RESEARCH PAPER

Pharmaceutico-Analytical Experimental Evaluation of Abhraka Satva.

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ABSTRACT

Introduction: Abhraka Satva is an essence material derived from Shuddha Krishna Vajrabhraka and used as a Shrestha Rasayana Dravya. For various therapeutic purposes, it serves as a key ingredient in a total of 56 formulations, as noted by Rasa Yoga Sagar and Bharat Bhaishajya Ratnakara. Despite its historical importance, standardized analytical data are lacking to ensure consistency and efficacy.

Aim: To standardize and analyze Abhraka Satva.

Methodology: The preparation involved Satva Patana based on Rasa Ratna Samucchaya guidelines, followed by Shodhana (purification) and Dhanyabhraka (refinement) processes. Further organoleptic, physicochemical, and sophisticated instrumental analyses were performed using Inductively Coupled Plasma Atomic Emission Spectroscopy (ICP-AES) and X-ray Diffraction (XRD).

Results: This process yielded 2.6% Satva from Dhanyabhraka. In the ICP-AES analysis, Iron, Aluminium, Silicon, and Boron were found to be in decreasing order from Raw Abhraka, Shuddha Abhraka, and Dhanyabhraka, respectively, while the XRD analysis revealed that the patterns of Abhraka Satva are similar to Kyanite.

Conclusion: This study provides a comprehensive pharmaceutical and compositional profile of Abhraka Satva, which is essential for establishing a standardized manufacturing process and verifying its mineral content.

Keywords: Abhraka Satva, Dhanyabhraka, ICP-AES, Shuddha Krishna Vajrabhraka, Shodhana, XRD.

How to cite this article: Patadia MP, Bedarkar P, Kumawat VB, Rotwar DS, Thakur J. Pharmaceutico-Analytical Experimental Evaluation of Abhraka Satva. Int J Drug Deliv Technol. 2026;16(16s): 367-376. DOI: 10.25258/ijddt.16.16s.38

Source of support: Nil.

Conflict of interest: None

Introduction: -

The mineral *Abhraka* or Mica is a vital substance known as *Gauri Teja.*[1] According to mythology, the union of the *Parada* (mercury) and *Abhraka* is essential to achieve *Deha-Siddhi* (rejuvenation) and *Lauha-Siddhi*[2] (alchemy). *Satva Patana* (metal extraction) is a process in which the mineral ores are mixed with other substances such as *Kshara Varga* (alkali), *Amla Varga*[3] (sour), or *Dravaka Varga*[4] (liquifying agents) and subjected to heat in *Angar Koshthi*[5] (charcoal furnace) to obtain the essence, known as *Satva*. In *Rasa Shastra, Satva Patana* of various *Rasa Dravya* (mineral ores) has been explained in several books of Indian alchemy.

Abhraka Satva (essence of mica) is the ultimate choice as a *Rasayana Dravya*[6] (rejuvenating material). Hence, it is recommended that *Rasaushadhi* or any *Rasaushadhi Kalpa* (herbo-mineral preparations) be used unconditionally with the administration of *Abhraka* as *Kshetrikarana* (body purification) in formulation or as separate formulations concomitantly. A total of 56 formulations of *Abhraka Satva* were mentioned in *Rasa Yoga Sagar* and *Bharat Bhaishajya Ratnakara*. *Abhraka Satva Bhasma* is considered 8 times more potent than *Abhraka Bhasma* as per *Rasa Hridaya Tantra*.[7]

Abhraka Satva possesses both therapeutic and alchemical properties.[8] Therapeutically, it was mentioned that *Abhraka Satva Bhasma* is effectively used in the treatment of *Kshaya* (degenerative disease), *Pandu Roga* (anemia), *Shula* (pain), *Urdhwa Swasa* (asthma), *Sangrahani* (IBS), *Amavata* (rheumatic arthritis), *Kustha* (skin disease), *Prameha* (diabetes mellitus), *Aruchi* (anorexia), *Daruna Kasa* (coughing), *Mandagni* (weak digestive power), *Udara Roga* (abdominal diseases), and incurable diseases along with suitable *Anupana* [9] (adjunct). Concerning *Dhatuvada* (alchemy), the importance of *Abhraka Satva* in mercurial processing is depicted in *Rasa Hridaya Tantra*, that there is no other agent except mica to clip the wings of Mercury (*Pakshachchedana*), which is imminent for swooning and binding for the same. [10]

Aim: - To standardize and analyze *Abhraka Satva*

Objective: -

- To enrich data for the development of the standard manufacturing processes (SMP) of *Abhraka Satva Patana*
- To evaluate the analytical profile of *Abhraka Satva*.

