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# Review of research works done on *Rajata Bhasma* [Incinerated Silver] at Institute of Teaching and Research in Ayurveda, Jamnagar

Kirtesh N Agey<sup>1</sup>, Poorvi P. Mahabdi<sup>2</sup>, Dilip Prajapati<sup>3</sup>, BJ Patgiri<sup>4</sup>

<sup>1,2</sup>Post Graduate Scholar, Dept. of Rasa Shastra & Bhaishajya Kalpana, Institute of Teaching and Research in Ayurveda Jamnagar, Gujarat, India.

<sup>3</sup>Lecturer, Dept. of Rasa Shastra & Bhaishajya Kalpana, Institute of Teaching and Research in Ayurveda Jamnagar, Gujarat, India.

<sup>4</sup>Professor & HOD, Dept. of Rasa Shastra & Bhaishajya Kalpana, Institute of Teaching and Research in Ayurveda Jamnagar, Gujarat, India.

## ABSTRACT

*Rajata* a well-known metal known for its *Medhya*, *Rasayana* and *Balya Karma*. *Rajata* is cost effective compared to *Swarna* and possess similar properties to that of *Swarna*. *Rajata Bhasma* (RB) is a calcined silver compound widely used by practitioners of Ayurveda for various ailments like depletion of body elements, neurological disorders, muscular dystrophy, infertility, diabetes, various infectious conditions. Aim of the present study was to compile such available research works done on *Rajata* in the Department of Rasa Shastra and Bhaishajya Kalpana (RS and BK), ITRA, Jamnagar and provide brief information about pharmaceutical, analytical, and pharmacological studies. Total five studies on *Rajata Bhasma*, which revalidated the impact of classical guidelines, safety issues, and therapeutic utilities, were screened from Department of RS and BK, Institute for Teaching and Research in Ayurveda, Jamnagar. All studies revealed that *Rajata Bhasma* is safe clinically, experimentally at Therapeutic Equivalent Dose (TED) levels as no toxic hazards were reported during the treatment period. The clinical efficacy of *Rajata Bhasma* has been evaluated in Female infertility, Depression (*Avasada*) and memory enhancing activity. conditions. Satisfactory responses with a decrease in the intensity of signs and symptoms were reported in all the studies. Though certain limitations were observed in these researches, the results can be considered as a lead for further well stratified studies covering larger population. No adverse effects were reported in any of these studies.

**Key words:** *Bhasma*, *Rajata*, *Silver*, *Rasayana*, *ITRA*

## INTRODUCTION

*Rasaushadhi's* are being used for treatment purpose since ages. These drugs are obtained and prepared from various herbal, metal and mineral origin. Use of these various kinds of preparations in therapeutics has been known since Vedic period. The advantages of the

*Bhasma's* that is the incinerated metals or minerals is its quick acting ability in small doses<sup>[1]</sup> These nanosized formulations are extremely potent in treating diseases of acute or chronic in nature. Though these *Bhasma's* are being safely practiced in Indian scenario, concerns are being raised on safety issues in the recent past.<sup>[2]</sup> At the same time a number of studies have been conducted in different institutes of India, which provided safety aspects of *Bhasma*. Metals and minerals are the integral part of therapeutics in Ayurveda and to make it fit for therapeutic use, *Rajata* has to pass through a set of classical pharmaceutical processes known as *Shodhana* (purification), *Marana* (incineration). *Rajata Bhasma* is useful in the treatment for *Prameha*, *Gulma*, *Kasa*, *Kshaya* and acts as a potent *Rasayana* and *Balya*.<sup>[3]</sup> Considering the utility of *Rajata Bhasma*, many research works have been carried out in the Department of Rasashastra and Bhaishajya Kalpana (RS and BK), Institute of Teaching

### Address for correspondence:

Dr. Kirtesh N Agey

Post Graduate Scholar, Dept. of Rasa Shastra & Bhaishajya Kalpana, Institute of Teaching and Research in Ayurveda Jamnagar, Gujarat, India.

E-mail: kirtesh.agey@gmail.com

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and Research in Ayurveda (ITRA), Jamnagar with an aim to revalidate the classical principles of therapeutics. The present study was to compile all available research works done on *Rajata* in the Department of RS and BK, and provide brief information about pharmaceutical, analytical, and pharmacological contributions.

