties and is used in various conditions involving excessive heat, bleeding and inflammatory disturbances. Its different parts, particularly the flower, seeds, rhizome and leaves, have been traditionally used for therapeutic purposes. Future aspects of study, such as DNA barcoding and molecular authentication, may additionally be explored for accurate identification and prevention of adulteration, particularly in dried or powdered crude drug samples.

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