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EFFECT OF HEATING METHODS ON *BHASMA* W.S.R. TO *SPHATIKAMANI*: A COMPARATIVE STUDY OF *GAJAPUTA* AND ELECTRIC MUFFLE FURNACE

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ABSTRACT

Background: *Sphatikamani*, identified as quartz (SiO_2), is an important mineral described in Rasashastra. Owing to its high hardness and thermal stability, the incineration process requires sustained high-temperature heating. *Gajaputa* is employed for *Marana* (incineration), whereas the Electric Muffle Furnace (EMF) provides a controlled heating environment. **Objective:** To evaluate the effect of *Gajaputa* and EMF heating methods on the pharmaceutical characteristics of *Sphatikamani Bhasma*. **Materials and Methods:** *Sphatikamani* was purified and processed into *Bhasma* by incineration using purified sulphur and Juice of Citrus limon L. Two batches were prepared using *Gajaputa* and EMF, respectively. The pharmaceutical process was evaluated by recording temperature profile, duration of heating, fuel requirement, weight variation and yield. Analytical evaluation of the prepared *Bhasma* was carried out using XRD and SEM-EDS. **Results:** Both methods yielded *Sphatikamani Bhasma* meeting the classical parameters. *Gajaputa* reached 845–863°C using approximately 36 kg of cow dung cakes and yielded 172 g, whereas EMF operated at 850°C for 1 hour per *Putra* and yielded 179 g. Differences were observed in heating pattern, colour, *Chakrika* brittleness, process duration, and operational convenience. XRD confirmed stable α -quartz (SiO_2) as the major phase, while SEM-EDS showed comparable elemental composition, with RCBE exhibiting a smoother surface morphology than RCB. **Conclusion:** Both *Gajaputa* and EMF were suitable for the preparation of *Sphatikamani Bhasma*. The controlled heating profile of EMF supports its use as a suitable alternative to *Gajaputa*.

Keywords: Incineration, *Marana*, Rock crystal, Quartz

INTRODUCTION

Ayurveda, the ancient system of Indian medicine, emphasizes the maintenance of health and prevention of disease through a holistic approach involving *Ahara* (diet), *Vihara* (lifestyle), and therapeutic interventions. Among its specialized branches, Rasashastra has contributed significantly to the development of mineral and metallic preparations with enhanced therapeutic efficacy. The branch primarily deals with the processing, purification, and transformation of metals, minerals, and gemstones into pharmaceutically suitable forms through various procedures such as *Shodhana* (purification), *Bhavana* (levigation), and *Marana* (incineration). These processes are intended to reduce toxicity, enhance bioavailability, and convert inorganic substances into therapeutically acceptable formulations.

Sphatikamani is an important mineral described under *Ratna*, *Uparatna* and *Kshudra Ratna* categories in Ayurvedic classical texts. It is indicated in the management of conditions such as *Jvara* (fever), *Daha* (burning sensation), *Raktapitta* (bleeding disorder), *Urahkshata* (thoracic trauma), *Raktavamana* (vomitus with blood), *Vishaprakopa* (poisoning), and *Raktastrava* (haemolacria), after appropriate pharmaceutical processing into *Bhasma*. In Rasa Ratna Samuchchaya, Prof. Dattatreya Anant Kulkarni, connects *Sphatikamani* to Rock crystal and also mentions that it can be different colours due to trace elements in it. Here, Rock crystal used for *Marana* is one of the hardest naturally occurring minerals, possessing a Mohs hardness of 7 and a stable crystalline structure. These inherent physicochemical properties make it resistant to mechanical size reduction and thermal transformation, necessitating repeated levigation and high-temperature incineration process to obtain a pharmaceutically acceptable *Bhasma*.

Gajaputa is a classical heating method used for *Marana* of mineral and metallic substances, wherein *Sharavasamputa* is subjected to sustained heat generated by cow dung cakes. Although it follows traditional pharmaceutical principles, variations in fuel quantity, environmental conditions, and manual operation may affect thermal reproducibility. The Electric Muffle Furnace (EMF) provides controlled and uniform heating with precise temperature regulation. Both methods aim to achieve the required thermal transformation during incineration; however, they differ in heat generation, temperature control, and operational reproducibility. Hence, evaluation of *Gajaputa* and EMF is essential to assess their influence on the pharmaceutical and analytical characterization of *Sphatikamani Bhasma*.

MATERIALS AND METHODS

The study involved the procurement of raw materials followed by the preparation of *Sphatikamani Bhasma* (incinerated Rock crystal). The complete pharmaceutical procedure, encompassing purification and incineration, was performed. Analytical evaluation of the prepared *Bhasma* was carried out using XRD and SEM-EDS to assess the mineralogical characteristics, surface morphology, and elemental composition of the prepared *Bhasma*.

1. Procurement and authentication of the raw material

All the raw materials were procured and used for the incineration of *Sphatikamani* after proper identification and authentication. For that, Rock crystal was procured from authentic gem traders from the market of Khambhat, Gujarat. Neel Gem's Testing Laboratory" [ISO (9001-2008) certified], Ahmedabad, Gujarat has identified and certified the sample as Rock crystal.

Fresh lemon and cow urine were procured from the local market of Vadodara. *Gandhaka* (Sulphur) was procured from the Government Ayurved Pharmacy, Vadodara, Gujarat.

2. Preparation of drug

Sphatikamani Bhasma was prepared through *Gajaputa* (RCB) and EMF (RCBE) methods following *Sphatikamani Shodhana* (RCS). The entire pharmaceutical study was carried out at the Pharmaceutical Laboratory of the Upgraded Department of Rasashastra and Bhaishajya Kalpana, Government Ayurved College, Vadodara, Gujarat, under the following headings.

