



## Research Article

## Characterization of *Kantakari* (*Solanum virginianum* L.) Through Microscopic Authentication and Micrometric Evaluation of Its *Kshara* and *Lavana*

Jeel Patel<sup>1\*</sup>, C.R. Harisha<sup>2</sup>, Dr. Bharti Umretia<sup>3</sup>

<sup>1</sup>PG Scholar, Upgraded Department of Rasashastra and Bhaishajya Kalpana, Government Ayurved College, Vadodara, Gujarat, India

<sup>2</sup>Head of Department of Pharmacognosy, IPGT & RA, Jamnagar, Gujarat, India

<sup>3</sup>Reader and Head Upgraded Department of Rasashastra and Bhaishajya Kalpana, Government Ayurved College, Vadodara, Gujarat, India

\*Corresponding Author: Jeel Patel, PG Scholar, Upgraded Department of Rasashastra and Bhaishajya Kalpana, Government Ayurved College, Vadodara, Gujarat, India.

E-mail: [jeelptl3998@gmail.com](mailto:jeelptl3998@gmail.com)

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## ABSTRACT

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*Kantakari* (*Solanum virginianum* L.) is a versatile medicinal plant used in Ayurvedic formulations including *Kshara* (alkalis) and *Lavana* (medicated salt), which undergo significant structural transformations during processing. While raw plant standards are established, there is a lack of definitive identity markers for these specialized dosage forms. **Objective:** This study aims to perform the microscopic authentication of *Kantakari Panchanga* (KP) and establish definitive micrometric characterization for *Kantakari Kshara* (KK) and *Kantakari Lavana* (KL) to serve as reliable identification markers. **Materials and Methods:** KP was collected from Junagadh, Gujarat, and identified through the pharmacognosy study. Subsequently, KK and KL were prepared and subjected to micrometric evaluation using chemical reagents—distilled water, hydrochloric acid (HCl), and sulfuric acid (H<sub>2</sub>SO<sub>4</sub>). Crystalline structures were measured and identified under 4X, 10X, and 40X magnification. **Results:** Microscopic analysis of the root, stem, leaf, and fruit validated the raw drug's authenticity. Micrometric evaluation revealed that KK contains calcium carbonate, phosphates and diverse calcium oxalate crystals, including rod, rhomboidal, cigar, and spindle shapes crystals. In contrast, KL was characterized by black debris, brown content, phosphates and specific square and rectangular calcium oxalate crystals. Treatment with HCl and H<sub>2</sub>SO<sub>4</sub> provided distinct reactionary profiles for both samples. **Conclusion:** This study establishes the first definitive micrometric standards for KK and KL. The distinct microstructural and crystalline profiles identified provide essential fingerprints for the standardization and quality assessment of these traditional dosage forms

## Introduction

The therapeutic efficacy of Ayurvedic formulations is fundamentally dependent on the precise botanical identification of raw materials and the standardization of their processed derivatives. *Kantakari* (*Solanum virginianum* L.), a prominent member of the Solanaceae family, is regarded as a valuable plant in both Ayurvedic and modern drug development for its versatile medicinal uses. In traditional clinical practice, it is indicated for various ailments such as Kasa (cough), Shvasa (dyspnoea), Pinasa (nasal discharge), Jvara (fever), and Kandu (itching). Depending on the patient's condition and the required therapeutic potency, it is administered in diverse Kalpana (dosage forms), including Svarasa (fresh juice), Churna (powder), Sneha (medicated Ghee / oil), *Kshara* (alkalies), *Lavana* (chlorides) and others. Among these, *Kshara* is a specialized medicament obtained from the water-soluble ash of dried plant material, involving the extraction of alkalis for internal or external clinical applications. Similarly, *Lavana Kalpana* (medicated salt) is a unique pharmaceutical preparation where the plant material is processed with salt, through heat, to enhance the therapeutic efficacy of the plant. The evaluation of these processed forms is critical because the chemical and structural nature of the plant material undergoes a significant transformation during the preparation. Microscopic and micrometric evaluations offer essential fingerprints for these drugs, allowing for precise identification even after the plant's physical structure has been altered. Establishing definitive micrometric parameters serves as a reliable method for the standardization and quality assessment of these formulations. Such standards are vital to ensure that the quality and therapeutic potential of the finished dosage form are consistently achieved throughout the manufacturing process. Considering the above facts, the present study aims to perform the microscopic authentication of *Kantakari Panchanga* (KP) and the micrometric characterization of *Kantakari Kshara* (KK) and *Kantakari Lavana* (KL). By establishing these micrometric quality profiles, this research contributes reliable identification markers that facilitate the standardization of these two different dosage forms derived from the same botanical identity[1-3]

## Materials and methods

Microscopic authentication of *Kantakari Panchanga* (KP) was performed, with *Kshara* and *Lavana* prepared from the same plant were subsequently subjected to micrometric evaluation to develop micrometric standards.