Materials & Methods: -

Procurement of raw materials

Raw *Abhraka* was procured from the GMP Certified pharmacy of the Institute of Teaching and Research in Ayurveda (ITRA), Jamnagar, as per the classical *Grahya Lakshana*[11] (acceptable characteristics) and authenticated by the subject experts of *Rasa Shastra*. Other allied materials, i.e., *Gou-dugdha* (cow's milk), *Shali Dhanya* (husk), *Sweta Musli* (*Chlorophytum borivilianum*), *and Ashudha Tankana (borax),* were procured from the local market of Jamnagar.

Method of *Abhraka Satva Patana*

The entire procedure is divided into three sections listed below.

A. *Abhraka Shodhana*
B. Preparation of *Dhanyabhraka*
C. *Abhraka Satva Patana*

A. *Abhraka Shodhana:*

Raw *Abhraka* was pounded into flakes, weighed, and placed in an iron pan. *Gou-dugdha* was boiled, self-cooled, measured, and filled in a stainless-steel vessel for quenching. The iron pan was heated in a charcoal burner using an electric blower. During the heating process, *Abhraka* flakes were flipped using metal tongs to ensure even heat exposure. Once *Abhraka* flakes reached the red-hot stage, they were quenched into measured cow milk and allowed to self-cool. This process was repeated seven times using fresh cow milk. Temperature was monitored using a digital laser infrared temperature gun.[12] (Table 2 & 3)

B. Preparation of *Dhanyabhraka*

Shodhita Abhraka (purified mica) was taken in an enamel tray, and one-fourth of the quantity of *Shali Dhanya* was mixed with it. This mixture was transferred into a jute bag, tied in *Pottali* form, and soaked in *Kanji*[13] (sour rice gruel) for 72 hours. After this soaking period, the *Pottali* was massaged with the hands until all *Dhanyabhraka* was extracted. Since some *Dhanyabhraka* remained in the *Pottali* after the first extraction, the *Pottali* was submerged in pure water overnight to maximize the yield. The following day, the water was poured off, leaving behind the sedimented *Dhanyabhraka*. The decanted water was then heated for evaporation, followed by the sedimentation of additional *Dhanyabhraka*. This entire process was repeated 8 times to extract maximum *Dhanyabhraka*.[14] (Table 1 & 4)

C. *Abhraka Satva Patana*

The process began by weighing one-part *Dhanyabhraka* and one-fourth *Ashuddha Tankan* (raw borax), then grinding them into a fine powder using *a Kharala* (mortar). *Musli Swarasa* (juice of *Chlorophytum borivilianum*) was added to the mixture as a *Bhavana Dravya* (wet grinding agent), and the paste was continuously ground until the juice was completely absorbed. The resulting mixture was shaped into balls and dried. These dried balls were placed in a *Vajra Musa* (crucible) and heated in an *Aangar Koshthi* (charcoal furnace) capable of reaching temperatures of up to 1500°C until the mixture had completely melted. Subsequently, the crucible was left to cool down. The following day, the crucible was broken, and small globules of *Abhraka Satva* were collected from the black slag.[15] (Table 5 & 6)

Pindikarana was performed by heating small globules of *Abhraka Satva* in an electric furnace until they reached a molten stage. After cooling, a coin-shaped *Pindita Satva* was obtained.

Churnikaran[16] (powdering) was performed by heating *Pindita Satva* until red-hot, then quenching it repeatedly in liquid media, followed by pounding in a *Khalva Yantra* and sieving.

A plate showing the whole process of *Abhraka Satva Patana* is pictured in Fig.1

Analytical Study

Various samples of *Abhraka* (raw *Abhraka*, *Shuddha Abhraka, Dhanyabhraka*) and *Shodhana* media *(Gou-Dugdha)* were subjected to physicochemical analysis such as pH,[17] specific gravity,[18] total solid content,[19] loss on drying,[20] ash value,[21] acid-insoluble ash,[22] and loss on ignition.[23] as per the standards of Ayurvedic Pharmacopoeia of India (API) at the institutional chemistry laboratory. (Table 7,8 & 9) Sophisticated instrumental analysis was conducted at S.A.I.F - I.I.T-Bombay. For elemental analysis, inductively coupled plasma-atomic emission spectroscopy (ICP-AES) was performed on samples of raw *Abhraka*, *Shuddha Abhraka, Dhanyabhraka*, and *Abhraka Satva* (Table 10). For compositional analysis, X-ray Diffraction (XRD) was performed on powdered *Abhraka Satva* using an EMPYREAN Diffractometer system equipped with a copper anode. The system operated at a generator voltage of 45 kV and a tube current of 40 mA, utilizing CuKα radiation (λ = 1.540598 Å), and the pattern was recorded with a continuous scan; gonio scan range 2 theta from 4.9872-99.00002 degrees, at the rate of scan, scan step size 0.026261 degree per 31.365 seconds, at a temperature of 45˚C. (Table 11 and Fig. 3).

