ISSN: 2322 - 0902 (P)
ISSN: 2322 - 0910 (O)

International Journal of Ayurveda and Pharma Research

Research Article

A COMPARATIVE STANDARD MANUFACTURING PROCEDURE OF *SWARJIKA KSHARA* PREPARED FROM *USHTRAPRIYA* (*FAGONIA CRETICA* LINN.) AND *RUDANTI* (*CRESSA CRETICA* LINN.)

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Article info

Article History:
Received: 18-01-2025
Accepted: 11-02-2025
Published: 07-03-2025

KEYWORDS:
Swarjika Kshara, SMP, *Ushtrapriya, Rudanti.*

ABSTRACT

Swarjika Kshara is a significant alkaline formulation in Ayurveda, traditionally prepared using plants like *Ushtrapriya* (*Fagonia cretica Linn.*) and *Rudanti* (*Cressa cretica Linn.*). Classical references such as *Rasatarangini* and *Ayurvediya Rasashastra* describe the preparation of *Kshara*, while modern practices often substitute it with chemically synthesized sodium bicarbonate. The Ayurvedic Pharmacopeia of India (API) lacks specific standards for plant-origin *Swarjika Kshara,* necessitating a study to develop and standardize its manufacturing process. **Aim**: To develop a Standard Manufacturing Procedure (SMP) for *Swarjika Kshara* prepared from *Ushtrapriya* and *Rudanti*. **Material and Methods**: Three batches of *Swarjika Kshara* were prepared from *Ushtrapriya* and *Rudanti* following classical references. Pharmaceutical observations were recorded, and standardized batches were produced to validate uniformity. Yield percentages, ash content, and procedural differences were analyzed. **Results**: The study found significant differences in yield, with *Rudanti* (47.41%) producing more than double the *Kshara* compared to *Ushtrapriya* (18.46%). Both samples were successfully standardized, and uniform operative procedures were established. **Conclusion**: The study validated SMP for *Swarjika Kshara* from *Ushtrapriya* and *Rudanti*, ensuring consistency in production. The findings offer a foundation for large-scale manufacturing and future research, addressing the gap in API standards for plant-origin *Swarjika Kshara.*

INTRODUCTION

Swarjika Kshara is included in all *Kshara* groups. It is used as a single drug in *Kasa, Shvasa, Gulma, Adhmana, Vrana, Udara Roga,* and *Krumi*[1]. It is also an important ingredient in many formulations, such as *Chitrakadi Gutika, Agnitundivati, Kshara Ghrita, Hingvadi Churna, Hinguvachadi Churna,* etc.

Swarjika Kshara is first time mentioned in *Samhita Kala* but references of the source and preparation methods of *Swarjika Kshara* are not found in *Samhita Kala* and *Samgraha Kala*. Later on, various classical texts such as Rasatarangini,[2] Rasamrita,[3] Raja Nighantu,[4] etc. describe different sources and methods of preparation for *Swarjika Kshara*.

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https://doi.org/10.47070/ijapr.v13i2.3583

In Rasatarangini *Swarjika Kshara* is prepared from a plant known as *Ushatrapriya* (*Fagonia cretica* Linn.).[5] In Punjab *Lakha-Lunkhi* plant is used for the preparation of *Swarjika Kshara*. The plant is dried and burnt in a pit; little by little quantity of plant is added to it for proper burning. When the pit is filled with ash, a pit is closed with *Mitti*. After 10-15 days *Kshara* is collected from the pit.[6] Author of Ayurvediya Rasashastra, described the salts extracted from ashes of the plant grow in saline soils are called *Swarjika Kshara*. *Lano* is an alkaline plant from which *Swarjika Kshara* is prepared by *Kshara-Nirmana Vidhi.*[7] *Lano* is the Gujarati vernacular name of the plant *Rudanti* (*Cressa cretica* Linn.) given in the textbook of Aryabhishak.[8] Although references of mineral origin *Swarjika Kshara* have been found in Rasamrita,[9] Rasajalanidhi,[10] Raja Nighantu[11] and Bhavaprakasha Nighantu.[12] According to API, *Swarjika Kshara* is impure Sodium Bicarbonate ($NaHCO_3$) and is available in the form of lumps and powder.[13]

Taking note of the above references, various methods and plants were found for the preparation of *Swarjika Kshara*. In the present era, chemically prepared sodium bicarbonate is used as *Swarjika Kshara.* Also, till date in Ayurvedic Formulary of India (AFI) and Ayurvedic Pharmacopia of India (API) have not published any standard for *Swarjika Kshara* prepared from plant source. In this study, based on classical reference *Ushtrapriya* (*Fagonia cretica* Linn.) and *Rudanti* (*Cressa cretica* Linn.) two plant were selected for prepration of *Swarjika Kshara*.