**Collection and identification of the sample:** KP was collected from local farming area of Junagadh, Gujarat in May 2024 and identified through Organoleptic, Macroscopic, Microscopic and powder microscopic study in the Upgraded Department of Dravyaguna, Government Ayurved College, Vadodara, Gujarat.

Preparation and micrometric characterization of KK and KL: KK and KL were prepared in the upgraded Department of Rasashastra and Bhaishajya Kalpana, Government Ayurved College, Vadodara, Gujarat, and their quality standards were developed through micrometric evaluation in the Department of Pharmacognosy, IPGT & RA, Jamnagar, Gujarat.

Organoleptic study: KP, KK and KL were examined for its organoleptic characteristics using various sensory organs.

Macroscopic study: *Kantakari* (*Solanum virginianum* L.) root, stem, leaf, flower, fruit and seed were examined for macroscopic characteristics such as colour, shape, length, width, surface and fracture.

Microscopic study: Transverse section (T.S.) of the fresh root, stem, leaf and fruit of *Kantakari* (*Solanum virginianum* L.) were prepared and stained with safranin and iodine for microscopic observations.

Powder microscopic study: KP was mounted on a glass slide using 1–2 drops of water and examined under a microscope to study its microscopic

Micrometric study: For micrometric evaluation, powder of KK and KL were spread on glass slides and processed with distilled water, hydrochloric acid and the sulphuric acid then observed measurement of the length and width of different crystals with their contents, including powder characters under microscope in 4X, 10X and 40X and measured under micrometre and took microphotographs.1

## Observation and results

Organoleptic study

Organoleptic characters of KP, KK and KL are mentioned in table no. 1.

**Table No. 1: Organoleptic characters of *Kantakari (Solanum virginianum L.) Panchanga powder***

Sr. no.	Organoleptic characters	Observation		
		KP	KK	KL
1.	Taste	Bitter, pungent	Salty, followed by slightly bitter inside the tongue	Salty, slightly pungent with tingling sensation
2.	Odour	Characteristic	Characteristic	Slightly characteristic
3.	Colour	Brownish green	White	Blackish grey
4.	Appearance	Fine, shiny	Fine	Fine
5.	Texture	Smooth	Rough	Rough

#### Macroscopic study

Macroscopic characters of fresh root, stem, leaf, flower, fruit and seed are mentioned in table no. 2.

**Table No. 2: Macroscopic characteristics of KP**

Sr.no	Characteristic	Observation					
		Root	Stem	Leaf	Flower	Fruit	Seed
1	Colour	Yellowish cream	Green	Green	Bluish purple	Yellowish green	Brownish cream
2	Shape	Cylindrical	Cylindrical	Elliptic, sharply serrate	Pedicels twisted	Round	Ovate
3	Length	11-12 cm	6-7 cm	12-14 cm	3-4 cm	1.5 to 2 cm	0.2 cm
4	Width	5-10 mm	0.5-1 cm	2-2.5 cm	2-3 cm	1-2 cm	0.1 cm
5	Surface	Hard, with tiny rootlets	Spiny, shiny	Upper and lower surface green, sharp prickles	Smooth	Smooth	Glossy, smooth
6	Fracture	Short	fibrous	-	-	-	-

#### Microscopic study

The T.S. of the root showed a cork region composed of 3–6 layers of thin-walled cells, with stone cells present either singly or in groups of 2–20 or more. The secondary phloem consisted of sieve elements and phloem parenchyma traversed by medullary rays, while the vascular region revealed well-developed vessels along with the presence of sandy calcium oxalate crystals[4,5]

The T.S. of the stem, measuring about 1.5–2 cm in thickness, showed 6–10 layers of thin-walled cork cells. The secondary cortex consisted of 7–11 layers of parenchymatous cells. The secondary phloem was composed of sieve elements and phloem parenchyma, with a few fibres and stone cells, and was traversed by phloem rays. Phloem fibres were scattered singly or in small groups in the outer and middle phloem regions, while the inner phloem was devoid of fibres; stone cells were present singly or in groups of 2–4. The vascular region exhibited well-developed xylem and vessels, and the central region was occupied by a large pith. Simple starch grains were observed in the cortex, secondary cortex, phloem, and pith cells.

