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Research Article

A Comparative Pharmaceutical Standardization of *Kshara* and *lavana* of *Kantakari* (*Solanum virginianum* L.)

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ABSTRACT

Background: In earlier classical Ayurvedic texts, such as the Charaka Samhita, *Kshara* and *Lavana Kalpana* (dosage forms) were described under the same category. However, later texts recognized them as separate preparations based on various factors. Therefore, systematic pharmaceutical standardization is essential to scientifically substantiate these distinctions and establish reliable manufacturing procedures for both. **Aim:** To develop and compare the standard manufacturing procedure (SMP) of *Kshara* and *Lavana* dosage forms of *Kantakari* (*Solanum virginianum* L.). **Materials and Methods:** The study involved the procurement and identification of raw materials, followed by the preparation of *Kantakari Kshara* (KK) and *Kantakari Lavana* (KL). The preparation of KK involved the burning of dried *Kantakari* to obtained ash, followed by aqueous extraction and evaporation. KL was prepared by mixing dried *Kantakari* with *Saindhava* and subjecting the *Gajaputa*. All stages were standardized for time, temperature and quantity to ensure reproducibility. **Results:** KK was obtained as a white, fine powder with a yield of 30.5% with reference to ash, while KL yielded a blackish-grey powder with a comparatively higher yield of 55.16%. Distinct differences were observed between KK and KL in terms of physical characteristics, yield, processing time and thermal exposure. **Conclusion:** This study establishes reproducible SMP for KK and KL, demonstrating that their distinct pharmaceutical identities are driven by variations in processing methods and heat application. These standardized protocols provide a scientific framework for differentiating their therapeutic uses and serve as a robust reference for future pharmaceutical, analytical and clinical research.

Introduction

Kantakari (*Solanum virginianum* L.) is a vital medicinal herb in Ayurveda utilized for its extensive therapeutic properties across various health conditions. The plant is versatile in its application, as its roots, stems, leaves, flowers, fruits, seeds, and the whole plant all serve as medicinal components. Among the diverse dosage forms utilized, Kshara and Lavana are two significant preparations. Establishing clear pharmaceutical profiles for such plants is necessary to maintain the integrity and consistency of the traditional medicines derived from them. Out of the many different dosage forms in Ayurveda, Kshara and Lavana dosage forms are quite similar, though some dissimilarities also exist in their preparatory methods, properties and therapeutic action. The classical Ayurvedic texts often do not explicitly differentiate between Kshara and Lavana dosage forms. In many instances, both are described as being prepared using the Antardhuma Dahana (heating in closed vessel) method. Moreover, both are classified under the broader category of Kshara, regardless of whether Lavana is incorporated or not. However, later texts and commentaries have delineated clear distinctions between these two pharmaceutical preparations. Kshara is typically prepared through the Bahirdhuma Dahana (burning in open environment) process, followed by alkaline extraction from the resulting ash. In contrast, Lavana dosage form involves the Antardhuma Dahana technique, wherein Lavana is heated in a closed vessel along with other herbal or mineral drugs. These varying conditions may significantly influence the properties of the finish product. Therefore, it becomes essential to assess whether factors such as the intensity of heat and the type of burning environment (open or closed) impact the quality and characteristics of these preparations.Pharmaceutical science is fundamental to the rational development and evaluation of Ayurvedic medicines, as it directly influences their quality, safety and therapeutic performance. The systematic design of different Ayurvedic dosage forms is essential to ensure appropriate drug delivery (i.e. Ksharasutra in Arsha and Paniya Kshara in Gulma, Ajirna etc.), stability (i.e. Sneha Kalpana), palatability (i.e. Avaleha) and consistency of therapeutic action. Proper pharmaceutical processing transforms raw materials into effective and reproducible formulations. Standardized manufacturing procedure (SMP) further strengthen the reliability of Ayurvedic medicines, thereby supporting their wider scientific acceptance and integration into contemporary systems.Considering these factors, the present study aims to develop and compare the pharmaceutical standardization of *Kshara* and *Lavana* of Kantakari by developing a SMP.[1,2]

MATERIALS AND METHODS

A. Procurement and identification of raw materials

I.Procurement of the raw materials

•Fresh Kantakari was collected from local farming area of Junagadh, Gujarat in the month of May 2024 by adopting Good Collection Practices (GCP) Guideline.