Results:

A total of 8.5 kg of prepared *Anna* and 25.5 liters of water were used for the process. The entire duration of the activity was 30 days, resulting in a final yield of 22.5 liters of *Sandhan Dravya*. As shown in Table 1.

(Table 1) Results obtained during the preparation of *Kanji* for *Dhanyabhrikarana*

Sr. No.	Parameters	Results
1.	Prepared *Anna* (Kg)	8.5
2.	Water (*l*)	25.5
3.	Total duration (days)	30
4.	Final yield of *Sandhan Dravya* (*l*)	22.5

During the *Shodhana* process, Batch 1 reached the red-hot stage in 22.00 minutes with an average soaking time (*Nirvapa*) of 6.14 minutes; the weight of *Abhraka* reduced from 1500 g before *Shodhana* to 1101 g after the 7th *Nirvapa*, resulting in a 26.6% loss. Batch 2 took 22.43 minutes to reach the red-hot stage and had a 6.04-minute soaking time, with a weight decrease from 500 g to 496 g (0.8% loss). For Batch 3, the red-hot stage was reached in 35.43 minutes with a 5.28-minute soak, and the weight dropped from 1000 g to 994 g, corresponding to a 0.6% loss. Lastly, Batch 4 required 42.57 minutes for the red-hot stage and 6.28 minutes for soaking, with the *Abhraka* weight going from 2000 g to 1946 g, which is a 2.7% loss. As shown in Table 2.

(Table 2) Observations and Results during *Shodhana*

Batch	Avg. duration to achieve red hot stage (min)	Avg. soaking time (*Nirvapa*) (min)	Weight of *Abhraka* (gm)	
			Before *Shodhana*	After *Shodhana* (7th *Nirvapa*)
Batch 1	22.00	6.14	1500	1101
Batch 2	22.43	6.04	500	496
Batch 3	35.43	5.28	1000	994
Batch 4	42.57	6.28	2000	1946

During the *Shodhana* process using milk as the medium, a progressive decrease in volume was observed after the seventh *Nirvapa* was completed. In Batch 1, the milk volume decreased from 3,000 ml to 1,746 ml, resulting in a 48% reduction. Batch 2, which initially contained 1,500 ml, retained 1,064 ml at the end, reflecting a 29.7% loss. Similarly, Batch 3 decreased from 2,000 ml to 1,288 ml, showing a reduction of 35.6%. For Batch 4, the volume dropped from 4,000 ml to 2,105 ml, corresponding to a 47.3% loss. As shown in Table 3.

(Table 3) Result of *Shodhana* Media

Batch	Avg. volume of milk (ml)		
	Initial	Final (after 7th *Nirvapa*)	% of loss
Batch 1	3000	1746	48
Batch 2	1500	1064	29.7
Batch 3	2000	1288	35.6
Batch 4	4000	2105	47.3

In the preparation of *Dhanyabhraka*, 4537 g of *Shodhita Abhraka* was utilized along with 1134 g of *Shali Dhanya* and 20 liters of *Kanji* as the fermentation medium. Upon completion of the process, the yield of *Dhanyabhraka* obtained was 4394 g, indicating a net loss of 143 g during the procedure. As shown in Table 4.

(Table 4) Parameters and results of *Dhanyabhraka*

Sr. No.	Parameters	Results
1.	*Shodhita Abhraka* (gm)	4537
2.	*Shali Dhanya* (gm)	1134
3.	*Kanji* (l)	20
4.	*Dhanyabhraka* yield(gm)	4394
5.	Loss (gm)	143

During the process of *Abhraka Satva Patana*, a total of 500 g of *Musli Swarasa Bhavita Dhanyabhraka* balls were subjected to the procedure, which required approximately 6 hours to complete. At the end of the process, 13 g of *Satva* was successfully obtained, corresponding to a yield of 2.6%. As shown in Table 5.

(Table 5) Observation of *Abhraka Satva Patana*

Sr.no	Ingredient	Quantity
1.	Weight of Balls (gm)	500
2.	Total time in *Satva Patana* (hr)	6
3.	Weight of *Satva* (gm)	13
4.	Percentage of *Satva* (%)	2.6

In the process of *Abhraka Satva Patana*, during initial heating, the odor of *Kanji* disappears by 700 °C, followed by progressive reddening of the *Musa* and its contents up to 1000 °C. Beyond 1100 °C, the material transitioned from semi-liquid to complete melting at 1150 °C, after which the crucible was left for overnight self-cooling. As shown in Table 6 and Fig. 2

(Table 6) Temperature Pattern and Observations of *Abhraka Satva*

me (min.)	Temp (°C)	Observations
00	100	Heating was started.
30	500	The burning smell of *Kanji* started coming out.
60	700	The burning smell of *Kanji* gradually decreased and stopped coming out.
90	800	The bottom part of *Musa* started to get red hot
120	1000	The whole *Musa* got red hot.
150	1050	The material inside the *Musa* started to get red hot.
180	1085	The material inside the *Musa* got red hot.
210	1100	The material started to melt down.
240	1115	The mixture became semi-liquid
270	1125	The mixture is still in a semi-liquid state.
300	1150	The mixture is still in a semi-liquid state.
330	1150	The mixture completely melts down.
360	1150	The mixture completely melted, and Musa was left in Koshthi overnight for self-cooling.