AIM

To develop standard manufacturing procedure of *Swarjika Kshara* prepared from *Ushtrapriya* (*Fagonia cretica* Linn.) and *Rudanti* (*Cressa cretica* Linn.).

MATERIAL AND METHODS

Fresh *Ushtrapriya* (*Fagonia cretica* Linn.) and *Rudanti* (*Cressa cretica* Linn.) *Panchanga* were collected in January 2023 respectively from Junagadh and Bhavnagar, Gujarat, following Good Collection Practices guidelines, and authenticated in the Pharmacognosy Laboratory of the upgraded department of Dravyaguna, Government Ayurved College, Vadodara, Gujarat. The pharmaceutical process was conducted in the upgraded department of Rasashastra and Bhaishajya Kalpana, Vadodara. Both formulations were prepared in three batches following standard operative procedures. The whole pharmaceutical procedure was carried out in the following septs and labeled as follows;

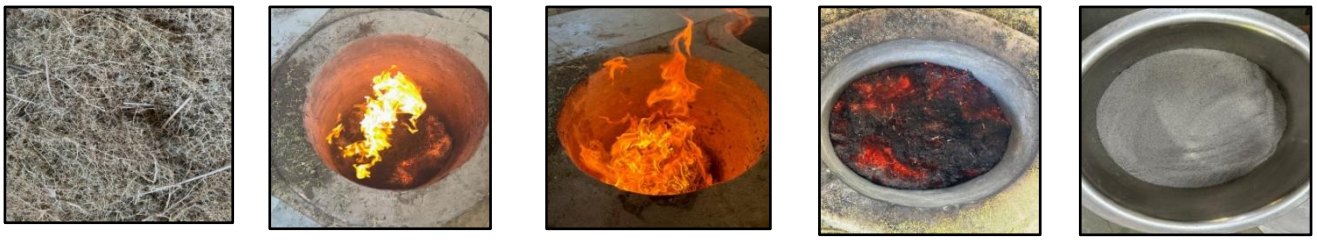
1) *Swarjika Kshara* from *Ushtrapriya* (*Fagonia cretica* Linn.)
   Ushtrapriya ash (AU)
   Ushtrapriya Ksharajala (KJU)
   Swarjika Kshara from *Ushtrapriya* (SKU)
2) *Swarjika Kshara* from *Rudanti* (*Cressa cretica* Linn.)
   Rudanti ash (AR)
   Rudanti Ksharajala (KJR)
   *SwarjikaKshara*from *Rudanti* (SKR)

First pilot batch was prepared as per the prepared proforma and findings obtained from that pilot batch; main batches were prepared by the adopting the same method to attain the reproducibility of that method. (Equipment specification was given in annexure 1.)

1) *Swarjika Kshara* from *Ushtrapriya* (*Fagonia cretica* Linn.)

For the preparation of *Swarjika Kshara* from *Ushtrapriya* (**SKU),** the volume/volume (v/v) method was selected due to its higher *Kshara* yield (10.65%) and better transparency of *Ksharajala* compared to the weight/volume (w/v) method (yield 8.4%). Fresh *Ushtrapriya Panchanga* was collected, cleaned, and sun-dried, then ignited in a pit by gradually adding more *Panchanga* until completely burned to ash, which was collected and weighed. (Plate-1) To prepare KJU, the ash was mixed with eight times its volume of potable water in a stainless steel (s.s.) vessel, macerated by hand, and left undisturbed for three hours. The clear liquid was drained through a rubber tube and filtered seven times using three-folded cotton cloth to obtain *Ksharajala.* (Plate-2) For the final preparation of SKU, the *Ksharajala* was heated in an s.s. vessel on a gas stove until it formed a thick paste. The paste was transferred to a smaller s.s. vessel and subjected to indirect heating until all the water evaporated and white colored *Kshara* was obtained. The *Kshara* was powdered and stored in an airtight glass container. (Plate-3)

Fig.1:*Swarjika Kshara* from *Ushtrapriya* (*Fagonia cretica* Linn.)