•Saindhava was procured from the Government Ayurved Pharmacy, Rajpipala, Gujarat.

II.Identification of raw material

•The sample of Kantakari and Saindhava were identified in Pharmacognosy Laboratory of Upgraded Department of Dravyaguna and Quality Control Laboratory of Upgraded Department of Rasashastra and Bhaishajya Kalpana, Government Ayurved College, Vadodara, Gujarat respectively.

B. Preparation of Drug

All samples of Kshara and Lavana of Kantakari were prepared in the Pharmaceutical Laboratory of the Upgraded Department of Rasashastra and *Bhaishajya Kalpana*, Government Ayurved College, Vadodara, Gujarat. To ensure Standard Manufacturing Procedures (SMP), three batches of each formulation were prepared. Prior to initiation of the study, a pharmaceutical proforma was designed to maintain uniformity and adherence to SMP throughout the pharmaceutical process.

I.Preparation of *Kantakari Kshara* (KK)

i. Preparation of Kantakari ash (KA)

Fresh *Kantakari Panchanga* was collected and dried thoroughly under sunlight. The dried material was then placed in a large iron pan and ignited until complete combustion of the organic matter was achieved, after which it was allowed to self-cool under ambient conditions.

ii.Preparation of *Kantakari Ksharajala* (KKJ)

A specified quantity of KA was mixed with the potable water and manually macerated to ensure uniform mixing. The mixture was kept undisturbed overnight for complete sedimentation. On the next day, the clear supernatant liquid was carefully decanted using a rubber tube and filtered seven times through four layers of cotton cloth. The same procedure was repeated for a second wash by adding water to the residual ash.

iii.Preparation of *Kantakari Kshara* (KK)

The previously obtained KKJ was heated until complete evaporation of the aqueous portion, resulting in the formation of white-colored Kshara at the bottom of the vessel. The obtained Kshara was accurately weighed, labeled and stored in an airtight glass container. The same procedure was repeated for the second wash.

II.Preparation of *Kantakari Lavana* (KL)

Reference for method: Rasatarangini 14/131- 132

The specified quantity of dried KP was coarsely ground and thoroughly mixed with Saindhava powder, after which the mixture was placed in an earthen pot and closed with an earthen lid. The pot was subsequently sealed and covered with a Multani Mitti smeared cloth. Once the pot was completely dried, it was subjected to Gajaputa. After self-cooling, the finished product was collected, weighed, properly labelled, and stored in an airtight container.[3-5]

OBSERVATIONS AND RESULTS

During the preparation of KA, the dried KP showed rapid combustion with mild crackling sounds. The fruits required a comparatively longer duration for complete combustion, and a whitish-grey ash was obtained after self-cooling. The yield of KA was 9.6% from 60 Kg of dried KP (Table No: 1). Upon the addition of water to the ash, effervescence was observed, followed by gradual settling of ash particles with a very few black particles remained floating on the surface of liquid. After overnight settling and filtration, KKJ was obtained, with an average yield of 85.5% in the first wash and 93.96% in the second wash (Table No: 2). On heating, the initially transparent KKJ gradually turned whitish, thickened to a semi-solid consistency, and finally converted into white-coloured powdered KK after complete evaporation of water, with an average total yield of 30.5% obtained from 1 Kg of KA (Table No: 3). The temperature of liquid media was maintained between 90ºC to 100ºC, and flame temperature was maintained between 298 to 408ºC throughout the procedure. (Graph No: 1)