Organoleptic evaluation showed progressive changes across samples: *Ashuddha Abhraka* (AA) is described as having a *Pashanavata* or stone-like, non-metallic, dull sound with a smooth, hard texture and shiny, large foliated flakes; *Shodhita Abhraka* (SA) produces a comparatively dull sound, feels rough, and appears as smaller, less shiny, blacker foliated lumps with a burnt milk odor; *Dhanyabhraka* (DA) is rough, powdery, dull black with brownish-orange hues, and has a fermentative smell; *Abhraka Satva* (AS) emits a metallic sound, is hard and rough, and exhibits a dark grey color with a silvery tint. As shown in Table 7.

(Table 7) Organoleptic characters of various samples

Sample	Shabda (Sound)	Sparsha (Touch)	Rupa (Appearance)	Rasa (Taste)	Gandha (Odor)
AA	Non-metallic, dull node	Smooth, hard	Shiny, foliated, large flakes	NA	N/A
SA	Comparatively dull node	Rough	Foliated smaller lumps/powder, less shiny, blacker	NA	Burnt milk
DA	-	Rough	Powder, less shiny, dull black with brownish-orangish tint	NA	Fermentative
AS	Metallic sound	Hard and rough	Dark grey with silvery tint	N/A	N/A

In *Kanji*, pH, specific gravity, and total solids increased from 2.56, 0.952, and 2.256% to 3.97, 1.005, and 2.890% respectively, after processing. Similarly, *Gou Dugdha* (milk) showed a rise in pH (6.39 to 6.92), specific gravity (1.030 to 1.056), and total solids (13.10% to 15.98%) after the 7th *Nirvapa*. As shown in Table 8.

(Table 8) Analytical Results of *Kanji* and *Gou Dugdha*

Sample		pH	Specific gravity	Total solid conten
Kanji	Before	2.56	0.952	2.256
	After	3.97	1.005	2.890
Gou Dugdha	Raw milk	6.39	1.030	13.10
	After 7th Nirvapa	6.92	1.056	15.98

The physicochemical analysis of different *Abhraka* samples revealed notable variations across successive processing stages. Raw *Abhraka* (RA) showed a loss on drying of 0.06%, an ash value of 96.98%, acid-insoluble ash at 42.55%, and a loss on ignition of 0.50%, with a pH range of 7–8 in 10% aqueous suspension. After *Shodhana* (SA), the loss on drying marginally increased to 0.09%, while the ash value rose substantially to 99.33%. The acid-insoluble ash was reduced to 32.05%, and the loss on ignition decreased to 0.24%, with the pH stabilizing at 7. In contrast, *Dhanyabhraka* (DA) presented a loss on drying of 0.08% and an ash value of 82.96%. In contrast, its acid-insoluble ash and loss on ignition values were 38.24% and 0.29% respectively, maintaining a neutral pH of 7. As shown in Table 9.

(Table 9) Results of physicochemical parameters of *Abhraka*

Loss on drying (%)	Ash value (%)	Acid insoluble ash (%)	Loss on ignition (%)	pH (10% suspension in DW)
0.06	96.98	4	0.50	7-8
0.09	99.33	32.05	0.24	7
0.08	82.96	3.24	0.29	7

Ferrosilite ($Fe^{2+}{}_2Si_2O_6$)	30.82 (100)	2.9008	27.73 (83.28)	3.2175	29.95 (74.93)
Kirschsteinite [$CaFe^{2+}(SiO_4)$]	34.50 (100)	2.5983	30.35 (70.87)	2.9441	33.49 (65.94)
Almandine [$Fe^{2+}{}_3Al_2(SiO_4)_3$]	34.77 (100)	2.5802	60 (42.44)	1.5420	31 (37.89)
Clinoferrosilite ($Fe^{2+}{}_2Si_2O_6$)	29.53 (100)	3.0253	19.25 (37.12)	4.6116	27.74 (34.20)
Pyroxferroite ($Fe^{2+}SiO_3$)	33.59 (100)	2.6681	30.30 (84.33)	2.9501	30.41 (51.82)
Kyanite (Al_2OSiO_4)	26.61 (100)	3.3541	46.27 (79.02)	1.9629	47.10 (78.77)
Boracite ($Mg_3B_7O_{13}Cl$)	29.62 (100)	3.0158	25.55 (57)	3.4804	42.37 (44.21)
Jacobsite ($Mn^{2+}Fe^{3+}{}_2O_4$)	35.32 (100)	2.5414	62.31	1.4901	29.98 (35.90)
Leucite $K(AlSi_2O_6)$	20.46 (100)	4.5649	28.86 (64.23)	3.2045	31.12 (50.24)

