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Standardization of Rajat Bhasma Prepared with the Classical Method of Rasendra Sara Sangrah

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Abstract:

Rasashastra is a branch of Ayurveda which deals with the processing of minerals and metals having therapeutic significance. Rajata (Silver) comes under the group of metals having high therapeutic value and used in the form of Bhasma. Rajata bhasma used in many diseases like smrutinasha, unmada, apsamara, vata roga etc. There are many methods in the texts to convert Rajat in to Bhasma with different types of marana. Rasendra sara sangraha mentioned a very easy method for making Rajata Bhasma.This method is easy to perform and prepares good quality Rajata Bhasma. An effort was made here to standardise the procedure of preparation of Rajat Bhasma according to the method described in Rasendra sara sangraha. Also, the prepared Bhasma was tested with the modern methods and equipment like XRF etc. The findings are according to the principle of Ayurveda.

Keywords: Rajata Bhasma, XRF, Rasendra sara sangrah

Introduction:

Rasashastra is an ancient branch of pharmaceutics and therapeutics which deals with use of herbo-mineral drugs for the wellbeing of human being. Now a days the Ayurvedic pharmacopoeia of India has routinely been used in practice to ensure their quality standards in different parts of India. They are prepared under the classical guidelines and said to be safe and effective even in minute doses. Rajata is a noble metal is known as silver having latin name is Argentum (Ag), atomic number is 47, specific gravity 10.5, with a melting point of 960°C[1]. Rajat (Silver) is bright shiny, lustrous white metal. In Ayurveda it is classified under Dhatu varga[2] also categorised as shuddh dhatu.[3] Synonyms of Rajata are Taara, Shubhra, Ruchira, Chandrahasa, Roupya, Rupyaka, Chandraloha[4] etc. Three types are mentioned by Rasa Ratna Samuchaya as Sahaja, Khanja, Kritrimal.[5]

Grahya Rajat lakshanas:[6] According to the classical text Rasa Tarangini Rajata having properties like Nirmal, Sawscha, Snigadh, Pischil, Nirdal, Mridu, Sharadindunibha is called Jatya Rajata and can be considered acceptable for therapeutic purposes. On cutting, rubbing and heating becomes clear (sawascha) as Sharada- kalin- chandrama, guru (heavy in weight) & snigadha.[7] Agrahya Rajata Lakshana: When Rajata is heated, it becomes maleen, peet, rakta. It also possesses the properties like Ruksha, Laghu, Saphutam. Kathina (Hard). Sadal.[8] It has been mentioned eight agrahya lakshana of Rajata: it becomes Rakta, Peeta. Krishan when heated on fire and also having properties like Ruksha. Saphutam. Laghu.

Shodhana and Marana are important procedures for all the metals. Agastyapatra Swarasa, Malkangni Taila, Nimbu Swarasa, Changeri Swarasa, Naga, Kshara, Amla, Tankana are given as the

Shodhana media of Rajata in various texts. Parada, Hartala, Gandhaka, Swarnamakshika, and Hingula are also used for maran as mentioned in Rasashastra texts for preparation of Rajata Bhasma. Now a days, there is need to standardize the pharmaceutical methods, so that we can obtain Bhasma of same quality in every batch. Rajat Bhasma is a herbo metallic preparation which is prepared from silver metal and some herbal ingredients through purification and calcination processes that changes Rajat metal into its oxide form as mentioned in the literature. The drug manufacturing processes of Ayurveda are included in discipline of Rasa Shastra and Bhaishajya Kalpana. Heating, boiling, quenching, dipping, trituration, distillation, washing, filtering etc. are the important procedures involved in drug manufacturing.[9] During Shodhana, Marana, bhavana classical processes, the above-mentioned procedures are adopted which ensure the proper transformation of basic metal in to bio-absorbable bhasma form.[10] Now a days, there is need to standardize the pharmaceutical methods, so that we can obtain Bhasma of same quality in every batch. For the safety of Rasoushadhis, it is advised to use the advanced modern technology to ensure the proper formation of bhasmas. A number of modern analytical techniques are available to know the material characterization of bhasmas. Among them, XRF (X Ray Fluroscense) is one of the important techniques by which compounds of the material and free metals in it can be detected.

Aim and Objectives: Pharmaceutical Standardization of Rajat Bhasma according to Rasendra sara sangraha.

Materials and Methods:

The process of Rajata shodhana involves two steps

Step I -Rajata Samanya shodhana

Step II Rajata Vishesha shodhana

1) Samanya shodhan of ashuddha Rajata

Reference: Rasendra sara sangraha. 1/296[11]

Ashuddha Rajat was procured from the local market and it was authenticated by XRF analysis from sophisticated analytical lab.