2.1. *Sphatikamani Shodhana* (RCS)

Purification of *Sphatikamani* was done on the principle of boiling, using cow urine (1 part), Juice of Citrus limon L. (1/8th part), Alkali of Hordeum vulgare L. (1/40th part) and Alkali of Fagonia cretica L. (1/40th part) as liquid media. 350 g of the material, which was bundled and suspended in a s.s. vessel containing a mixture of cow urine (1 part - 1200 ml), Juice of Citrus limon L. (1/8th part - 150 ml), Alkali of Hordeum vulgare L. (1/40th part - 29 g) and Alkali of Fagonia cretica L. The materials were boiled in prepared liquid media for 6 hours. After that, the material was washed with hot water and kept for drying. (Figure 1)

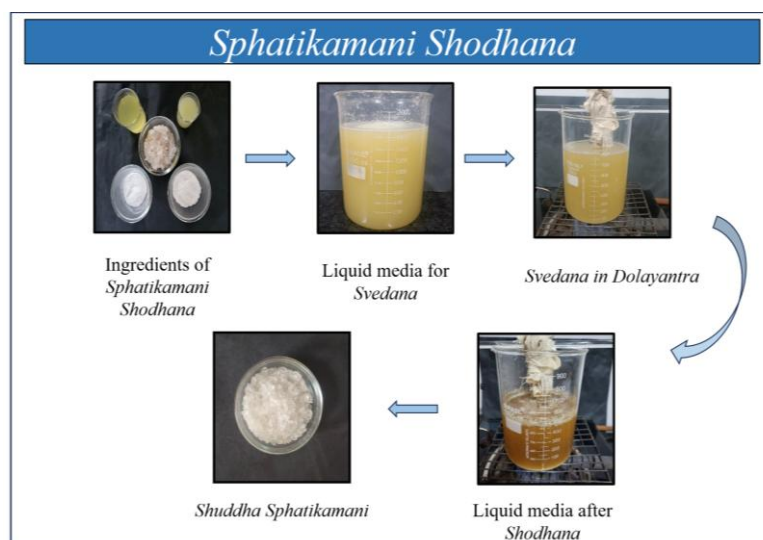


Figure 1. Preparation of *Sphatikamani Shodhana*

2.2. *Sphatikamani Bhasma* (RCB) prepared by *Gajaputa* method

Purified Rock crystal and purified sulphur were taken in equal quantity, each weighing 150 g. The materials were mixed, followed by the addition of juice of Citrus limon L. and continuous levigation for 12 hrs. After completion of levigation, pellets of 2 *Tola* (~24 g) were made, which were weighed and dried in the sunlight. Dried pellets were weighed again and arranged in one layer in an earthen saucer. *Sharavasamputa* was prepared using a clay-smeared cotton cloth and left to dry in the sunlight. After drying, the material was subjected to *Gajaputa*. Following self-cooling, the incinerated material was collected and triturated again. The same procedure was repeated six additional times, with the incorporation of purified sulphur after each *Putra*. After completion of the required number of *Putra* cycles, the obtained *Bhasma* was finely powdered, passed through a sieve, weighed, labelled, and stored in an airtight container for further analysis (Figures 2 and 3).

2.3. *Sphatikamani Bhasma* (RCBE) prepared by EMF method

The procedure up to *Sharavasamputa* drying was carried out as described for the *Gajaputa* method. After drying, it was subjected to incineration in EMF at 850°C for one hour. After self-cooling, the material was collected and ground again. This process was repeated six additional times, incorporating 150 g of purified sulphur after each *Putra*. Finally, the *Bhasma* was ground to a fine powder, sieved, weighed, labelled, and stored in an airtight container. (Figure 2 and 3).