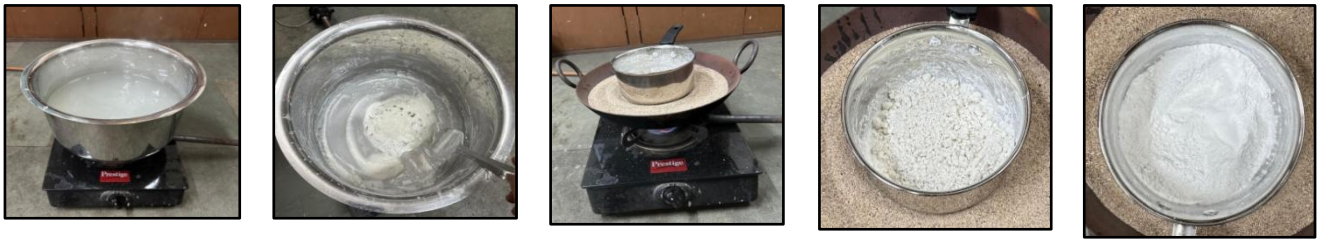


a **b** **c** **d** **e**

Plate-1 preparation method of *Ushtrapriya Ash*: a-Dried *Ushtrapriya Panchanga*, **b**-Ignition of dried *Ushtrapriya Panchanga* in pit, **c**-Burning *Ushtrapriya Panchanga*, **d**- allow to Completely burnt and cooling self, **e**-*Ushtrapriya* as from *Ushtrapriya Panchanga*

a **b** **c** **d** **e**

Plate-2 Preparation method of *Ushtrapriya Ksharajala*: **a**-*Ushtrapriya* ash and water, **b**-Keep undisturbed for three hours, **c**-Decantation of *Ksharajala*, **d**- Filtration of *Ksharajala*, **e**-*Ushtrapriya Ksharajala* from *Ushtrapriya* ash



a **b** **c** **d** **e**

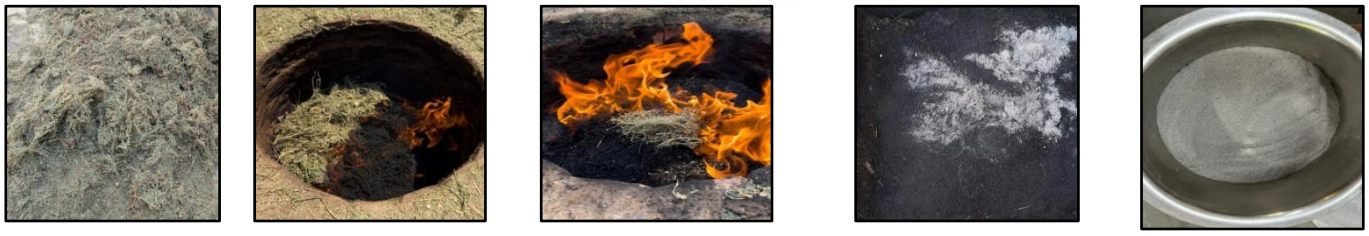
f

Plate – 3 Preparation method of SKU: **a**-Heating of *Ksharajala*, **b**-Slurry form of *Kshara*, **c**-Shift material to indirect heat, **d**- Granules form of *Kshara*, **e**-Last stage of *Kshara* preparation, **f-***Swarjika Kshara* from *Ushtrapriya*

2) *Swarjika Kshara* from *Rudanti* (*Cressa Cretica* Linn.)