The ICP-AES analysis revealed compositional changes in *Abhraka* samples across different processing stages. Raw *Abhraka* contained Fe 12.65%, Al 1.76%, Si 14.32%, K 5.22%, and Mg 0.74%. Following *Shodhana* (SA), values were reduced to Fe 11.55%, Al 0.92%, Si 13.98%, K 4.54%, and Mg 0.52%. *Dhanyabhraka* (DA) showed further reductions with Fe 9.89%, Al 0.56%, Si 13.59%, K 3.42%, and Mg 0.89%. In contrast, the final *Abhraka Satva* (AS) demonstrated a drastic shift, being enriched with Fe (77.07%) and trace Boron (0.354%), while other elements such as Al, Si, and Mg were nearly eliminated. As shown in Table 10.

(Table 10) Result obtained from ICP-AES analysis

Sample	B %	Fe %	Al %	Si %	K%	Mg%
RA	-	12.654	1.757	14.317	5.224	0.739
SA	-	11.545	0.924	13.982	4.543	0.523
DA	-	9.896	0.561	13.588	3.422	0.894
AS	0.354	77.07	0.184	0.608		

Powder XRD diffraction data of *Abhraka Satva*, compared to authenticated databases such as RRUFF, NBS (National Bureau of Standards), and the American Mineralogist Crystal Structure Database (AMCSD), is illustrated in Table 11.

(Table 11) Comparison of three most intense peaks of *Abhraka Satva* and probable reference standards

...rence ...rd	*Abhraka satva* and reference standard					
	d1		*d2*		*d3*	
	Pos. [°2θ]	*d*-spacing [Å]	Pos. [°2θ]	*d*-spacing [Å]	Pos. [°2θ]	*d*-spacing [Å]
	Abhraka Stava					
	26.5313 (100)	3.35970	35.3448 (11.18)	2.53953	29.3719 (6.78)	3.04092
	Reference standard					
...etite (...$_2O_4$)	35.51 (100)	2.5315	62.61 (41.80)	1.4842	30.16 (28.10)	2.9685
(Fe_2O_3)	33.21 (100)	2.7009	35.69 (73.67)	2.5183	54.11 (45.43)	1.6955
(CFe_3**)**	45.02 (100)	2.0138	43.76 (64.44)	1.8530	49.17 (54.58)	1.8530
...ite ...iO_4)]	35.92 (100)	2.5002	31.64 (92.07)	2.8276	34.98 (65.11)	2.5648

Discussion:

Acharya Nagarjuna was the first to describe the *Abhraka Satva Patana* process in *Rasendra Mangala*.[24] Furthermore, it has been referenced in other classical texts, such as *Anandkand*, *Rasarnava*, *Rasa Hridaya Tantra*, *Rasendra Chudamani*, *Rasa Rātna Samūcchaya*, and *Rasa Tarangini*.

In the current study, 5 kg of *Abhraka* was taken for *Shodhana*, resulting in a weight loss of 9.26% in *Gou-Dugdha* and 2.86% in *Dhanyabhrikarana*. The reason for this weight loss is the reduction in the particle size and solubility of specific compounds. During the *Shodhana* process, a characteristic burnt smell was noted due to the burning of casein protein found in *Gou-Dugdha*.

The *Pindita Satva* was repeatedly immersed in liquid media for *Churnikaran*, resulting in a greyish-brown powder due to oxidation.

The *Satva* obtained in the current study is similar to *the Lohanibha* and *Mruta Lauha* (like iron), as described in ancient texts. It is attracted to magnet and has metallic, lustrous, malleable, and heavy properties, with a metallic luster and sound. It likely has a medium carbon content, allowing for the replacement of soluble and free graphitic carbon through carbonization, de-carbonization, nitriding, and cyaniding using medicated carbon compounds. Subsequent processes such as *Satva Mrudu Karana* (softening of essence), *Satva Shodhana* (purification of essence), *Satva Marana* (incineration of essence), and post-*Marana* treatments like *Amrutikarana* (remove trace impurities) and *Lohitikarana* (regain lost colour) may significantly alter the formed organo-inorganic compounds in the derived formulation, thus expanding its therapeutic arena.