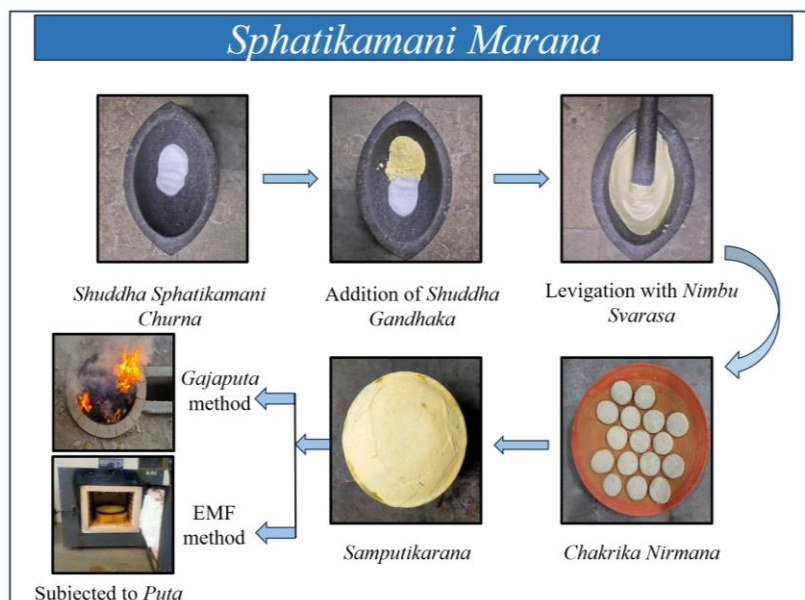


Figure 2. Preparation of *Sphatikamani Marana*

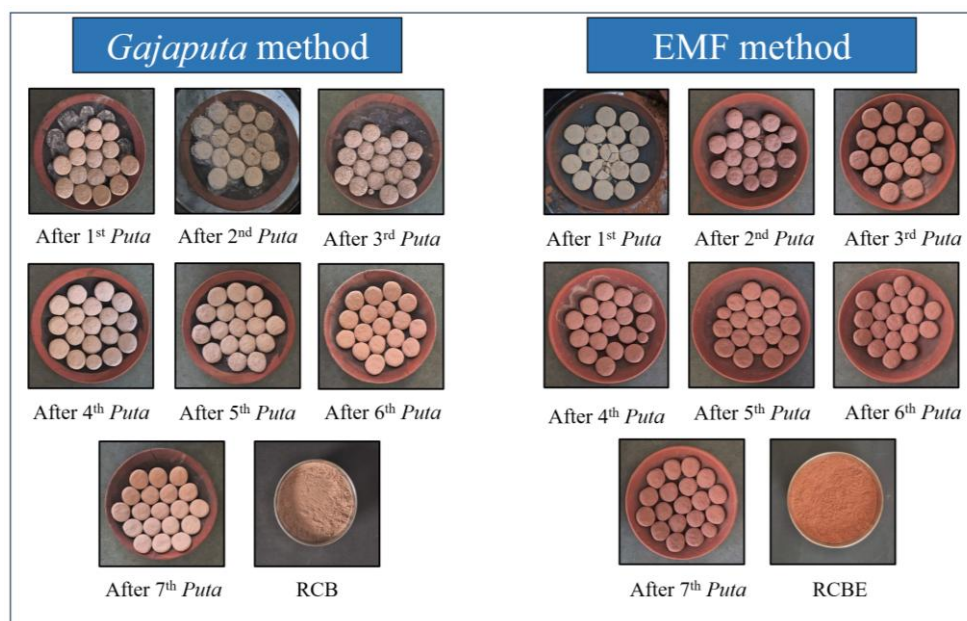


Figure 3. Preparation of *Sphatikamani Bhasma*

3. Sophisticated instrumental techniques

X-Ray Diffraction (XRD) and Scanning Electron Microscope with Energy Dispersive Spectroscopy (SEM with EDS) analysis were conducted at Analytical and Environmental Science Division and Centralized Instrument Facility (AESD&CIF), Central Salt & Marine Chemicals Research Institute (CSMCRI), Bhavnagar, Gujarat.

RESULT

Purification of 350 g of raw Rock crystal was completed over 2 days using a total of 1330 ml of liquid media. The process yielded 343 g of purified Rose quartz, corresponding to a 98 % recovery, with an overall weight loss of 7 g (2 %), mainly due to the loss of fine particles during processing.

The pharmaceutical observations recorded during the preparation of *Sphatikamani Bhasma* by the *Gajaputa* and EMF methods were recorded. The pharmaceutical parameters for *Gajaputa* method recorded during successive *Putra* were presented in table no. 1, while the corresponding changes in the physical characteristics of the pellets observed during the incineration process are summarized in table no. 2.

Table no. 1: Parameters of RCB

No. of <i>Putra</i>	Quantity of material (g)	Quantity of liquid media (ml)	Weight of <i>Chakrika</i> (g) Before <i>Putra</i> Wet	Weight of <i>Chakrika</i> (g) Before <i>Putra</i> Dry	Weight of <i>Chakrika</i> (g) After <i>Putra</i> After <i>Putra</i>	Loss (g)
1	300	170	377	331	158	142
2	308	195	385	330	162	146
3	312	220	403	354	164	148
4	314	245	424	362	165	149
5	315	260	430	389	167	148
6	317	290	431	392	170	147
7	320	310	453	412	172	148

Table no. 2: Parameters of RCB

No. of <i>Putra</i>	Colour of <i>Chakrika</i> Before	Colour of <i>Chakrika</i> After	Hardness	Number of <i>Chakrika</i>	Cow dung cakes Number	Cow dung cakes Weight (kg)
1	Light green	Brownish white	Brittle	16	320	36
2	Light brown	Brownish white	Brittle	16	317	36
3	Light brown	Pinkish white	Brittle	17	314	36
4	Light brown	Pinkish white	Brittle	18	318	36
5	Light brown	Pinkish white	Brittle	18	319	36
6	Light brown	Light pink	Brittle	18	321	36
7	Light brown	Light brown	Brittle	19	318	36

The pharmaceutical parameters recorded during successive *Putra* using the EMF method are presented in table no. 3, and the corresponding changes in the physical characteristics of the pellets observed during incineration are summarized in table no. 4.

Table no. 3: Parameters of RCB

No. of <i>Putā</i>	Quantity of material (g)	Quantity of liquid media (ml)	Weight of <i>Chakrika</i> (g) Before <i>Putā</i> Wet	Weight of <i>Chakrika</i> (g) Before <i>Putā</i> Dry	Weight of <i>Chakrika</i> (g) After <i>Putā</i> After <i>Putā</i>	Loss (g)
1	300	175	374	325	161	139
2	311	190	385	352	163	159
3	313	210	396	361	168	145
4	318	235	419	376	172	146
5	322	260	423	379	173	149
6	323	290	430	387	176	147
7	326	315	447	402	179	147

Table no. 4: Parameters of RCB

No. of <i>Putā</i>	Colour of <i>Chakrika</i> Before	Colour of <i>Chakrika</i> After	Hardness	Number of <i>Chakrika</i>
1	Light green	Light brown	Brittle	16
2	Light brown	Brownish pink	Brittle	16
3	Light brown	Reddish pink	Brittle	17
4	Light brown	Reddish pink	Brittle	18
5	Light brown	Reddish pink	Brittle	18
6	Light brown	Reddish pink	Brittle	18
7	Light brown	Reddish brown	Brittle	19

The *Gajaputa* method required 21 days for completion of the pharmaceutical process, whereas the EMF method required 28 days, including the self-cooling period after each heating cycle. During *Gajaputa*, the peak temperature ranged from 845°C to 863°C, reaching the maximum temperature within 2 h 15 min to 2 h 30 min. In contrast, the EMF method achieved a controlled temperature of 850°C, which was maintained for 1 hour during each *Putā*. The self-cooling duration in the EMF method was approximately 32 hours.

XRD report of RCB is tabulated in table no. 5.