The T.S. of the leaf showed a single-layered epidermis covered with a thick cuticle. The midrib consisted of 3–4 layers of collenchymatous hypodermis

with a central vascular bundle and two small lateral bundles. The petiole exhibited a circular to wavy outline with a single-layered epidermis. The lamina showed mesophyll differentiated into a single layer of palisade tissue and 4–6 layers of loosely arranged spongy parenchyma. Stellate trichomes (4–8 armed) and sandy calcium oxalate crystals were present, along with well-defined xylem and phloem[6-8]

The T.S. of the mature fruit showed a single-layered epidermis covered with a thin cuticle, followed by 1–2 layers of collenchyma. The mesocarp consisted of oval to polygonal cells containing starch grains and a few fibres, along with well-defined epicarp, seeds, and placenta.

#### Powder microscopy study

KP powder showed starch grains, spiral vessels, fragments of trichomes, cells with sandy crystal of calcium oxalate and endosperm with aleurone grains, epidermis of stem, pollen grains, sclerids from spines, testa, prismatic crystal, pitted vessel and fragments of fibre.

#### Micrometric study

Micrometric measurement of different structures of KK and KL under binocular microscope are mentioned below.

**Table No. 3: Micrometric measurement of different structures of KK and KL**

Parameters	KK	KL
<b>Processed with water</b>		
<b>Calcium carbonate</b>	Founded in clumps	-
<b>Calcium oxalate</b>		
Rod shape	0.4 µm	-
Rhomboidal shape	0.6 × 0.4 µm (40 x)	-
Cigar shape	1.6 × 0.2 µm	-
Prismatic square shape	0.4 × 0.4 µm (40 x)	-
Prismatic diagonal shape	1.4 × 0.4 µm	-
3D square shape	-	0.3 µm
Square shape	-	0.5 µm, 0.7 µm
Rectangular shape	-	0.5 × 0.2 µm

Acicular shape	0.4 $\mu\text{m}$	-
Spindle shape	1.4 $\times$ 0.1 $\mu\text{m}$	-
<b>Phosphate</b>	-	1.3 $\mu\text{m}^2$ , 0.4 $\mu\text{m}^2$ , 0.2 $\mu\text{m}^2$
Pentagonal shape	0.8 $\times$ 0.4 $\mu\text{m}$	-
Uneven shape (slight oval)	0.4 $\mu\text{m}^2$	-
<b>Processed with HCL</b>		
<b>Phosphate</b>	Founded in clumps	0.5 $\mu\text{m}^2$
	Processed with Sulphuric acid	
<b>Phosphate</b>	Founded in clumps at all over slide	1.4 $\mu\text{m}^2$ , 0.7 $\mu\text{m}^2$ , 0.4 $\mu\text{m}^2$ , also founded in clumpings
<b>Calcium oxalate</b>		
Rhomboidal square shape	1.4 $\times$ 1.4 $\mu\text{m}$	-
Hexagonal shape	From the centre 2.4 $\times$ 1.5 $\mu\text{m}$	-

### Discussion

In this study, the authenticity of KP was established through organoleptic, macroscopic, and microscopic evaluation. The observed characteristics of the raw drug were consistent with the standards documented in the Ayurvedic Pharmacopoeia of India<sup>2</sup> and the Quality Standards of Indian Medicinal Plants,<sup>3</sup> thereby validating the authenticity and quality of the plant material used for further processing. In microscopic study of Kantakari T.S. of root showed medullary rays, vessels and sandy crystal of calcium oxalate. T.S. of stem showed pith, phloem, phloem fibres, xylem, vessel, cortex, cork and collenchyma. T.S. of leaf showed epidermis, collenchyma, sandy crystals of calcium oxalate, palisade, xylem, phloem and trichome. In T.S. of fruit epicarp, collenchyma, cuticle, mesocarp, starch grains, seeds and placenta was found<sup>[9-12]</sup>

A micrometry study of KK and KL was carried out under various chemical reactions involving water, hydrochloric acid (HCl), and sulfuric acid (H<sub>2</sub>SO<sub>4</sub>) to identify and measure different crystals, such as calcium carbonate, calcium oxalate and phosphate.

KK, when dissolved in water, it exhibited the presence of calcium carbonate, calcium oxalate, and phosphate. The calcium oxalate crystals displayed various shapes, including rod-shaped (0.4  $\mu\text{m}$ ), rhomboidal-shaped (0.6  $\times$  0.4  $\mu\text{m}$ ), cigar-shaped (1.6  $\times$  0.2  $\mu\text{m}$ ), prismatic square-shaped (0.4  $\times$  0.4  $\mu\text{m}$ ), prismatic diagonal-shaped (1.4  $\times$  0.4  $\mu\text{m}$ ), acicular-shaped (0.4  $\mu\text{m}$ ), and spindle-shaped (1.4  $\times$  0.1  $\mu\text{m}$ ). Upon dissolution in HCl, the calcium oxalate crystals dissolved, revealing clumps of phosphate under the microscope. The reaction with H<sub>2</sub>SO<sub>4</sub> led to the dissolution of calcium carbonate crystals, indicated high sensitivity of sample with strong acids.