Rajata samanya shodhan:

Ingredients:

Sr. No.	Content	Batch-1	Batch-2	Batch-3
1	Ashuddha Rajata	50 gm	50 gm	50 gm
2	Kadali moola vari	200 ml X 7=1.4L	200 ml X 7=1.4L	200 ml X 7=1.4L

The procedure followed for samanya shodhana:

Procedure:

Kadali moola vari ie. Juice of the root of a banana plant was extracted by uprooting the plant, chopping and grinding its root and squeezing the grinded material to extract juice. 200ml of this juice was taken in a glass beaker which was kept beside the gas stove. Rajata patra, one at a time was held in a pair of SS forceps and held over high flame till red hot and instantaneously quenched in the beaker with kadali moola vari. One by one all the Rajata patra were heated till red hot and quenched as above. This was the 1st nirvaapa of samanaya shodhana of Rajata. After 1st nirvapa, the used kadali moola vari was discarded. Then fresh kadali moola vari of volume 200 ml was taken in the glass beaker and the process of nirvapa

(heating and quenching) was done as mentioned above for a total of 7 times including the 1st nirvapa. This procedure of 7 times nirvapa in kadali moola vari was carried out individually and separately for R1, R2 and R3. All the 3 batches were allowed to dry and their respective weights were taken and noted. At the end of the procedure, they were called Samanya shuddha Rajata patra of batches R1, R2 and R3 respectively. A sample was taken at the end of samanya shodhana in order to study the changes using organoleptic and XRF analysis.

Precautions:

Root of banana plant contains plenty of juice. To extract it, the root was finely chopped before grinding or else, the fibres get entangled in the blades preventing effective grinding.

While heating the Rajata patra, they should be taken away from flame immediately after becoming red hot or else, the patra starts melting and its edges start curling inwards thus increasing the thickness of the patra which is undesirable.

Beaker with kadali moola vari must be kept near gas stove to ensure that the Rajata patra remains red hot at the time of nirvaapa.

Rajat vishesh Shodhana from Rasendra sara sangraha 1/261[12]

Sr.no.	Content	Batch 1	Batch 2	Batch3
1	Samanya shodhit Rajat	50gm	50gm	50gm
2	Shuddha tankana	50 gm	50 gm	50 gm
3	Nimbuka swarasa	250 ml	250 ml	250 ml

Samanya shuddha Rajata patra of weight 50 gm were taken in an SS vessel. Shuddha tankana 50 gm was added to it. Nimbuka swarasa (fresh lemon juice) was then added to it such that all the Rajata patra get submerged in it. For the present study 250 ml of Nimbuka swarasa per batch was required. The mixture was heated on medium flame till complete evaporation of the liquid media. It was allowed to self-cool up to room temperature and then thoroughly rinsed with water. Then it was kept undisturbed for 30 mins to allow the sedimentation of the tiny broken pieces of Rajata patra. After 30 mins, the water at the top was carefully decanted. Very small quantity of water remaining, was dried by heating over flame and the dried Rajata patra were carefully collected on cooling. The tiny particles at the base of the SS vessel were collected by using a zero number paint brush to prevent loss.

This procedure of Vishesha shodhana was carried out individually and separately for batches R1, R2 and R3. All the 3 batches were allowed to dry and their respective weights were taken and noted. At the end of the procedure, they were called Shuddha Rajata patra of batches R1, R2 and R3 respectively. A sample was taken at the end of vishesha shodhana in order to study the changes using organoleptic and XRF analysis.

Preparation of Rajat Bhasma

Rajat Marana from Rasendra sara sangraha 1/262[13]

Sr. No.	Content	Batch-1	Batch-2	Batch-3
1	Shuddha Rajat	49 gm	49 gm	49 gm
2	Shuddha suvarna makshika	49 gm	49 gm	49 gm
3	Shuddha gandhaka	49 gm	49 gm	49 gm
4	Arka ksheera	40 ml	40 ml	40 ml

The procedure followed for Rajat Marana:

Observations during the first laghu puta

For 1st laghu puta, a paste of shuddha suvarna makshika and shuddha gandhaka was prepared with arka ksheera which was applied over shuddha rajata patra and dried. After sharava samputikarana, laghu puta was given to all the three batches of Rajata bhasma. It was observed in all the three batches that after just one laghu puta given to these shuddha suvarna makshika-gandhaka coated Rajata patra, the shuddha Rajata patra which were initially tensile (although a little less compared to ashuddha Rajata patra) before the process had become extremely brittle. The brittleness had increased so much that it could be easily crushed to coarse powder by just pressing between the thumb and index finger. This proved the effectiveness of this method of Rajata marana.