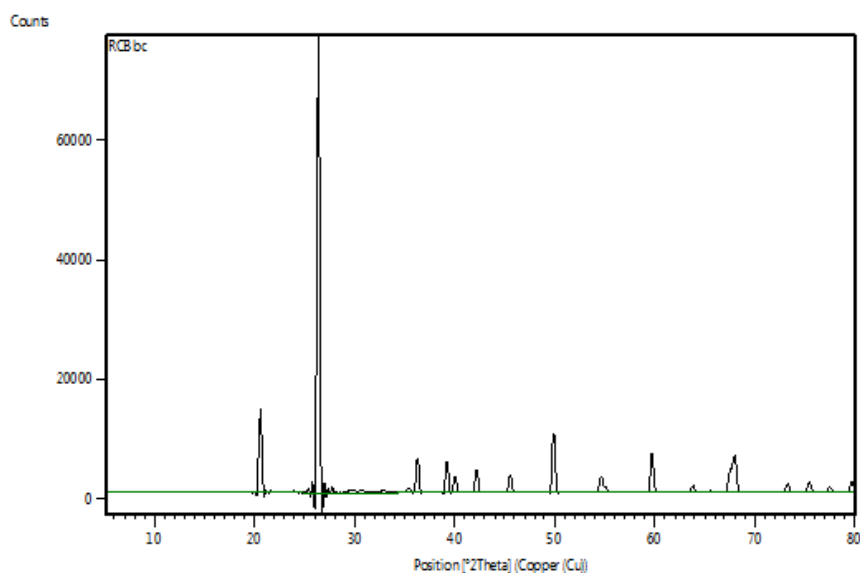
Table no. 5: peak list obtained in XRD of RCB

Pos. [°2Th.]	Height [cts]	FWHMLeft [°2Th.]	d-spacing [Å]	Rel. Int. [%]
20.0514	273.91	0.1791	4.42839	0.36
20.6038	14050.44	0.4349	4.31089	18.30
21.1353	290.53	0.2047	4.20366	0.38
25.0394	411.61	0.1791	3.55639	0.54
25.4462	787.99	0.2047	3.50045	1.03
25.8586	1394.31	0.1791	3.44555	1.82
26.3865	76759.81	0.4861	3.37780	100.00
26.9287	1579.87	0.1791	3.31101	2.06
27.3202	741.95	0.1791	3.26445	0.97

Pos. [°2Th.]	Height [cts]	FWHMLeft [°2Th.]	d-spacing [Å]	Rel. Int. [%]
27.7376	1049.07	0.2047	3.21626	1.37
30.7244	540.00	0.3582	2.91007	0.70
32.8283	593.51	0.3582	2.72822	0.77
35.3813	947.46	0.2814	2.53700	1.23
36.2942	5792.08	0.3838	2.47526	7.55
39.2252	5264.11	0.4093	2.29679	6.86
40.0810	2651.81	0.4093	2.24970	3.45
42.2024	3879.52	0.3838	2.14139	5.05
45.5510	2794.80	0.3838	1.99146	3.64
49.9109	10017.55	0.4093	1.82724	13.05
54.6444	2762.79	0.3326	1.67962	3.60
59.7546	6735.35	0.4093	1.54762	8.77
63.7927	1151.22	0.3582	1.45905	1.50
67.4835	3602.86	0.2558	1.38795	4.69
68.0477	6157.16	0.3838	1.37781	8.02
73.2921	1417.28	0.3838	1.29163	1.85
75.4259	1697.85	0.3838	1.26031	2.21
77.5249	776.08	0.3582	1.23135	1.01
79.6873	1857.20	0.4093	1.20328	2.42

Graphical peaks of RCB

Peak pattern obtained from XRD of RCB is presented in graph below. (Graph 1)



Graph no. 1: Graphical Peaks of RCB

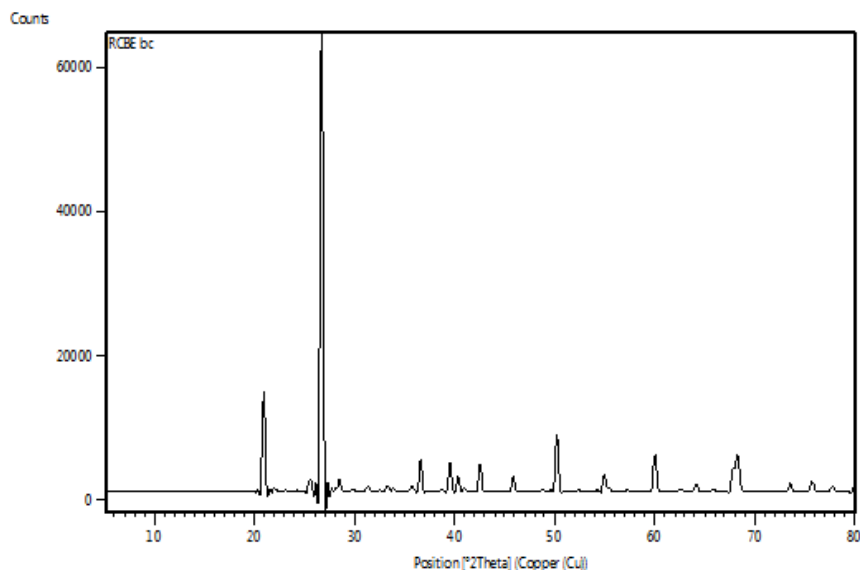
XRD report of RCBE is tabulated in table no. 6.

Table no. 6: peak list obtained in XRD of RCBE

Pos. [°2Th.]	Height [cts]	FWHMLeft [°2Th.]	d-spacing [Å]	Rel. Int. [%]
20.3772	308.22	0.1535	4.35831	0.48
20.9342	13720.25	0.4349	4.24359	21.37
21.4706	246.52	0.1791	4.13877	0.38
21.9226	541.85	0.2558	4.05446	0.84
25.4014	1500.11	0.2558	3.50652	2.34
25.7721	1215.49	0.2303	3.45691	1.89
26.2011	951.50	0.1791	3.40128	1.48
26.7200	64195.16	0.5117	3.33640	100.00
27.2485	1293.70	0.1791	3.27287	2.02
27.6669	910.27	0.1791	3.22432	1.42
28.4811	2195.51	0.2558	3.13397	3.42
31.2999	945.35	0.5117	2.85787	1.47
33.2465	1106.46	0.3070	2.69485	1.72
33.8700	723.63	0.2558	2.64666	1.13
35.6743	1073.37	0.3326	2.51683	1.67
36.6197	4730.42	0.3838	2.45400	7.37
39.5399	4135.46	0.3838	2.27923	6.44
40.3808	2193.21	0.3582	2.23369	3.42
42.5510	3830.13	0.3582	2.12465	5.97
45.8878	2189.77	0.3582	1.97763	3.41
50.2326	7736.63	0.4093	1.81629	12.05
54.9490	2343.80	0.3326	1.67103	3.65
60.0471	5158.54	0.4093	1.54078	8.04
64.0968	1031.01	0.3582	1.45286	1.61
67.7592	2806.34	0.2558	1.38297	4.37
68.3294	5029.72	0.3582	1.37282	7.84
73.5960	1158.84	0.3582	1.28705	1.81
75.6864	1382.58	0.3838	1.25662	2.15
77.7248	752.32	0.3582	1.22868	1.17

Graphical peaks of RCBE

Peak pattern obtained from XRD of RCBE is presented in graph below. (Graph 2)



Graph no. 2: Graphical Peaks of RCBE

SEM image and EDS peak pattern graphs were given in figures 4 and 5 for RCB and 6 and 7 for RCBE, respectively.