Table No. 1: Result of KA preparation

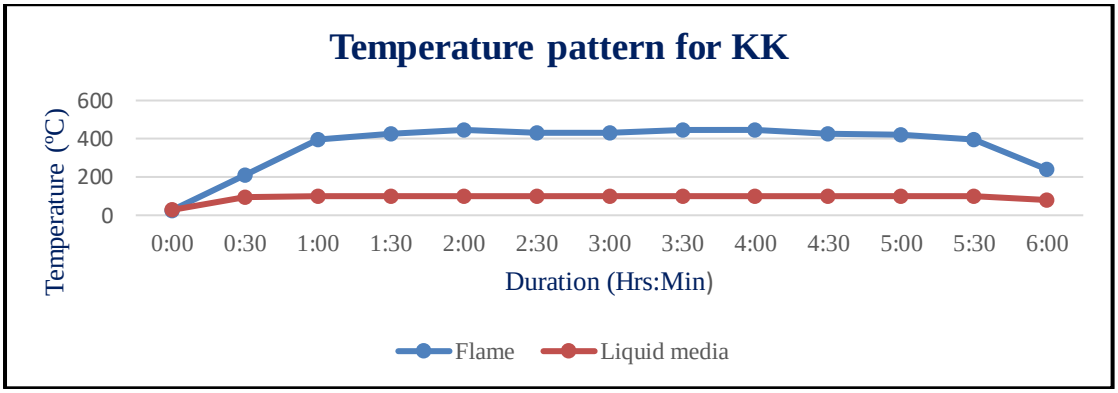
Parameters		Result
Total quantity of fresh KP	Kg	400
Quantity of KP after drying	Kg	60
	%	15
Final quantity of ash obtained from dried KP	Kg	5.8
	%	9.6
Total loss in ash preparation from fresh KP	Kg	394.2
	%	98.55
Total loss in ash preparation from dried KP	Kg	54.2
	%	90.33
Reason of loss in ash preparation from fresh KP	Evaporation of moisture content	
Reason of loss in ash preparation from dried KP	Due to burning of organic part of the material.	
Total days required for ash preparation	20 (18 days for drying and 2 days for ash preparation)	
Total time taken for preparation of KA from dried KP (hrs:min)	48:00 (2 hours for burning and 46 hours for self-cooling)	

Table No. 2: Result of KKJ preparation

Parameters			Result			
			Batch 1	Batch 2	Batch 3	Average
Total quantity of ash	Kg		01	01	01	01
	L		2.1	2.2	2.1	2.1
Total quantity of water	For 1st wash	L	16.80	17.60	16.80	17.07
	For 2nd wash	L	14.50	15.00	14.30	14.6
Total quantity of obtained *Ksharajala*	After 1st wash	L	14.50	15.00	14.30	14.6
		%	86.30	85.23	85.11	85.55
	After 2nd wash	L	13.60	14.00	13.55	13.72
		%	93.79	93.34	94.75	93.96
Remain quantity of *Ksharajala* with ash	After 1st wash	L	2.30	2.6	2.50	2.47
		%	13.7	14.77	14.89	14.45
	After 2nd wash	L	0.90	1.00	0.75	0.88
		%	6.21	6.66	5.25	6.04
Reason of loss	Due to decantation and filtration					
Quantity of residue	After 1st + 2nd wash	L	5.10	5.80	5.15	5.35
Total time taken for preparation of KKJ (hrs)			12	12	12	12

Table No. 3: Result of KK preparation

Parameter			Result			
			Batch 1	Batch 2	Batch 3	Average
Total quantity of KKJ	After 1st wash	L	14.50	15.00	14.30	14.6
	After 2nd wash	L	13.60	14.00	13.55	13.72
Total quantity of obtained *Kshara* from ash	After 1st wash	g	228	231	227	228.67
	After 2nd wash	g	79	75	77	77
	1st + 2nd wash	g	307	306	304	305.67
		%	30.7	30.6	30.4	30.56
Total loss from ash	1st + 2nd wash	g	693	694	696	694.33
		%	69.3	69.4	69.6	69.43
Reason of loss			Due to evaporation of water			
Time taken for evaporation of KKJ (hrs:min)			6.00	6.00	6.00	6.00