### Photoplate no: 1 Macroscopic characters of KP



Figure : 1



Figure : 2



Figure : 3



Figure : 4

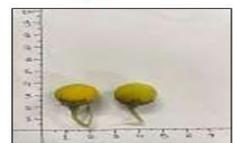


Figure : 5



Figure : 6

(Figure: 1 Root, Figure: 2 Stem, Figure: 3 Leaf, Figure: 4 Flower, Figure: 5 Fruit, Figure: 6 Powder of KP)

### Photoplate no: 2 Microscopic characters of KP

When KL was dissolved in water, it revealed a varied mineral composition, including black

debris from burnt plant material, calcium oxalate, phosphate, brown content and slight silica deposition. The calcium oxalate crystals had a distinctive rectangular shape (0.5  $\times$  0.2  $\mu\text{m}$ ) and square-shaped crystals of various sizes (0.5  $\mu\text{m}$ , 0.7  $\mu\text{m}$ ). Phosphate crystals appeared in different sizes (1.3  $\mu\text{m}^2$ , 0.4  $\mu\text{m}^2$ , 0.2  $\mu\text{m}^2$ ). After treatment with HCl, the calcium oxalate crystals dissolved entirely, leaving behind phosphate crystals (0.5  $\mu\text{m}^2$ ), demonstrating the reactivity of these components. When dissolved in H<sub>2</sub>SO<sub>4</sub> caused bubbling and effervescence, with the black debris dissolving and phosphate clumping increasing, with clumps observed in various sizes (1.4  $\mu\text{m}^2$ , 0.7  $\mu\text{m}^2$ , 0.4  $\mu\text{m}^2$ ).

KK and KL revealed notable differences in their structural features. KK contains key components such as calcium carbonate, calcium oxalate, and phosphate, while KL contains black debris, calcium oxalate, and phosphate. Calcium carbonate is found exclusively in KK, while KL is characterized by the presence of black debris and brown material. Both samples showed high amount of phosphate with slight silica deposits observed in each<sup>[13-16]</sup>

### Conclusion

The present study authenticates Kantakari (*Solanum virginianum* L.) through comprehensive microscopic evaluation of the raw drug and represents the first attempt to establish definitive micrometric parameters for its Kshara and Lavana formulations. The distinct microstructural and crystalline characteristics observed between the two preparations serve as reliable identification markers and provide a micrometric quality profile for the standardization and quality assessment of these dosage forms derived from the same botanical source.

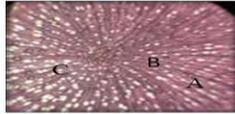


Figure : 1

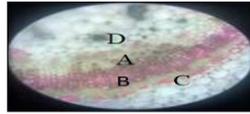


Figure : 2

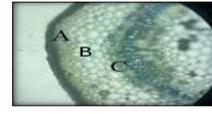


Figure : 3

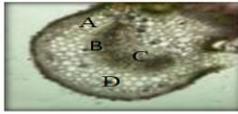


Figure : 4



Figure : 5

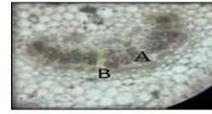


Figure : 6

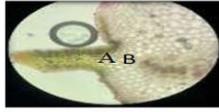


Figure : 7



Figure : 8

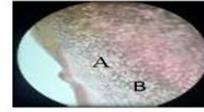


Figure : 9



Figure : 10

(Figure1: T.S. of Root, 1A: Medullary rays, 1B: Vessels, 1C: Sandy crystals of Calcium Oxalate, Figure 2 and 3: T.S. of stem, 2A: Phloem, 2B: Xylem, 2C: Vessel, 2D: Pith, 3A: Cork, 3B: Collenchyma, 3C: Cortex, Figure 4 -7: T.S. of Leaf, 4A: Epidermis, 4B: Collenchyma, 4C: Palisade, 4D: Sandy crystals of calcium oxalate, 5A: Trichome, 6A: Phloem, 6B: Xylem, 7A: Palisade, 7B: Collenchyma, Figure 8 – 10: T.S. of Fruit, 8A: Cuticle, 8B: Epicarp, 8C: Collenchyma, 9A: Mesocarp, 9B: Starch grains, 10A: Placenta, 10B: Epicarp, 10C: Seed)