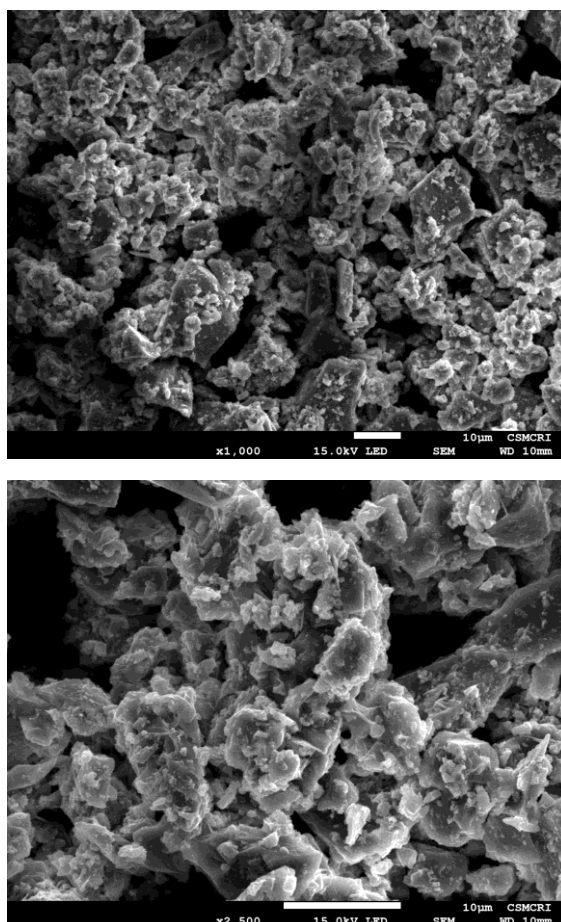


Figure 4: SEM Images of RCB

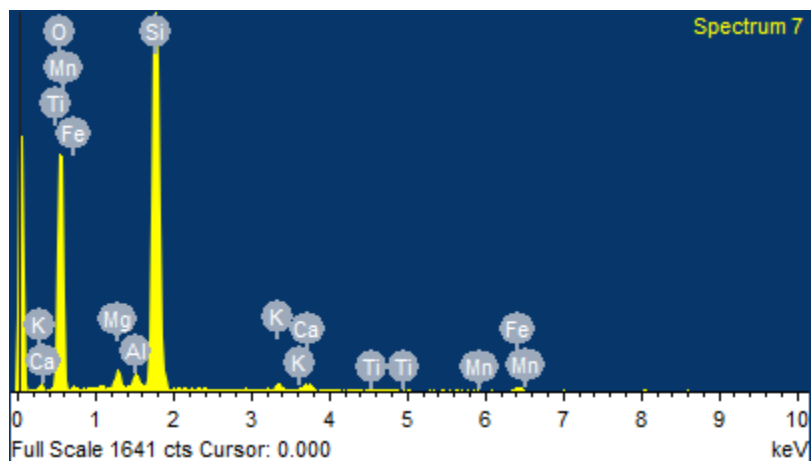


Figure 5: EDS Graph of RCB

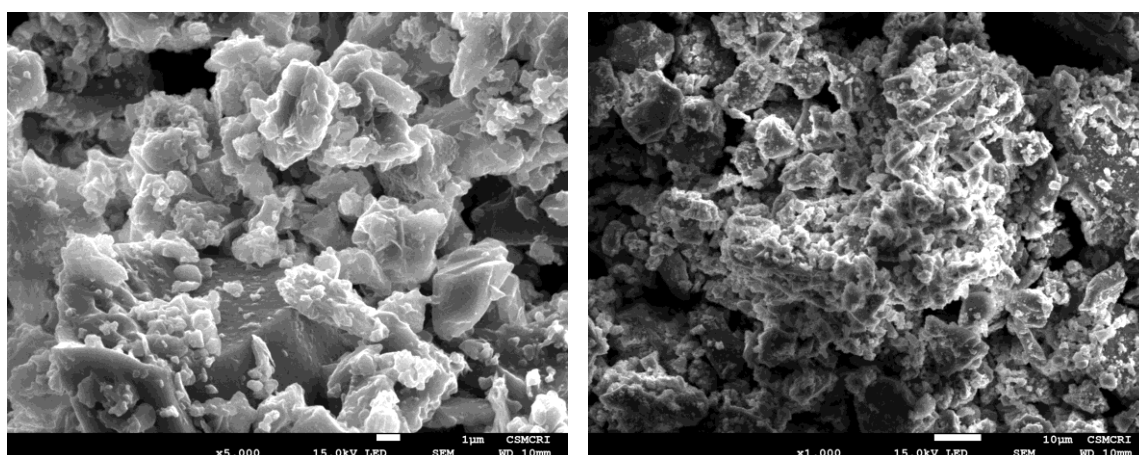


Figure 6: SEM Images of RCBE

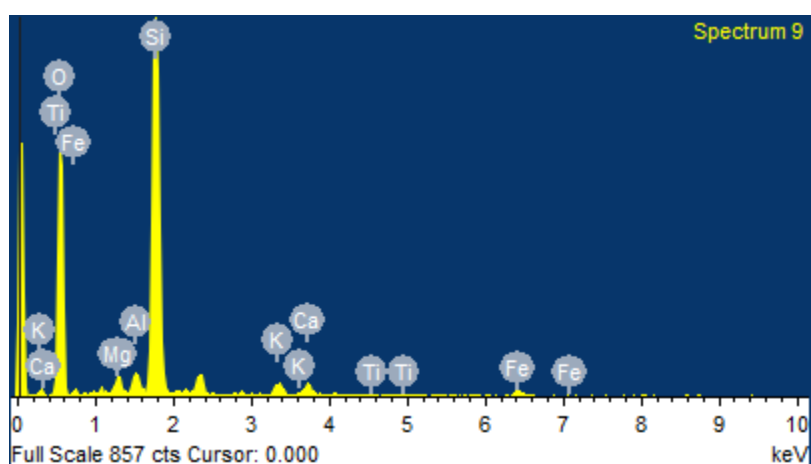


Figure 7: EDS Graph of RCBE

Results of EDS reports of RCB and RCBE are mentioned in table no. 7.