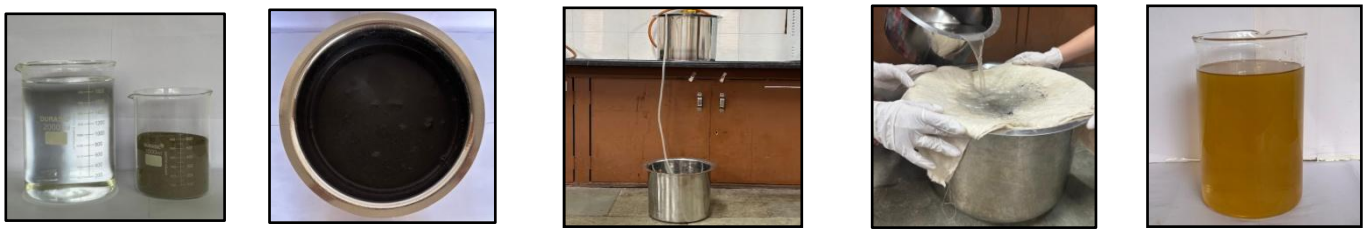
For the preparation of ***Swarjika Kshara* from *Rudanti* (SKR),** a sedimentation time of 3 + 12 hours was selected for obtaining more transparent *Ksharajala* compared to shorter durations. Fresh *Rudanti Panchanga* was collected, cleaned, and sun-dried, then ignited in a pit by gradually adding more *Panchanga* until completely burned to ash, which was collected and weighed. (Plate-4) To prepare *Rudanti Ksharajala* (KJR), the ash was mixed with eight times its volume of potable water in a s.s. vessel, macerated by hand, and left undisturbed for three hours. The supernatant liquid was drained through a rubber tube and filtered seven times using three-folded cotton cloth. The drained liquid was left undisturbed for 12 hours, after which it was drained again and again filtered seven times through three folded cotton cloth to obtain *Ksharajala*. (Plate-5) For the final preparation of SKR, the *Ksharajala* was heated in an s.s. vessel on a gas stove until it reached a thick paste-like consistency. The paste was transferred to a smaller s.s. vessel and subjected to indirect heating until all the water evaporated and light cream colored Kshara was obtained. which was powdered and stored in an airtight glass container. (Plate-6)

Figure 2: *Swarjika Kshara* from *Rudanti*



a **b** **c** **d** **e**

Plate – 4 preparation method of *Rudanti Ash*: **a**-Dried *Rudanti Panchanga*, **b**-Ignition of dried *Rudanti Panchanga* in pit, **c**-Burning of *Rudanti Panchanga*, **d**- allow to Completely burnt and cooling self, **e**-*Rudanti* ash from *Rudanti Panchanga*



a **b** **c** **d** **e**



f **g** **h**

Plate – 5 Preparation method of *Ushtrapriya Ksharajala*: **a**-*Rudanti* ash and water,**b**-Keep undisturbed for three hours, **c**-Decantation of *Ksharajala* after 3 hours, **d**- Filtration of *Ksharajala*, **e**-Keep again undisturbed for twelve hours, **f**-2nd time decantation of *Ksharajala* after 12 hours, **g-**2nd time Filtration of *Ksharajala,* ***h-****Rudanti Ksharajala* from *Rudanti* ash





a **b** **c** **d** **e**

f

Plate – 6 Preparation method of SKR: **a**-Heating of *Ksharajala*, **b**-Slurry form of *Kshara*, **c**-Shift material to indirect heat, **d**- Granules form of *Kshara*, **e**-Last stage of *Kshara* preparation, **f-***Swarjika Kshara* from *Rudanti*

OBSERVATIONS AND RESULTS

1) *Swarjika Kshara* from *Ushtrapriya* (*Fagonia cretica* Linn.)

A total of 50 kg of *Ushtrapriya* was gradually added to the pit over 2.5 hours. Initially, it burned quickly with a crackling sound, and the material was periodically stirred to settle. Flames were visible until 2 hours and 15 minutes; then, the pit was filled with glowing embers. After 26 hours of cooling, grayish-white ash was collected.

Table 1: Results obtained during the preparation of *Ushtrapriya* ash

Parameters			Result
Quantity of fresh *Ushtrapriya* (Kg)			82
Quantity of dry *Ushtrapriya* (Kg)			50
Time taken for drying (Days)			18
Final weight of *Ushtrapriya* ash (Kg)			4.9
% of obtained *Ushtrapriya* ash			9.8
Loss	Compare to dry *Ushtrapriya*	(Kg)	45.1
		(%)	90.2
	Compare to fresh *Ushtrapriya*	(Kg)	77.1
		(%)	94.02
Time taken for preparation of *Ushtrapriya* ash (Hr:min)			26:00
Reason of loss			Due to burning organic part of the material

During the preparation of KJU, effervescence was observed upon adding water to the ash. After 30 minutes, most ash particles settled at the bottom, with a few floating on the surface. After 3 hours, the decanted *Ksharajala* was transparent, light yellow, and salty in taste.