The balls of *Satva* are non-magnetic, light in weight, greyish-white, and spherical. They are softer and lighter in weight with less luster, and may be considered as *Kacha* (slag). This suggests a reaction of molten *Kacha Satva* with silicate, resulting in the formation of borosilicate, as per the XRD results. Therefore, the silvery balls may contain significant amounts of boron. *Kacha Satva* may be considered as a potassium borate with a small quantity of aluminium borate, as aluminium borates have a melting point in the range of 1050°C-1400°C. Potassium borate has a significantly lower melting temperature (950 °C).

In the present study, the average yield of *Satva* from 500 g of *Dhanyabhraka* was 2.6% without the repetition of *Dhamana* (melting). Based on previous work [25], it has been found that a maximum of 10% yield can be achieved by repeating *Dhamana* with the same *Dhanyabhraka*. The quality of raw *Abhraka* is the primary factor contributing to variations in the yield of *Satva*. It is suggested that to acquire a good yield, a minimum of 3 times of *Dhamana* is required on the same *Dhanyabhraka,* followed by maintaining consistent temperature for 1 hour, as it provides more sources of carbon that aid in proper reduction.

The organoleptic features resemble the accepted variety of *Abhraka* as per the classics and the Ayurvedic Pharmacopoeia of India. Biotite is acceptable if it contains a minimum of 6% iron, 5% aluminium, 9% magnesium, and 5% potassium.[26]

There was an overall increase in pH, specific gravity, and total solid content of *Gou Dugdha* and *Kanji* after *Nirvapa* (quenching) and *Dhanyabhrikarana*, respectively. This indicates that alkaline elements from biotite were leached into the liquid media, partially neutralizing *kanji*. This is supported by the increase in specific gravity and total solid content due to the addition of particles and the water-soluble portion of *Abhraka* and *Shuddha Abhraka*.

The acid digestion method was employed to prepare the samples for ICP-AES analysis. Fe, Al, Si, and K contents decreased successively from their levels in Raw *Abhraka*, further reducing after *Shodhana* and even more after *Dhanyabhrikarana*. This indicates the leaching of elements owing to weathering and the formation of surface oxides and hydroxides. The elemental composition was found to be 77.07% iron, 0.184% aluminium, 0.608% silicon, and 0.354% boron.

The iron content of *Satva* in the present study was found to be 77.07%, significantly lower than that reported in a previous study (98.2%). This discrepancy may be attributed to the lower iron content of the raw sample.

The X-ray diffraction pattern of *Abhraka Satva* reveals three characteristic reflections at 26.53° 2θ (d = 3.360 Å, 100% relative intensity), 35.34° 2θ (d = 2.540 Å, 11.18%), and 29.37° 2θ (d = 3.041 Å, 6.78%). Comparison with standard mineral phases shows that the principal peak at 3.360 Å closely corresponds to the primary reflection of kyanite (Al_2OSiO_4), which has a d-spacing of 3.354 Å (difference: 0.006 Å). The second peak at 2.540 Å matches excellently with jacobsite ($Mn^{2+}Fe^{3+}{}_2O_4$) at 2.541 Å (difference: 0.002 Å), as well as with magnetite ($Fe^{2+}Fe^{3+}{}_2O_4$) at 2.531 Å (0.008 Å) and hematite (Fe_2O_3) at 2.518 Å (0.021 Å). Additional matches for this peak include fayalite [$Fe^{2+}{}_2(SiO_4)$] reflections at 2.565 Å (0.025 Å) and 2.500 Å (0.039 Å). The third, lower-intensity peak at 3.041 Å aligns with boracite ($Mg_3B_7O_{13}Cl$) at 3.016 Å (0.025 Å), Ferrosilite ($Fe^{2+}{}_2Si_2O_6$) at 2.983 Å (0.058 Å), jacobsite again at 2.980 Å (0.061 Å), and magnetite at 2.969 Å (0.072 Å). These correspondences indicate that *Abhraka Satva* contains a mixture of aluminum silicate phases, chiefly kyanite, as well as iron-rich phases such as magnetite, hematite, jacobsite, fayalite, and Ferrosilite, with minor boron-bearing boracite. The predominance of iron oxide phases (magnetite and hematite) reflects the high-temperature oxidation–reduction environment, while the kyanite signature indicates formation of high-temperature aluminum silicates. The presence of jacobsite suggests trace manganese incorporation, and the boracite match points to possible boron uptake. Relative intensities imply that the kyanite-like phase dominates, whereas secondary phases are present as smaller crystallites or preferentially oriented grains.