Table no. 7: Result of EDS reports of RCB and RCBE

Element	RCB Weight %	RCB Atomic %	RCBE Weight %	RCBE Atomic %
Si	35.87	25.45	34.36	24.74
O	56.55	70.44	55.07	69.59
Fe	2.37	0.85	3.54	1.28

Element	RCB Weight %	RCB Atomic %	RCBE Weight %	RCBE Atomic %
Mg	1.52	1.25	1.49	1.24
Ca	1.41	0.70	1.91	0.96
K	1.05	0.54	2.18	1.13
Al	0.88	0.65	1.37	1.03
Mn	0.20	0.07	0.00	0.00
Ti	0.14	0.06	0.08	0.03

DISCUSSION

The preparation of *Sphatikamani Bhasma* requires an adequate degree of heat because *Sphatikamani* possesses Mohs hardness of 7 and exhibits considerable thermal stability. The classical reference in Rasatantrasaar & Siddhaprayoga Sangraha recommends the use of *Gajaputa* for its *Marana*. Two batches of *Sphatikamani Marana* were conducted to assess the pharmaceutical procedure, including the appropriate temperature pattern and quantity of *Bhavana Dravya* required for the levigation of *Bhasma*. Among these, one batch was prepared using the *Gajaputa* method, while the other was processed through the EMF method.

Rationale for the selection of heating methods (*Gajaputa* and EMF) in the preparation of *Sphatikamani Bhasma*

Gajaputa was selected as a classical incineration method described in Rasashastra, while EMF was selected to provide controlled and uniform heating conditions. Both methods were used to evaluate their pharmaceutical outcomes during *Sphatikamani Bhasma* preparation.

Comparative studies between classical *Putra* and EMF methods have been conducted to assess the feasibility of controlled electric heating in *Bhasma* preparation. Pathiraja et al. compared traditional *Varaha Putra* and EMF methods for *Swarna Makshika Bhasma* preparation. The study showed comparable pharmaceutical and analytical characteristics in both methods, indicating that EMF can reproduce traditional heating conditions with better temperature control. Gautam et al. compared traditional *Putra* and EMF methods for *Naga Bhasma* preparation. Both methods resulted in lead sulphide formation; however, traditional *Putra* showed better homogeneity of the final product, indicating the influence of heating pattern on *Bhasma* characteristics. Similar to this study, the present work evaluates *Gajaputa* and EMF heating methods during *Sphatikamani Bhasma* preparation to assess whether controlled electrical heating can provide effective pharmaceutical outcomes to the classical *Putra* method. Two batches of Rock crystal *Bhasma* were prepared, one using *Gajaputa* (RCB) and the other an EMF (RCBE) method.

RCB prepared by *Gajaputa*

In this procedure, 150 g of *Shuddha Sphatikamani* was mixed with an equal quantity of purified sulphur and subjected to levigation with juice of Citrus limon L. for 12 hours. pellets of approximately 2 Tola (~24 g) were prepared. *Gajaputa* was given to the prepared *Sharavasamputa*. The quantity of cow dung cakes was adjusted to fill a *Gajaputa* of 27 × 27 × 27-inch dimensions, requiring 312 - 321 cow dung cakes with a total weight of approximately 36 kg. Brittleness of the pellets was observed after the initial *Putra*. *Varitaratva* was achieved after the 6th *Putra*. After 7 *Putra*, *Bhasma* attained *Rekhapurnatva*, *Varitaratva*, *Mridutva* and *Sukshma*,

all classical parameters. The prepared *Bhasma* exhibited a light brown colour in RCB. The final weight of RCB was 172 g.

Effect of Thermodynamic Laws on *Gajaputa*

The *Gajaputa* method also operates according to the First and Second Laws of Thermodynamics, where the energy of cow dung cakes is converted into thermal energy and transferred gradually to the *Sharavasamputa* and pellets. The gradual heating and prolonged natural cooling produced sustained thermal exposure, which likely enhanced the brittleness of the pellets and facilitated the formation of finer *Bhasma*. (Figure 8)