**Photoplate no: 3 Microscopic characters of KP powder**

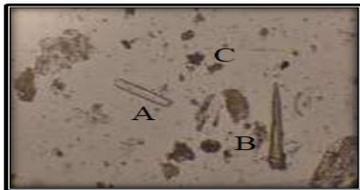


Figure : 1

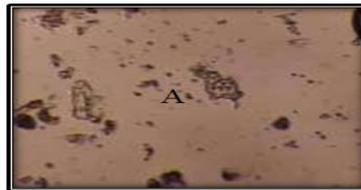


Figure : 2

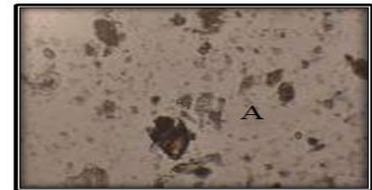


Figure : 3

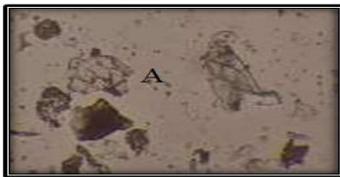


Figure : 4



Figure : 5



Figure : 6

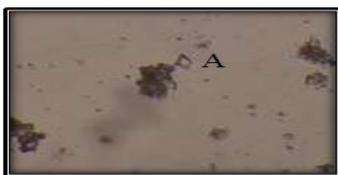


Figure : 7

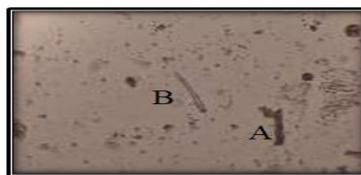


Figure : 8

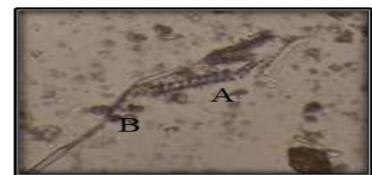


Figure : 9

(Figure 1A: Spiral vessels, 1B: Fragment of Trichomes, 1C: Starch grains, Figure 2A: Cells with sandy crystals of calcium oxalate, Figure 3A: Cells of endosperm with aleurone grains, Figure 4A: Epidermis of stem in surface view,

Figure 5A: Pollen grains, Figure 6A: Sclereids from spines, 6B: Testa in surface view, Figure 7A: Prismatic crystal, Figure 8A: Pitted vessel, 8B: Trichome, Figure 9A: Spiral vessels, 9B: Fragments of fibre)

**Photoplate no: 4 Micrometric characters of KK**



Figure : 1



Figure : 2



Figure : 3



Figure : 4



Figure : 5



Figure : 6



Figure : 7

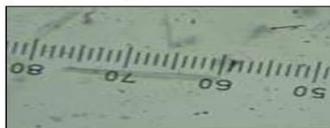


Figure : 8



Figure : 9

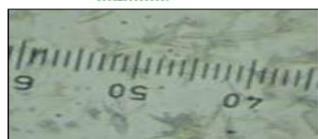


Figure : 10

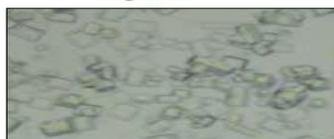


Figure : 11



Figure : 12

(Figure 1: KK, Figure 2: Clumps of calcium carbonate, Figure 3: Crystal of Rod shape calcium oxalate, Figure 4: Crystal of Rhomboidal shape calcium oxalate, Figure 5: Crystal of Cigar shape calcium oxalate, Figure 6: Crystal of Prismatic square shape calcium oxalate, Figure 7: Crystal of Prismatic diagonal shape calcium oxalate Figure 8: Crystal of Acicular shape calcium oxalate Figure 9: Crystal of Spindle shape calcium oxalate Figure 10: Crystal of phosphate Figure 11: Phosphate clumps in Hydrochloric acid Figure 12: KK processed with Sulphuric acid)

**Photoplate no: 5 Micrometric characters of KL**



Figure : 1



Figure : 2



Figure : 3



Figure : 4



Figure : 5



Figure : 6



Figure : 7



Figure : 8



Figure : 9



Figure : 10



Figure : 11

(Figure 1: KL, Figure 2: Black debris of burnt plant material, Figure 3: Crystal of square shape calcium oxalate, Figure 4: Crystal of 3D square shape calcium oxalate, Figure 5: Crystal of rectangular shape calcium oxalate, Figure 6: Brown content, Figure 7 and 8: Crystals of phosphates, Figure 9: KL processed with Hydrochloric acid, Figure 10 and 11: KL processed with Sulphuric acid)

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