Conclusion

The study reveals that *Abhraka* were subjected to *Shodhana*, resulting in 9.26% weight loss in *Gou-Dugdha* and 2.86% after *Dhanyabhrikarana*. The yield of *Abhraka Satva* from 500 g of *Dhanyabhraka* was 13 g, which is 2.6%. The derived *Satva* resembled metallic characteristics such as magnetic, lustrous, malleable, and heavy. ICP-AES analysis confirmed that *Abhraka Satva* is predominantly composed of iron (77.07%) with traces of aluminium (0.184%), silicon (0.608%), and boron (0.354%), indicating element leaching due to weathering. In contrast, the XRD fingerprint demonstrates that *Abhraka Satva* contains predominantly kyanite-like aluminium silicate phases as the primary component, accompanied by multiple iron oxide phases including magnetite, hematite, and jacobsite, along with minor boron-containing minerals such as boracite. These findings enrich data for standardization and the analytical profile of *Abhraka Satva*.

Abbreviations: -

RA: - Raw *Abhraka*
SA: - *Shuddha Abhraka*
DA: - *Dhanyabhraka*
AS: - *Abhraka Satva*
ICP AES: - Inductively coupled plasma-atomic emission spectroscopy
XRD: - X-ray Diffraction
KB: - Ketjen Black

Acknowledgement: -

The author expresses gratitude to ITRA, Jamnagar, for materials and facilities. Special thanks to Mr. Parimal Patadia for his valuable guidance, the Department of Rasa Shastra & Bhaishajya Kalpana for their support, and to SAIF, IIT Bombay, for the instrumental analyses.