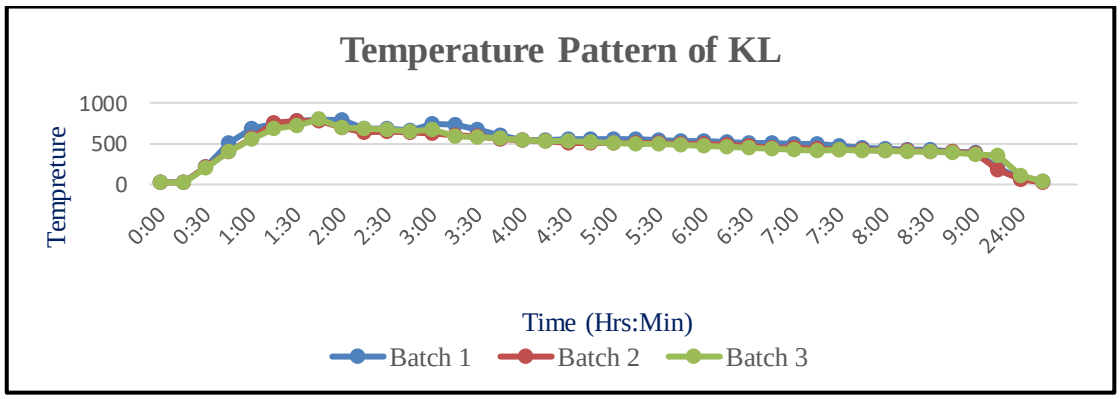


Graph 1: Temperature pattern for KK

After self-cooling of KL, upon opening the pot, greyish-black coloured burnt plant material was observed in the uppermost layer of the finished product, followed by a greyish powder beneath it. After powdering, a fine blackish-grey powder was obtained, with an average yield of 55.16%. (Table No: 4) The average temperature of the *Gajaputa* reached **809 °C** in **2 hours.** The *Gajaputa* process, including self-cooling, took **48 hours.** After self-cooling, **KL** was collected, yielding an average of **55.16%**. (Graph No: 2)

Table No. 4: Result of KL preparation

Parameters		Results			
		Batch 1	Batch 2	Batch 3	Average
Initial quantity of dried KP (g)		250	250	250	250
Initial quantity of *Saindhava* (g)		250	250	250	250
Initial quantity of KP+ *Saindhava* (g)		500	500	500	500
Final quantity of KL	g	276.5	276	275	275.83
	%	55.3	55.2	55.0	55.16
Total loss	g	223.5	224	225	672.5
	%	44.7	44.8	45	44.83
Reason of loss		Due to heating and evaporation of water content in raw material			
Total time required for preparation of KL (Days)		4 days	4 days	4 days	4 days



Graph 2: Comparative Temperature pattern of three batches of KL

DISCUSSION

In the present study, three batches of KK and KL were prepared to establish SMP. Review of the available literature indicated that no previous pharmaceutical standardization of KK and KL has been reported, highlighting the novelty of the present work.

For the preparation of KK, dried KP was burnt in an open environment to ensure complete combustion. The fruits burnt more slowly than other plant parts, which may be attributed to their higher mucilage content, compact pericarp, and carbohydrate-rich composition, collectively delaying ignition and oxidation. Crackling sounds perceived during burning can be explained by sudden vaporization of residual moisture and volatile compounds, resulting in tissue rupture and rapid gas release.

All batches of KK were prepared using the obtained KA. During preparation of KKJ, effervescence was observed on the addition of water to KA, which may be due to the liberation of CO_2 resulting from the reaction between alkaline carbonates present in the ash and residual acidic impurities. , Floating black particles were observed and were identified as partially burnt plant residues. After sedimentation, a clear and colourless supernatant was obtained, representing the water-soluble alkaline fraction, while insoluble components such as siliceous matter and certain calcium salts settled at the bottom.

Evaporation of KKJ resulted in the formation of KK. A distinct characteristic odour of *Kshara* was perceived throughout the evaporation process, indicating concentration of alkaline constituents. During boiling, the appearance of white froth was observed, which may be due to decomposition of bicarbonates with liberation of CO_2, while increasing concentration of soluble salts caused turbidity and imparted a whitish appearance. The final KK obtained was white in colour, consistent with the classical description of *Kshara* as Shukla Varna. The yield of KK, calculated on a w/w basis, was 22.87% from the first wash and 7.7% from the second wash, giving a total yield of 30.56% with reference to KA, whereas the yield calculated with respect to dried KP was 2.95%.[6-8]