## MATERIALS AND METHODS

Works carried-out in the Department of RS and BK, ITRA, Jamnagar at PhD and PG levels during 1960-2022 were compiled and screened to revalidate the classical concepts of *Rajata Bhasma* preparation.

## OBSERVATIONS AND RESULTS

First ever study conducted on *Rajata* was done in 1960<sup>[4]</sup> where it gave a detailed description of *Rajata* with reference to its *Vaidika Utpatti* and various aspects of Silver related to Geology and Mineralogy. Further it also describes various *Shodhana* and *Marana* methods of *Rajata* along with *Guna of Rajata* which has a wide therapeutic significance. The Author has also evaluated various case studies wherein *Rajata Bhasma* has been used as a part of treatment protocol. Author concluded his work by reviewing various formulations of *Rajata Bhasma* from classics along with percentage of *Rajata*.

Another study on *Rajata Bhasma* following the previous work was carried out in 1962<sup>[5]</sup> where the author described in brief about the history of *Rajata* and various *Shodhana* and *Marana* methods from different references. The Author also explained the concept and importance of *Bhavana* and *Putra* in his work. The efficacy of *Rajata Bhasma* was tested clinically in various diseases.

A study carried out in 1989<sup>[6]</sup> evaluated the effect of two different media in the action of *Rajata Bhasma* w.s.r. to *Vandhyatava* (female infertility).

### Pharmaceutical findings

No loss was observed during the processing of Silver (*Samanya* and *Vishesha Shodhana*). Following the *Bhasmikanrana* procedure outlined in Rasatarangini, two 55-gram batches of pure silver were subjected to *Putra*. One batch incorporated *Swarnakshiri* (*Argemone*

*mexicana* Linn.) as the *Marana Dravya*, while the other used *Gandhaka* and *Somala*. Both batches required five *Putra* cycles to pass all *Bhasma Pariksha*. The final product exhibited a weight increase of 12.73% for the *Swarnakshiri* batch and 9.1% for the *Gandhaka-Somala* batch.

### Clinical findings

A study involving 30 participants was conducted, divided into two groups of 15. One group received *Swarnakshiri-Marita Rajata Bhasma*, while the other received *Gandhaka-marita Rajata Bhasma*. Both groups were administered 250mg daily with cow's milk (*Godugdha*) as a vehicle, beginning on the first day of the menstrual cycle. Results indicated that *Swarnakshiri-Marita Rajata Bhasma* demonstrated greater efficacy than *Gandhaka-marita Rajata Bhasma* in treating infertility (*Vandhyatava*).

Another study carried out in 2006<sup>[7]</sup> evaluated a comparative pharmaceutico-pharmaco-clinical study of *Rajata Bhasma* and *Rajata Sindura* w.s.r. to depression.

### Pharmaceutical findings:

*Rajata Sindura* and *Rajata Bhasma* were prepared using three batches of *Rajata Kajjali* (a 1:1:1 mixture of silver, mercury, and sulphur). The *Sindura* was synthesized using both a sand bath (*Valuka Yantra*) and an electric muffle furnace (EMF), reaching peak temperatures of approximately 700°C and 580°C, respectively. The *Valuka Yantra* method yielded a higher quantity of *Rajata Sindura*.

### Analytical findings

Phase identification of *Rajata Bhasma* by X-ray diffraction method reveals  $Ag_2S$  (silver sulphide) as major phase and  $Ag_5SiO_4$  as minor phase. Almost 80% compounds were detected by this X-ray diffraction method. Inductively coupled plasma analysis of *Rajata Bhasma* and *Rajata Sindura* reveals that silver (73.594%) is the major constituent along with sulphur (17.246%) and iron, copper, lead, cadmium etc. are present as traces in *Rajata Bhasma*, while

mercury (91.995%) is the major constituent along with sulphur (11.685%) and Silver (0.020481%) is also found

in *Rajata Sindura*. Other elements like iron, cadmium, lead are present as traces elements in *Rajata Sindura*.