Table 2: Results obtained during the preparation of *Ushtrapriya Ksharajala*

Parameters		Result			
		Batch 1	Batch 2	Batch 3	Average
Ushtrapriya ash	ml	1000	1000	1000	1000
	g	689	697	693	693
Potable water	ml	8000	8000	8000	8000
	g	7895	7911	7922	7909.33
Ksharajala obtained after filtration	ml	6350	6200	6100	6216.66
	g	6300	6081	6038	6139.66
% of obtained *Ksharajala*	v/v	79.38	77.5	76.25	77.71
	w/w	79.8	76.87	76.22	76.96
Times taken for preparation of *Ushtrapriya Ksharajala* (Hr:Min)		3:45	3:45	3:45	3:45
Reason of loss		Due to decantation and filtration			

During the heating process, Initially, the liquid was transparent and salty, and vapor began to form after 1 hour. By 2 hours, the liquid turned milky white, and a white layer appeared on the surface by 4 hours. At 4:30 hours, *Kshara* started adhering to the vessel walls, and crackling sounds were heard. The consistency thickened to a slurry-like texture at 5:45 hours and a paste-like consistency by 5:55 hours. After moving to indirect heat, the material became off-white semisolid mass then change into off-white granules and it turned into dry, white powder. Temperature readings for three batches showed gradual increases in both flame and liquid media temperatures, with flame temperatures reaching 400°C and liquid media temperatures peaking at 102°C by 5:00 hours. After switching to indirect heat, temperature of flame slightly decreased to 305°C–350°C, while temperature of material and *Valuka* were stabilized around 60°C–80°C and 170°C–200°C respectively in the final stages.

Table 3: Results obtained during the preparation of SKU

Parameters			Result			
			Batch 1	Batch 2	Batch 3	Average
Ushtrapriya Ksharajala		ml	6350	6200	6100	**6216.66**
		g	6300	6081	6038	**6139.66**
Kshara obtained (g)			124	131	129	**128**
% of *Kshara*	Compared to ash		17.99	18.79	18.61	**18.46**
	Compared to dry plant		1.76	1.84	1.82	**1.81**
	Compared to fresh plant		1.01	1.12	1.11	**1.10**
Time taken for evaporation of *Ksharajala* (Hr:Min)			6:55	06:45	06:58	**6:53**
Reason of loss			Due to evaporation of water			

2) *Swarjika Kshara* from *Rudanti* (*Cressa cretica* Linn.)

A total of 50 kg of *Rudanti* was gradually added to the pit over 5.5 hours, burning slowly with intermittent stirring to ensure complete combustion. Flames were visible until 5 hours and 45 minutes; then, the pit was filled with glowing embers. After 39 hours of cooling, grayish-white ash was collected.

Table 4: Results obtained during the preparation of *Rudanti* ash

Parameters	Result
Quantity of fresh *Rudanti* (Kg)	87
Quantity of dry *Rudanti* (Kg)	52
Time taken for drying (Days)	27
Time taken for preparation of *Rudanti* ash (Hr:min)	39:00

Final weight of *Rudanti* ash (Kg)			5.135
% of obtained *Rudanti* ash			9.875
Loss	Compare to dry *Rudanti*	(Kg)	46.865
		(%)	90.125
	Compare to fresh *Rudanti*	(Kg)	81.86
		(%)	94.09
Reason of loss			Due to burning organic part of the material

During the preparation of KJR, effervescence occurred when water was added to the ash. After 75 minutes, most ash particles settled at the bottom and a thin layer of ash particles was seen on the upper surface of the liquid. After 3 hours, the decanted *Ksharajala* was yellowish-brown, and after 12 hours, it became clear yellow. The *Ksharajala* was salty.