Fig.1 Methodology for Preparation of *Abhraka Satva*

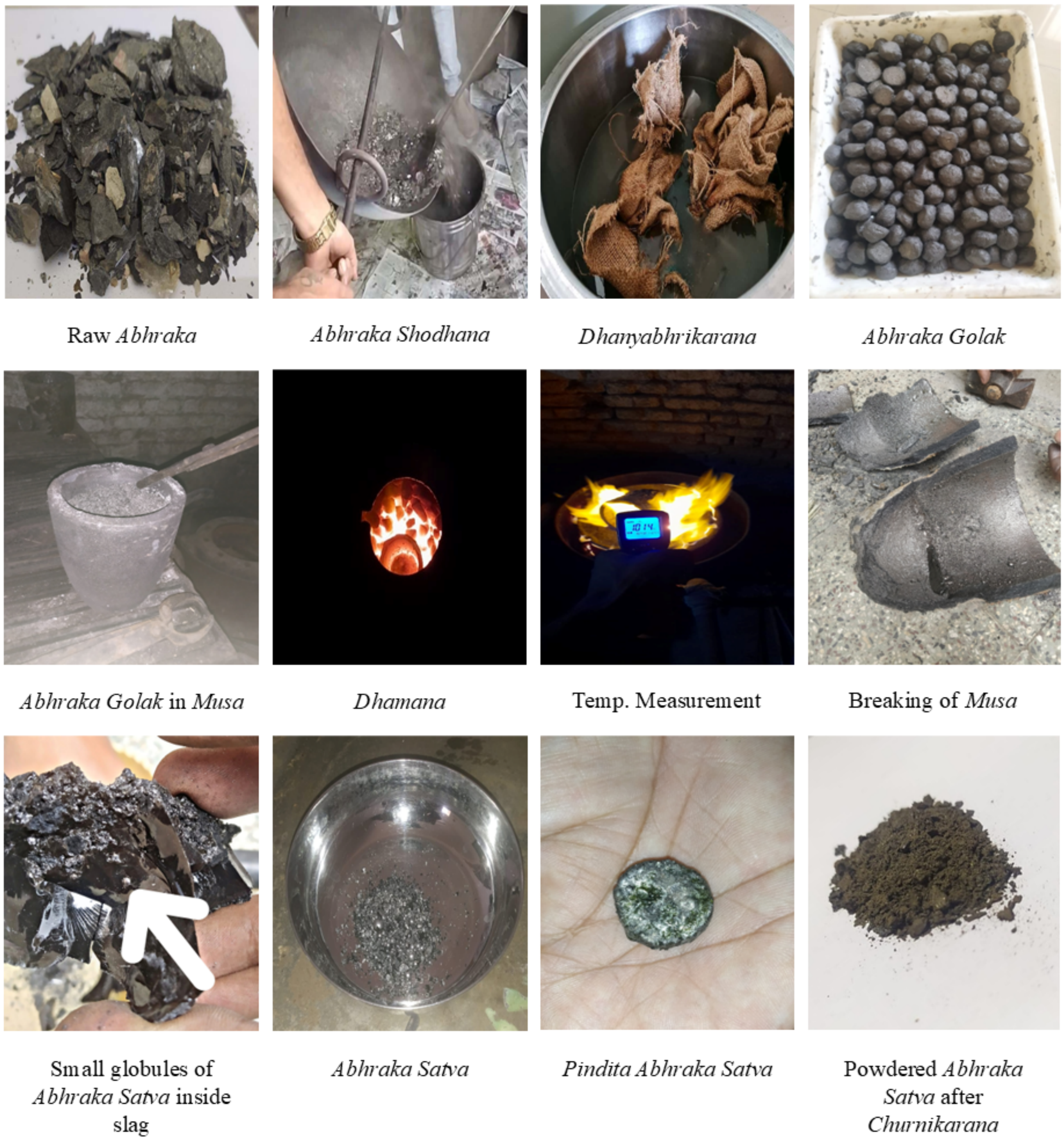


Fig 2. Temperature Pattern Graph

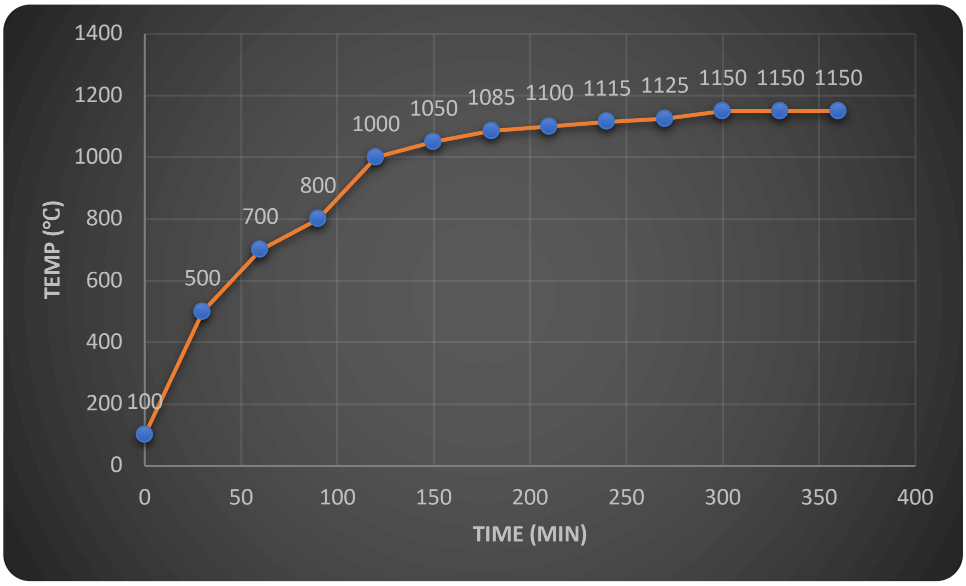
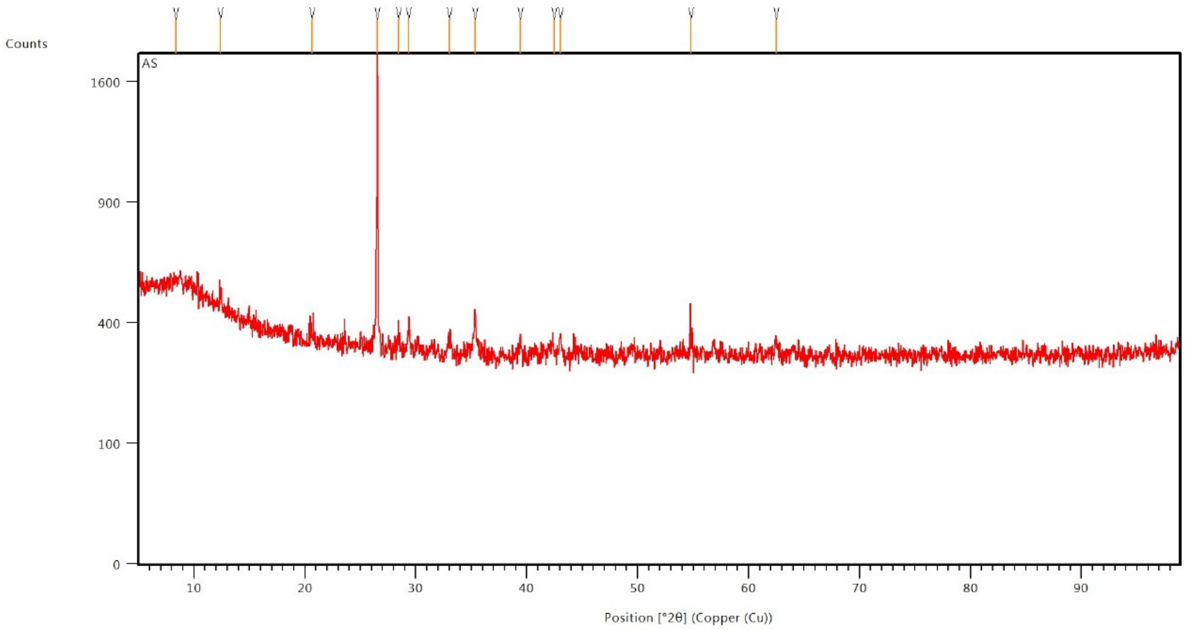


Fig 3. XRD pattern of *Abhraka Satva*



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