### Pharmacological findings

Total 33 Wistar rats of both sex weighing between 160 to 300g were divided into 11 groups, each containing 3 animals. Group I, VI and XI were given in single oral dose of five times more than therapeutic dose of *Rajata Bhasma*, *Rajata Sindura* and in control group (XI) honey and water were given while group II and VII were given in single oral dose of 10 times more than therapeutic dose of *Rajata Bhasma* and *Rajata Sindura*. Likewise, III and VIII were given 20 times, group IV and IX were given 40 times and group V and X were treated with 80 times more than therapeutic dose of *Rajata Bhasma* and *Rajata Sindura*. Three different concentrations of suspensions were prepared e.g. 6 mg/ml, 12 mg/ml and 48 mg/ml to maintain equality in the quantum of drug solution administered. Acute toxicity with gross behaviour: In this phase of study, acute toxicity of *Rajata Bhasma* and *Rajata Sindura* were assessed and effect on gross behaviour was also noted. Anti-depressant activity: To ascertain the presence of the anti-depressant activity in *Rajata Bhasma* and *Rajata Sindura*- they were evaluated in the following test protocols: Open field behaviour and Behavioural despair test. L-DOPA potentiation induced test Anti-reserpine test. On the basis of pharmacological study, *Rajata Bhasma* and *Rajata Sindura* both the drugs do not process a profile of classical anti-depressants. However, they produced CNS stimulation and partial potentiation L-dopa effects and it can be suggested that *Rajata Sindura* produces better CNS stimulation in comparison to *Rajata Bhasma*.

### Clinical findings

In the clinical study, clinical trial of *Rajata Bhasma* and *Rajata Sindura* has been performed on patients of Depression (*Avasada*). The drugs were given in 120 mg dose along with honey as vehicle. The duration was of 28 days and follow up was carried out for a month. Total 18 patients were registered for the clinical trial of *Rajata Bhasma* and *Rajata Sindura* which were divided in two groups. Among the 18 patients, 44.44% patients

were from age group 41 - 50 years, 61.11% patients were male, 72.22% patients were having school level education, 38.89% patients were belonged to lower middle class and 72.22% patients reported to have disturbed sleep. All the patients had taken allopathic medicine before starting the treatment. *Rajata Bhasma* has shown statistically highly significant results, while *Rajata Sindura* has shown significant results on Hamilton's Depression Rating Scale. But the *Rajata Sindura* has the *Rasayana* properties and on that basis, it provides good results in the patients of Depression (*Avasada*). Hence, *Rajata Bhasma* was found to be more efficacious than *Rajata Sindura* in the treatment of Depression (*Avasada*).

Recently conducted study in 2018<sup>[8]</sup> on comparative safety study of *Rajata Bhasma* and silver nano particles synthesized by plant extract through green synthesis method.

### Pharmaceutical findings

The *Shodhana* process of *Rajata* was carried out in two stages viz. *Samanya Shodhana* (general purification) and *Vishesha Shodhana* (specific process) using process of *Dhalana* 3 times in each media for *Samanya Shodhana* and 7 times for *Vishesha Shodhana*. 1.5 % loss was found during *Samanya Shodhana* of *Rajata* where as 1.01 % loss was observed in *Vishesha Shodhana* of *Rajata*. Average 60.73% *Parada* was obtained from the *Hingula*. For an average of 500 g *Gandhaka*, 481.75 g was obtained after *Shodhana*. The average temperature recorded is 120°C with an average duration of 24 minute for melting. An average 1.63 % loss of *Gandhaka* was observed during *Shodhana* process. It took an average of 6 hours to form proper *Rajata-pishti* and an average 25.67 hours to form *Kajjali*. For first *Putra*, 150 ml *Kumari Swarasa* was required and this amount was constant up to fifth *Putra* then gradually reduced to 100 ml. *Putra* was given at maximum 550°C maximum temperature in later *Putra*. There was none uniformity in intermediate product of *Marana* till 7<sup>th</sup> to 9<sup>th</sup> *Putra* then after it achieved uniformity in this parameter which is suggestive of formation of uniform compound. *Varitaratva* & *Rekhapurnata* was observed after



4<sup>th</sup> Puta. Uniformity in subsequent operating procedures and its outcomes from 10<sup>th</sup> Puta onwards which is apart from effect of maintenance of uniform temperature pattern. Average 150 g of *Rajata Bhasma* was obtained from 95g of *Shodhita Rajata*.