Observations during all the succeeding laghu puta after the 1st laghu puta.

a. During levigation : It was extremely difficult to levigate with arka ksheera as it dried away relatively quicker compared to other liquid media, before the particles being levigated could be finely grounded. Thus a little quantity of water was added so that the process of levigation could be prolonged slightly, thus facilitating the fine grounding of the contents in the khalva yanta. As the number of puta progressed, levigation became smoother and smoother.

b. Changes in Pellets : After drying, the pellets used to be brittle, but the same would became considerably hard following puta. Typical breaking sound 'kat' was presented while breaking pellets after puta, which was not existing previously. Colour of rajata bhasma gradually changed from black to brownish black, to reddish black, to reddish progressively with the increasing number of puta. The sparsha which was rough initially, progressively became smoother with successive puta and became smooth from 8th puta onwards. Rekhapooranatva was seen from 8th puta onwards. In the present study, it was observed for all the three batches of Rajata bhasma that, as the number of puta progressed, the presence of chandrika went on decreasing till they became absent. The following were the observations. Upto 1-4 puta- ++++ Dense occurrence in 1 sq.cm; Upto 4-8 puta- +++ Sparse occurrence in 1 sq.cm; Upto 8-9 puta- ++ Sporadic occurrence in 1 sq.cm; Upto 9-10 puta- + Scarce occurrence in 1 sq.cm; Upto 11-13 puta- Merely visible; After 14th puta- Absolutely absent. Partial varitaratva started to appear from 9th puta onwards which progressively went on increasing till the end of the marana procedure. The rice grain remained as it is on

the floating layer of bhasma, thus passing the Unnama test. No colour change of dadhi was observed, thus passing the Amla pariksha test. The bhasma also passed Avami test as its ingestion did not produce any nausea/vomiting. On exposing to high heat in presence of mitra panchaka no lustred particles or accumulated masses seen thus passing Apunarbhavatva test. No change in the initial weight of silver patra seen after heating thus passing the Nirutthatva test. It did not produce any smoke on heating thus passing the Nirdhooma test.

Temperature recording was done at the start of laghu puta, and multiple times at fixed intervals and at the end at the swanga sheeta stage. Including Step I and step II of Rajata marana, a total of fifteen times laghu puta were required for each of the batches of Rajata bhasma in order to obtain Rajata bhasma of desired standard metioned in bhasma pariksha.

Organoleptic analysis of Rajata Bhasma:

Sr. no.	Test	Batch 1	Batch 2	Batch 3
1	Appearance	Soft Fine powder	Soft Fine powder	Soft Fine powder
2	Colour	Reddish	Reddish	Reddish
3	Taste	Tasteless	Tasteless	Tasteless
4	Odour	Odourless	Odourless	Odourless

Physico-chemical analysis of Rajat Bhasma:

Sr. no.	Test	Batch 1	Batch 2	Batch 3	Mean	S.D.
1	pH	7.91	7.89	7.89	7.896	0.012
2	Total Ash%	98.44	98.26	98.39	98.36	0.093
3	Acid Insoluble Ash%	92.26	91.8	91.58	91.88	0.347
4	Water soluble Ash%	6.4	6.3	6.08	6.26	0.164
5	Loss on drying	0.484	0.487	0.488	0.486	0.002
6	Loss on ignition	11.45	11.37	11.54	11.45	0.085

XRF analysis of Ashuddha, Shodhit and Vishesh shodhit Rajata

Rajata form	Cu (element) Mass%	Ag (element) Mass%
Ashuddha Rajata	0.09	99.91
Samanya shodhit Rajata	0.01	99.99
Vishesh shodhit Rajata	0.04	99.96

XRF Analysis of Rajat Bhasma:

Sr. No.	Components	Rajata Bhasma	Rajata Bhasma	Rajata Bhasma		
		Batch - 1	Batch-2	Batch-3	Mean	S.D.
1	Ag	57.8	57.6	56.9	57.43	0.4726
2	Fe	32.6	33	33	32.87	0.2309
3	Si	3.5	3.52	3.74	3.587	0.1332
4	S	2.65	2.62	2.72	2.663	0.0513
5	Ca	1.74	1.61	1.79	1.713	0.0929
6	Al	1.13	1.11	1.24	1.16	0.07
7	Ti	0.199	0.145	0.22	0.188	0.0387
8	Ba	0.151	0.161	0.152	0.155	0.0055
9	P	0.11	0.121	0.103	0.111	0.0091
10	Cu	0.0455	0.034	0.054	0.045	0.01
11	As	0.0278	0.028	0.03	0.029	0.0012
12	Hg	0.0272	0.0235	0.0297	0.027	0.0031
13	Cr	0.0223	---------	0.0246	0.016	0.0016
14	V	0.0191	<0.0001	<0.0001	0.006	0.011
15	Pb	0.0172	0.0149	0.0167	0.016	0.0012
16	K	0.001	<0.0001	---------	0.0004	0.0006
17	Ni	---------	0.0037	---------	0.001	0
18	Zn	---------	0.0008	0.0052	0.002	0.0031

Discussion:

As per the reference of Rasendrasara Sangraha, shodhana process of Rajata was carried out in two stages. Samanya shodhana and Vishesh shodhana

Samanya Shodhana: Samanya shodhana of Rajata was carried out as per the reference Rasendrasara Sangraha, by the process of nirvapa.

Nirvapa process: This process can be visualized in two phases, in first phase where kantakavedhi Rajata patra were heated up to red hot state on high flame, and in the second phase, the red-hot Rajata patra were quenched in liquid media. These heating and quenching were repeated for 7 times in kadali moola vari.

a) First Phase- Phase of heating: In this, the kantakavedhi Rajata patra were heated at a high temperature till they became red hot. In a majority of cases, for transformation to occur, heat is essential. So, in Rasashastra, for every processing, a particular heating pattern is indicated. This pattern of heating must be followed to achieve the desired change in the matter. In case of the process of nirvapa, heating till red hot state was mentioned in classical texts. The temperature attained at this stage might be essential for bringing about desired changes when quenched in liquid media. It took hardly 10 to 15 seconds for a single Rajata patra to become red hot. This is because it was thin and also because Rajata is a good conductor of heat.

b) Second phase- Phase of quenching: In this phase, the kantakavedhi Rajata patra were quenched in kadali moola vari. The quenching must be immediate as the thin Rajata patra do not remain in the red-hot state for a longer time and thus the desired changes in the metal might not be achieved if not suddenly cooled by quenching. If delayed, the contact of heated Rajata patra will not take at the desired temperature because in case of metals cooling is rapid as they are good conductors of heat. The change in the structure of the matter depends on intensity of heat and mode of cooling. A particular change might be expected hence the method stated. Metals or minerals, when heated, expand, so intermolecular spaces also increase and crystal lattice of the metals deform. Metals are solid, closed packed crystal structure. The condition in which a number of atoms occupy equilibrium positions of this kind in an aggregate is known as the solid state of matter. The distance between such positions is the inter-atomic distance. Displacement of the equilibrium in either direction can be accomplished only by the application of a force of some kind, and a solid structure resist either an inward force, a compression, or an outward force, a tension. To a certain extent this resistance to tension operates to prevent separation of the atoms of a solid which is commonly known as the force of cohesion. By the application of force in the form of heat, the tension in matter is increased, causing increase in interatomic distance. It is also called as linear expansion. After heating, immediate cooling in liquid media leads to decrease in tension and increase in compression force. Repeated heating and cooling cause's disruption in compression tension equilibrium leads to increased brittleness, reduction in hardness and finally reduction in the particle size. This concept was also applicable to nirvaapa of lauha.

ii. Role of Media:

For the samanya shodhana of Rajata, kadali moola vari was used. It is well known that kshara can be extracted from the juice of the roots and stems of a banana plant. Although it is mild compared to other kshara, it has been found to be useful in urinary calculus. Thus, it has ashmari hara properties. By virtue of its kshariya nature and ashmari hara properties, it might be facilitating in the breaking of the surfaces of metal thus making them bhangura which helps to ease the marana process. Being alkaline in nature, kadali moola vari also acts a cleansing agent thus facilitating in the cleaning of the surfaces of Rajata patra. During samanya shodhana of Rajata, some minute Rajata particles were observed at the base of the beaker containing Kadali moola vari used for the nirvapa procedure from 5th nirvapa onwards and their number was seen to be increasing with the progressive nirvapa. The presence of these minute Rajata particles at the bottom of the beaker and the increase in their number seen with progressive nirvapa during samanya shodhana suggest that the kshariya nature of kadali moola vari helps to make the Rajata brittle ie. it causes bhanguratva which is essential in marana process of Rajata. Thus, it can be said that the method of samanya shodhana of Rajata makes it suitable for marana. There was no change in weight at the end of the process of samanya shodhana. This indicates the method of holding each Rajata patra in a pair of SS forceps while heating and quenching in glass beaker is the most efficient way of handling noble and expensive elements like Ag. The use of glass beaker allowed in identifying the minute Rajata particles at it base which could be collected using a paint brush thus preventing loss. The comparative study of results of XRF analysis of ashudda Rajata vs shuddha Rajata does not reveal any significant change.