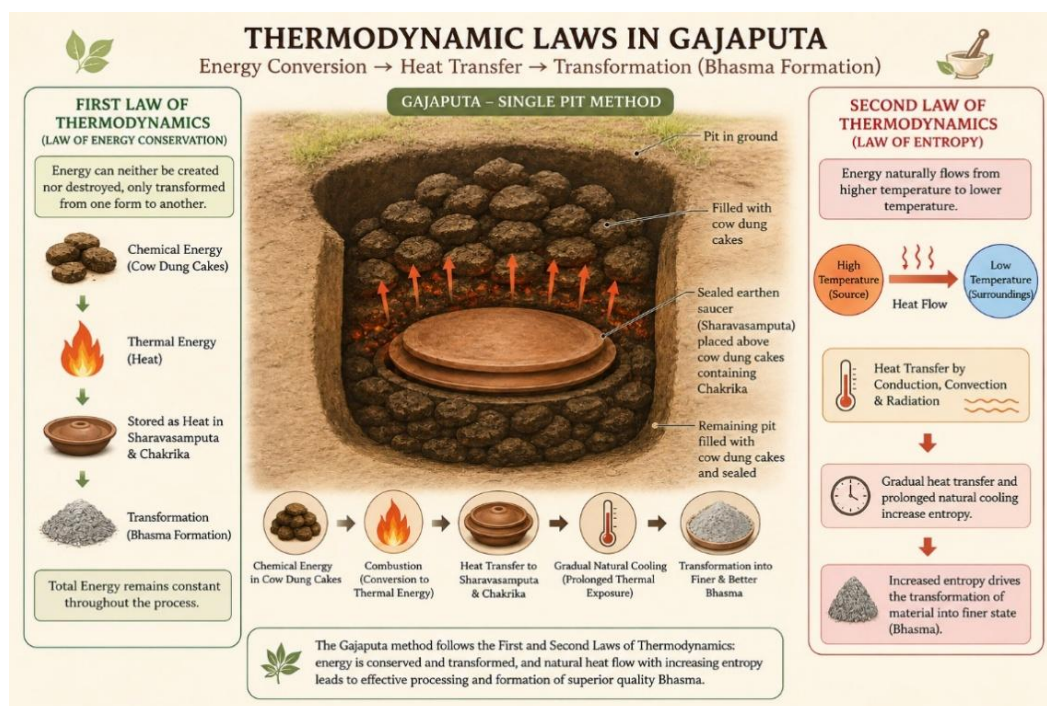


Figure 8

Role of *Gajaputa* in incineration

The temperature profile observed during *Gajaputa* in the present study showed gradual heating with a peak temperature range of 860 - 894°C, followed by slow cooling. Similar characteristics of the traditional *Puta* process have been reported by Ganesh Kumar et al. that the temperature and pressure profile of Pudam during the preparation of Siddha medicine *Padigara Parpam*. They observed that increasing the quantity of cow dung cakes increased the maximum temperature and holding duration while reducing the heating rate due to prolonged combustion of fuel, allowing better heat penetration through the earthen enclosure.

In the present study, the use of 36 kg cow dung cakes for *Gajaputa* provided sustained heat exposure required for repeated thermal processing of *Sphatikamani*. The gradual heating and slow cooling characteristics may facilitate controlled transformation during *Marana* while preventing sudden thermal stress. The earthen *Sharava* and sealing material act as insulating and porous media, helping maintain a controlled heating environment with negligible pressure development.

RCBE prepared by EMF

Rock crystal was processed by the EMF method following the same procedure, except that *Putā* was carried out at 850°C for 1 hour. Progressive brittleness and colour change from light brown to reddish-brown were observed after successive *Putā*. The final weight of RCBE was 179 g.

Effect of Thermodynamic Laws on EMF

The heating process in the EMF follows the Zeroth, First, and Second Laws of Thermodynamics. The Zeroth Law ensures precise temperature regulation through the thermocouple and controller, while the First Law governs the conversion of electrical energy into thermal energy. According to the Second Law, heat is transferred uniformly from the heating elements to the *Sharavasamputa* and *Chakrika*. This provides controlled and reproducible heating. (Figure 9)