#### Analytical findings

TIR spectra of all samples were taken in the region of 419.47-3383.52 cm<sup>-1</sup>. These peaks indicate stretching vibrations between various inorganic molecules. Various peaks obtained in FTIR analysis of sample of *Rajata Bhasma* were raised due to stretching vibrations between C-H, C-N, C-O and O-H bonds. In this sample, primary amines are represented by the peak obtained at 3383.52 cm<sup>-1</sup>, which are assigned to ammonium ions. Three peaks 1118.09, 1001.42 cm<sup>-1</sup> were raised due to C-O stretching vibrations which are representative of phenolic hydroxyl group 670.28 cm<sup>-1</sup> peak were raised due to O-H stretching vibrations which are representative of alcohol and phenol of RB20 showed peaks which shows presence of Alcohols and phenols, Aromatic ring compounds, Phenolic hydroxyl, Methylene, Methyl Aromatic benzene ring functional groups. Proportion of all elements. X-ray powder diffraction (XRD) reveals 2 theta value peaks of 34.4627, 100% relative intensity is observed in *Rajata Bhasma*, which is near to peak obtained at 38.318, 2 theta value in AgNp as mentioned in standard powder diffraction card of Joint Committee on Powder Diffraction Standards (JCPDS), silver file No. 04-0783. Upon analysis of JCPDS data of oxides and sulphides of silver, observed 2 theta values of sample suggest presence of these compounds, which lies between 24-55 which also supports stoichiometric possibility of these compounds in *Rajata Bhasma* through elemental analysis. The XRD study confirms / indicates that the resultant particles are (Face centred cubic) Silver Nanoparticles *Rajata Bhasma* face-centered cubic ( $\gamma$ -form) of silver sulfide is most probably present owing to color, thermostability and structure. There were total 42 peaks (intense peaks) noted during scanning which suggest *Rajata Bhasma* as polycrystalline sample. Average particle size of *Rajata Bhasma* was found to be 68.79 nm which is nearly half than that of Average particle size derived from SEM image analysis.

Thus, *Rajata Bhasma* in view of average particle size is nano size formulation. ICP-AES analysis of both the samples revealed that silver is constituent as 15.92 % and mercury as 0.0015 % in *Rajata Bhasma*.

#### Pharmacological findings

In Acute toxicity study the LD<sub>50</sub> value of both *Bhasma* was found to be >2000mg/kg by oral route with non-significant increase in relative body weight. In histopathology, cell infiltration and fatty degenerative changes in kidney at TED 10 dose level, Sinusoidal inflammation and aggregation of hepatocytes with fatty changes in liver at TED 10 dose level, Effusion was noted in lungs at TED 10 level and no any pathological changes were observed in the remaining organs in comparison to control group. Hence, no major toxicity is reported in *Rajata Bhasma* at therapeutic and 5 timed dose levels. There was significant 82% reduction in scopolamine induced delay in latency period on third day of administration of *Rajata Bhasma* which is suggestive of instant memory enhancing effect of drug in 3 doses at therapeutic dose level.

#### DISCUSSION

Metals are used in various disease conditions from Vedic period, but their use increased after development of *Rasashastra*, which is an integral part of Ayurveda. *Bhasma* of metals or minerals are one of the suitable pharmaceutical forms in *Rasashastra*. There is a need to revalidate these classical principles and develop safety profiles to generate evidences. In this course, a screening has been done through the works carried out in the Department of RS and BK, ITRA, Jamnagar.

Total five studies were carried out at ITRA out of which the earlier two studies were mainly focused on the conceptual part of *Rajata* along with various methods of *Shodhana* and *Marana*. The clinical studies conducted in these works evaluated the use of *Rajata Bhasma* along with different Herbo-mineral formulations.

Therapeutic efficacy of *Rajata Bhasma* was evaluated in *Vandhyatva* and *Swarnakshiri-Marita Rajata Bhasma* was found to be more efficacious compared to

*Gandhaka-Marita Rajata Bhasma*.<sup>[9]</sup> The preparation of *Rajata Sindura* in *Valuka Yantra* had yield a better percentage of the product compared to EMF.