Table 5: Results obtained during preparation of KJR

Parameters		Result			
		Batch 1	**Batch 2**	**Batch 3**	**Average**
Rudanti ash	ml	500	500	500	500
	g	445	457	463	455
Potable water	ml	4000	4000	4000	4000
	g	3940	3951	3967	3952.67
Ksharajala obtained after filtration	ml	2900	2800	3010	2903.33
	g	3006	2980	3106	3030.67
% of obtained *Ksharajala*	v/v	72.5	70	75.25	72.58
	w/w	76.30	75.42	78.30	76.67
Times taken for preparation of *Rudanti Ksharajala* (Hr:Min)		3:45	16:30	16:30	16:30
Reason of loss		Due to decantation and filtration			

During the heating process, Initially, the liquid was clear yellowish with a salty taste. As the heating continued, the liquid turned turbid yellowish-brown. Around after 3:00 hours, it became a thick cream-colored liquid, and *Kshara* started sticking to the walls of the vessel. The consistency became slurry-like by 3:25 hours and reached a thick paste-like consistency by 3:45 hours. After moving to indirect heat, the material changed from a thick paste to a semisolid mass, then granules, and it turned into dry, light cream-colored powder. The temperature for all three batches increased steadily during the process. Flame temperatures ranged from 24°C to 500°C, and liquid media temperatures ranged from 30°C to 96°C during direct heating phase while the temperature of material was stabilized between 64°C and 79°C during the indirect heating phase.

Table 6: Results obtained during preparation of SKR

Parameters		Result			
		Batch 1	**Batch 2**	**Batch 3**	**Average**
Rudanti Ksharajala	ml	2900	2800	3010	**2903.33**
	g	3006	2980	3106	**3030.67**
Time taken for evaporation of *Ksharajala* (Hr:Min)		04:53	05:00	05:23	**05:05**
Kshara obtained (g)		213	209	216	**212.67**
% of *Kshara*	Compare to ash	47.86	47.73	46.65	**47.41**
	Compare to dry plant	4.72	4.51	4.60	**4.61**
	Compare to fresh plant	2.83	2.70	2.76	**2.76**
Reason of loss		Due to evaporation of water			

Equipment with their specification

Sr.no.	Equipment	Specifications	
1.	Pit	Depth - 72 cm Diameter - 69 cm	
2.	Spatula	Material- Iron length -180 cm Width -12 cm	
3.	Weighing balance	Swisser (An ISO 9001:2008) Cls-3 Maximum capacity: 100 kg, Minimum capacity: 10 g	
4.	Electric weighing balance	Company – Swisser (An ISO 9001:2008) Maximum capacity – 10 kg Minimum capacity – 10 g	
5.	Measuring cylinder	Material – Plastic Capacity- 1 L, 5 L	
6.	s.s. vessel	Material: s.s. Diameter: 23 cm Depth: 24 cm Capacity: 10 L	
7.	Cotton cloth	Material – Cotton Size – 1 x 1 m	
8.	Rubber tube	Material – Silicon rubber Diameter -12 x 16 mm Length – 1.5 m	
9.	Electric weighing balance	Company – Swisser (An ISO 9001:2008) Maximum capacity – 10 kg Minimum capacity – 10 g	
10.	Measuring cylinder	Material – Plastic Capacity- 5 L	
11.	S.S.vessel	Material - s.s. Depth - 19 cm Diameter - 30 cm Capacity - 16 L	Material - s.s. Depth - 8 cm Diameter - 15 cm Capacity - 2 L
12.	Heating device	Prestige Gas cook tops Model no.: Gas Top GTM-01 Supply by Gas line	
13.	Spatula	Material- s.s. Length - 62cm Width -8.5cm	
14.	Infrared Thermometer	Fluke 64 max Maximum: 600° C, Minimum: - 30° C	
15.	Pyrometer	26ºC to 1200ºC capacity K type Diameter-19 mm × 450 mm	
16.	Mortar & Pestle	Mortar: Material - Porcelain Depth - 11 cm	Pestle: Material - Porcelain Length - 10 cm

		Lower diameter - 4 cm Upper diameter - 8 cm	Lower Circumference- 2.5 cm Upper Circumference- 5 cm
17.	Glass bottle	Material – Glass Diameter: 6.73 cm Height: 8.19 cm Capacity: 140 g	

DISCUSSION

Three batches of *Swarjika Kshara* were prepared from *Ushtrapriya* and *Rudanti* to develop SMP. Pilot batches were prepared from *Ushtrapriya* and *Rudanti*, and the findings were recorded as per the pharmaceutical proforma. Based on these findings, three batches of each sample were prepared by using the same methodology.