As no uniform classical procedure exists for *Lavana Kalpana*, variations are observed in the heating method, condition of raw materials, and desired product characteristics. In the present study, dried KP was used for the preparation of KL to ensure pharmaceutical comparability with KK. During Gajaputa, temperatures reach approximately 800 °C; under these high-temperature, reducing conditions, the organic components of *Kantakari* undergo pyrolysis, yielding carbonized matter and mineral-rich ash. These inorganic components interact with Saindhava, facilitating chemical transformations and the formation of alkaline salts. The temperature profile is critical, as an adequate peak temperature ensures complete pyrolysis and effective interaction with Saindhava, including ionic exchange, resulting in a stable and chemically consistent product. Controlled self-cooling further promotes orderly crystallization, enhancing crystallinity, structural stability, and chemical uniformity of the finished KL.[9-11]

The cost estimation of KK and KL was calculated by considering expenses for raw materials, labor charges, and ancillary costs such as cow dung cakes and gas. Based on the overall expenditure for procurement, processing and preparation, the cost of KK was estimated at ₹5,600/Kg, while that of KL was ₹3,200/Kg.[11-13]

CONCLUSION

The systematic pharmaceutical evaluation of three batches for each dosage form successfully established reproducible SMP for KK and KL. The study confirms that the distinct pharmaceutical identities of these two forms are fundamentally driven by variations in processing techniques and the nature of heat application. KK, characterized by open-environment burning and subsequent aqueous extraction, resulted in a white, fine powder with a lower yield and a higher estimated cost due to its multi-stage complexity. Conversely, the preparation of KL, involving a closed-vessel heating method, yielded a blackish-grey powder with a significantly higher yield and a lower estimated cost. These standardized protocols substantiate the traditional distinctions between the two forms, providing a scientific framework to differentiate their therapeutic applications and serving as a robust reference for future research.

Photos of KK preparation

Figure : 1

Figure : 2

Figure : 3

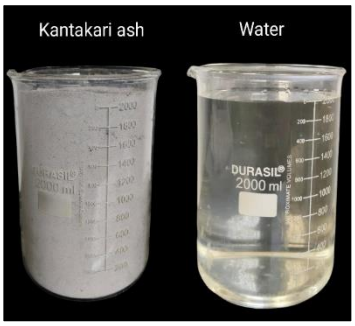


Figure : 4

Figure : 5

Figure : 6

Figure : 7

Figure : 8

Figure : 9

Figure : 10

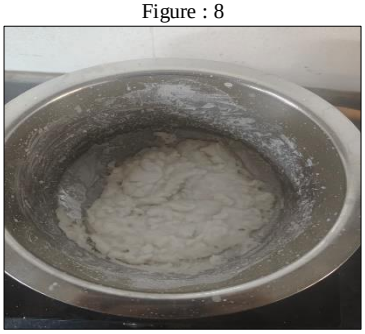


Figure : 11

Figure : 12

(Figure1 and 2: Burning of KP; Figure 3: KA; Figure 4: Raw material for KKJ; Figure 5: Overnight sedimentation of the mixture after mixing KA and water; Figure 6 and 7: Decantation and filtration of KKJ ; Figure 8: KKJ; Figure 9 and 10: Evaporation of KKJ; Figure 11: Semi-solid consistency of KK; Figure 12: KK)

Photos of KL preparation

Figure : 1

Figure : 2

Figure : 3

Figure : 4

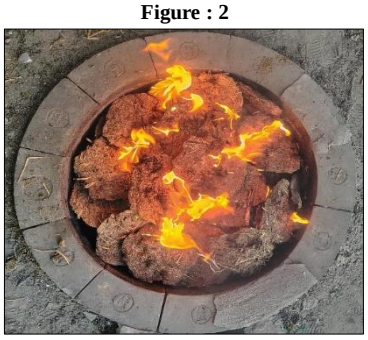


Figure : 5

Figure : 6

(Figure 1: Dried Raw Materials of KL; Figure 2: Mixing of KP and SL; Figure 3: Placing the mixture into an earthen pot; Figure 4: After sealing the earhen pot and lid with *Multani Mitti*-smeared cloth; Figure 5: *Gajaputa*; Figure 6: KL)

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