*Rajata Bhasma* considered as *Medhya*<sup>[10]</sup> has been proven to possess Anti-depressant activity in both i.e. an experimental study and clinical study.<sup>[11]</sup> No toxicity was reported on TED and 5 times TED dose. A significant 82% reduction in scopolamine induced delay in latency period on third day of administration of *Rajata Bhasma* which is suggestive of instant memory enhancing effect of drug in 3 doses at therapeutic dose level.<sup>[12]</sup>

There are many research articles published across various scientific journals which illustrates the importance of *Rajata Bhasma*.

An experimental study published in 2017<sup>[13]</sup> on *Rajata Bhasma*, investigated for acquisition (learning) memory in *Wistar albino* rats. The methodology consisted of three groups of rats, test group was administered with *Rajata Bhasma* (11.25mg/kg per day p.o.), standard group was administered piracetam (100mg/kg per day i.p.) and control group was fed with food and water, to assess the *Medhya* activity in *Wistar albino* rats followed by the Morris water maze test. The escape latencies, acquisition memory were recorded, results are analysed statistically with the help of parameters to assess the memory. Results indicate that *Rajata* (silver) *Bhasma* has moderate effect on learning and acquisition, statistically significant result on the paradigm of thigmostatic behaviour average duration and frequency. The conclusion was that *Rajata* (silver) *Bhasma* has facilitatory effect on acquisition memory (learning and memory).

An article published in 2019<sup>[14]</sup> based on a study conducted on evaluation of antidiabetic effect of RB in streptozotocin-induced diabetic rats. The two different batches of *Rajata Bhasma*, RB1 (9 *puta*'s) and RB2 (17 *puta*'s) were prepared by the following classical methods. After the treatment with RB1 and RB2 to streptozotocin-treated rats, it significantly lowered the blood glucose level. Further, it also significantly decreased the elevated total cholesterol, triglycerides, and low-density lipoprotein level while increased the

high-density lipoprotein. Glibenclamide was used as a standard drug at a dose of 0.50 mg/kg body weight. The study showed that RB does have antidiabetic activity. The animals of diabetic control showed significant increase in serum TGL, total cholesterol, and LDL while increase in HDL when compared with normal animals. The animals treated with Glibenclamide also reduced TGL, total cholesterol, LDL, and increased HDL compared to diabetic control group. The RB1 and RB2 treated animals showed a significant decrease in total cholesterol, LDL, TGL, and a significant increase in HDL.

A latest article published in 2022<sup>[15]</sup> on *in-vitro* anti-cancer activity of *Rajata Bhasma*. This study revealed that the *Rajata Bhasma* is a lesser toxic form of silver compound ( $Ag_2S$ ) and that the atomic ratio of the *Bhasma* is majorly distributed in Ag, Si, and C. The particle size confirms the formation of nanoparticles in the range of 10–100nm. The MTT assay reveals the potent cytotoxic activity of *Rajata Bhasma* against MCF-7 cell lines. *Rajata Bhasma* is showing effective cytotoxicity and may be considered as potent anti-breast cancer agent due to its low  $IC_{50}$ .

## CONCLUSION

Metals and minerals are the integral parts of therapeutics in Ayurveda. Classical texts emphasized on following classical guidelines (such as *Shodhana* and *Marana*) while preparing *Bhasmas* (incinerated powders) of the metals. Analytically *Rajata Bhasma* is reported to be sulphide of Silver. The differences in chemical forms of incinerated silver reveal that *Bhasmas* prepared in different media have different compositions and show different chemical reactions. Pharmacologically, *Rajata Bhasma* was found safe in TED and 5 times TED and it also exhibited anti-depressant activity and memory enhancing activity. The clinical efficacy of *Rajata Bhasma* has been studied in *Vandhyatva*. The dose of *Rajata Bhasma* administered was 250 mg, and the was started at the first day of Menstrual cycle. The *Bhasma* was administered with milk. Positive results were reported in all the studies. These studies were limited to a few number of cases; hence statistical significance did not draw. Since no adverse effects were reported in any of

these studies, and satisfactory responses were noted by the patients; the results can be considered as a lead for further well stratified studies covering larger population. All these studies prove that, the classical principles have their own scientific rationale and need to be followed mandatorily while processing in order to avoid the possibilities of unwanted effects.

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