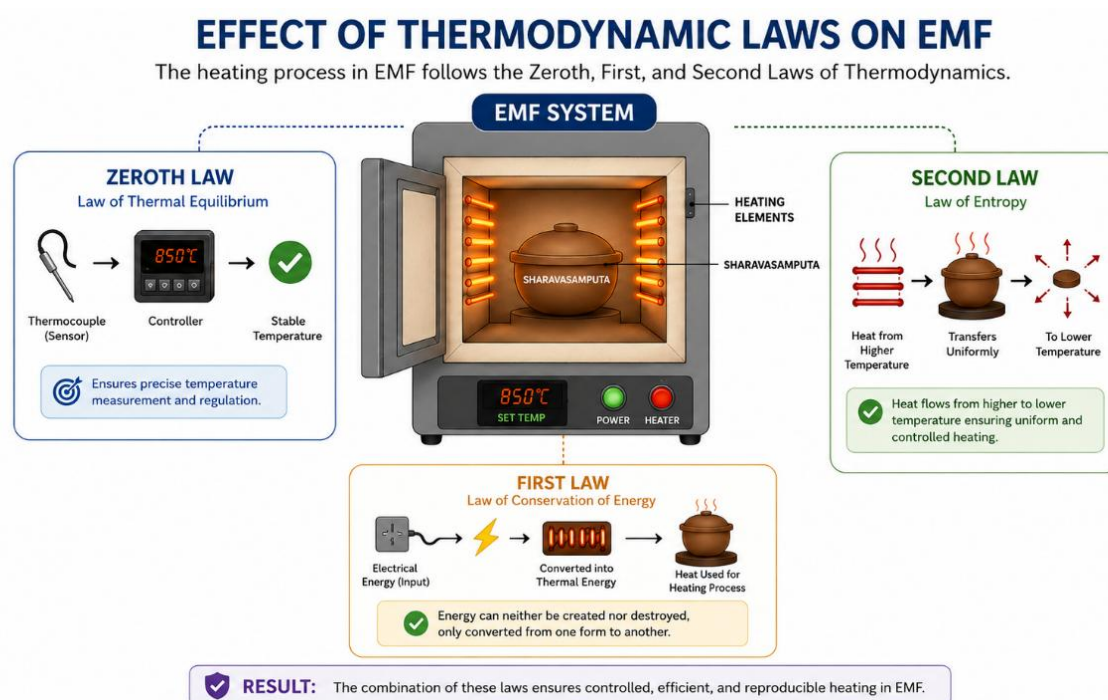


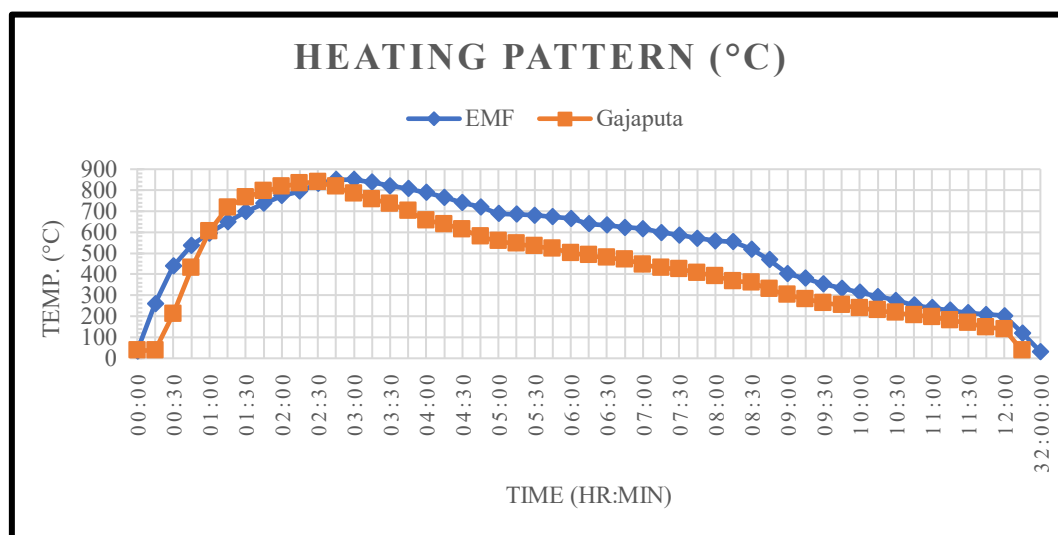
Figure 9

Although both methods successfully produced *Bhasma*, noticeable differences were observed in the physical characteristics of the pellets. After 1st *Putā*, the pellets prepared by the *Gajaputa* method appeared brownish white and exhibited greater brittleness, whereas the EMF treated *Chakrika* showed a light brown colour with comparatively lower brittleness. After completion of seven *Putā*, the EMF prepared *Bhasma* developed a reddish-brown colour, while the *Gajaputa* prepared *Bhasma* was light brown.

These differences may be attributed to the nature of heat transfer in the two-heating means. In the EMF, heat is supplied in a controlled and relatively uniform manner throughout the heating chamber, allowing all pellets to receive nearly identical thermal exposure. In contrast, *Gajaputa* generates heat through the combustion of cow dung cakes, where the temperature distribution is influenced by factors such as the arrangement and quality of fuel, airflow and heat dissipation to the surroundings. Consequently, the thermal exposure in *Gajaputa* is comparatively non-uniform, which may influence the extent of physicochemical transformation, resulting in differences in colour and brittleness of the pellets. Madhvi K. et al. reported 80% yield of RCB with a light brown colour using the Rasatarangini method with 36 hours of levigation during

each *Puti*. The variation in present yield may be attributed to differences in pharmaceutical procedure, pellet size, levigation duration, heat exposure, and process related losses. Based on these observations, the *Gajaputa* method yielded more brittle pellets and finer *Bhasma* than the EMF method.

The comparative temperature profile of RCB and RCBE



Graph No.3: Average Temperature Pattern of RCB and RCBE

Colour variation of *Bhasma*

The principle of Fourier's Law suggests that heat is conducted from regions of higher temperature to lower temperature in the pellets. In the EMF, the constant and uniform temperature promotes homogeneous heat conduction throughout the pellets, whereas the variable thermal conditions in *Gajaputa* may result in comparatively non-uniform heat transfer. These differences in thermal exposure can influence the extent of physicochemical transformations, thereby contributing to the observed colour variation in the final *Bhasma*.

Table no. 8: Comparative XRD peaks of RCB and RCBE

Sample	Chemical Compound	Compound Name	Score	Displ.[°2Th]	Scale factor
RCB	Ca7 F2 K1 Li3 O36	Baratovite	39	0.000	0.044
RCB	SiO2	Quartz	67	0.000	0.356
RCBE	Ca7 F2 K1 Li3 O36	Baratovite	45	0.000	0.056
RCBE	SiO2	Quartz	74	0.000	0.715

The XRD phases of RCB and RCBE showed good correlation with the RRUFF mineral database, confirming α -quartz (SiO_2) as the major crystalline phase. The reference pattern shows the characteristic highest intensity peak at approximately $2\theta = 26.6^\circ$ (101 plane) with a d-spacing of $\sim 3.34 \text{ \AA}$, along with other characteristic reflections confirming the trigonal crystal structure of α -quartz. The findings indicate that pharmaceutical processing did not induce detectable

lattice strain, crystal distortion, or phase transformation, and the α -quartz structure remained stable after purification.

Both methods resulted in processed *Sphatikamani* with similar elemental composition; SEM demonstrated variation, with RCBE showing comparatively smoother and more homogeneous surface characteristics than RCB. This difference may contribute to variations in particle interaction, surface area, and physicochemical behaviour of the final product. The elemental analysis also showed comparable Si and O content in both samples, with minor differences in trace elements, supporting that the observed surface changes are mainly related to processing conditions rather than major compositional alteration.

EDS analysis of RCB and RCBE showed Si and O as the predominant elements, confirming SiO_2 as the principal constituent of both samples. Minor variations were observed in the trace elements, with RCBE showing slightly higher Fe, K, Ca, and Al contents, while Si and O were marginally lower. These variations are likely due to differences in heating conditions and the heterogeneous distribution of trace elements. Overall, both *Gajaputa* and EMF methods preserved the elemental composition of *Sphatikamani Bhasma*, with no significant differences in the major constituents. The comparatively higher Fe content in RCBE may have contributed to its reddish-brown colour, whereas the relatively lower Fe content in RCB corresponded to its light brown appearance, as iron-bearing minerals are known to impart reddish to brown hues in *Bhasma*.

CONCLUSION

Sphatikamani Bhasma was successfully prepared using both the *Gajaputa* and EMF methods. Despite differences in the pharmaceutical process and heating conditions, both methods yielded *Bhasma* that satisfied the classical parameters. XRD confirmed the stability of α -quartz (SiO_2) without phase transformation, while SEM-EDS showed comparable elemental composition with minor trace variations. RCBE exhibited a smoother surface morphology and higher Fe content, contributing to its reddish-brown colour. The controlled temperature and heating profile of the EMF support its use as a suitable alternative to the *Gajaputa* for preparation of *Sphatikamani Bhasma*.

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