B. Rajata Vishesha Shodhana

The classical reference quotes that for Vishesha shodhana, pachana of Rajata patra is to be done along with kshara and amla dravya. In the present study, shuddha tankana was used as the kshara dravya

and nimbuka swarasa was used as the amla dravya. Tankana is commonly employed for this procedure as a kshara dravya as per the commentaries in hindi and translations in regional languages. The increase in the lustre of Rajata patra at the end of Vishesha shodhana can be attributed to cleansing action of Nimbooka swarasa and shuddha tankana. In the present study, 99.9% pure Rajata was used which was put to process almost immediately after removing the chips from their sealed packing. Thus, at no point of time was the Rajata used in this study was kept away and allowed to tarnish. This might be the probable reason why the siginificance of Vishesha shodhana was not evident in this study. Considering the nature of both Nimbooka swarasa and Tankana, it can be assumed that they might have greatly facilitated in the cleansing in case the Rajata was tarnished which is the general scenario unless the packed and sealed 99.9 % pure silver is used.

Rajata Marana (bhasma preparation)

Step I of Rajata Marana

In this laghu puta was given to Suvarna makshik- ganhaka coated Rajata patra. A drastic level of bhanguratva was observed in all the three batches of Rajata bhasma at the end of of this step which involved just one laghu puta. This shows that the mixture of shuddha suvarna makshik, shuddha ganhaka and arka ksheera is extremely effective in the process of Rajata marana. Also, a drastic loss in weight of contents before and after gajaputa was seen. Average loss seen in all three batches was 33.96%. The reason behind this huge loss was that, almost all the gandhaka in each of these batches had burnt and vapourised during the heating process in laghu puta.

Step II of Rajata Marana

In this step, the four stages ie. levigation, pellatization, sharavsamputikarana and laghu puta were repeated over and over for a total 14 times after which Rajata bhasma of the desired quality was obtained. The addition of shuddha gandhaka during the levigation process of every puta is not mentioned anywhere in the original sutra of Rajata marana of Rasendrasara sangraha. However, this procedure addition of shuddha gandhaka during every levigation has been mentioned in a couple of hindi commentaries on Rasendrasara sangraha. The opinion given by these experts in Rasashastra in their respective hindi commentaries was highly respected and noted but in the pharmaceutical study of the present study, this practice was not followed. A comparative study by preparing Rajata bhasma by adding gandhaka during the levigation stage of every puta and without adding gandhaka in every puta becomes a scope of further study. Such a comparative study can help us to understand the role behind adding shuddha gandhaka during the levigation process of every puta by employing modern and sophisticated methods of analysis. The duration for marana of Rajata bhasma had extended due to the unavailability of arka ksheera in the known locations (as the plants in the known areas were used up during the previous procedures of this study). The process of marana was again resumed in the month of August when the arka plants had grown back. It was observed that the arka ksheera collection was easier in the rainy season as the plant exuded more latex in the rainy season, compared to the spring and summer seasons. Thus, procuring and storing cow dung cakes in the summer season and giving laghu puta in the dry spells of the rainy season was the best strategy for preparation of Rajata bhasma by this method as arka ksheera was comparatively easy available in the rainy season. As less time and less cow dung cakes were required for laghu puta, performing this procedure in rainy season was a manageable task.

Analytical study of Rajata bhasma

The reports of XRF analysis of samples of all the three batches of Rajata bhasma showed that Ag (average- 57.43%) and Fe (average- 32.87%) were found in high percentage in all the three batches. The presence of such high levels of Fe seen in the Rajata bhasma can be attributed to the suvarna makshika used in the process of marana. This might also have been reason why the Rajata bhasma obtained by this method of preparation was reddish in colour and not black.

CONCLUSION

The statistical analysis of the results of physico-chemical and XRF analysis of all the three batches of Rajata Bhasma showed very small Standard Deviation. It can be concluded that the pharmaceutico-analytical approaches used in the present study was useful in the quality control and standardization of Rajata Bhasma according to the mentioned reference of Rasendrasara sangraha.

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