During the preparation of ash, dried material was burned in an open pit to help achieve maximum yield by reducing the loss of materials; It also ensures a more efficient burn by allowing sufficient airflow, which aids in complete combustion. The comparative yield of ash from *Ushtrapriya* and *Rudanti* shows a very slight difference. The yield of ash from dry *Ushtrapriya* (9.80%) is almost equivalent to that of dry *Rudanti* (9.87%), indicating that both plants produce similar quantities of ash when dried. However, when fresh plant material was used, the yields were slightly lower, with *Ushtrapriya* producing 5.98% and *Rudanti* yielding 5.91%. This minor variation in ash yield could be due to slight differences in the moisture content between the two plants.

A cylindrical vessel was chosen to maximize yield by minimizing surface area, while stainless steel vessels were utilized to prevent chemical reactions with the materials. To ensure the maximum extraction of *Ksharajala* without disturbing the ash sediment, a rubber tube was employed for draining the supernatant liquid. In the preparation of KJU and KJR, notable differences in the physical characteristics and settling times were observed. Effervescence was observed immediately upon adding water to the ash in both samples, it may be due to the presence of potassium bicarbonate, calcium carbonate and sodium bicarbonate in ash. In the case of KJU, the ash particles settled within 30 minutes, producing a light yellowish clear supernatant liquid after 3 hours, with a few particles floating on the surface. In contrast, ash particles of *Rudanti* required 75 minutes to settle, and the supernatant liquid was yellowish-brown, with a clearer liquid appearing after 15 hours. The taste of KJR was notably saltier than that of KJR, suggesting possible differences in their mineral content or concentration of soluble salts.

During the preparation of *Kshara*, significant differences were observed between the evaporation processes of KJU and KJR in terms of temperature, color changes, and consistency. For KJU, evaporation started at a lower temperature, with the liquid turning milky white at around 95°C and thickening into a paste by 5 hours and 55 minutes. After shifting to indirect heat, it transformed into off-white granules and, ultimately, a white powder. In contrast, KJR began evaporation at a higher temperature, with vapor appearing at 86°C. The liquid turned turbid yellow and then yellowish-brown, thickening into a cream-colored paste. By the end of the process, it became cream-colored granules and a dry, light cream-colored powder. Due to its hygroscopic nature, *Kshara* should be stored in an airtight container to protect it from moisture absorption. The comparative yield of *Swarjika Kshara* from *Ushtrapriya* and *Rudanti* shows that *Rudanti* consistently provides a higher yield in all forms. The most significant difference is observed from ash, with *Rudanti* producing 47.41% *Kshara*, more than double that of *Ushtrapriya* at 18.46%. This is due to *Rudanti* ash containing more water-soluble salts, minerals, and organic compounds compared to *Ushtrapriya* ash which contributes to a higher *Kshara* production.

The cost analysis for *Swarjika Kshara* preparation reveals that producing 128 g of SKU in a 1000 ml batch amounts to approximately Rs. 3820 per kg, while the production of 212.67 g of SKR in a 500 ml batch costs around Rs. 1750 per kg. The higher yield of SKR results in a comparatively lower cost per kilogram. The overall expenses include raw materials, labor, gas charges, and packaging costs, with SKR being more economical due to its higher yield and lower input costs.

CONCLUSION

Rasatarangini mentioned *Ushtrapriya* to prepare *Swarjika Kshara*, while Ayurvediya Rasashastra mentioned *Rudanti* to prepare *Swarjika Kshara*. SKU and SKR were standardized by preparing three batches with reference of Rasatarangini. SKR was better than SKU in the context of their pharmaceutical study. The findings of the present study ensure uniformity in the operative procedures. Thus, the present SMP of SKU and SKR can be adopted by future utilization in large-scale production, and the observations of the present study can be considered as standards for further research.

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Cite this article as:
Janaki Patel, Bharat Kalsariya. A Comparative Standard Manufacturing procedure of Swarjika Kshara prepared from Ushtrapriya (Fagonia cretica Linn.) and Rudanti (Cressa cretica Linn.). International Journal of Ayurveda and Pharma Research. 2025;13(2):1-9.
https://doi.org/10.47070/ijapr.v13i2.3583
Source of support: Nil, Conflict of interest: None Declared

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