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ORIGINAL RESEARCH ARTICLE

A Pharmaceutical Study of Two Different Methods of Mercury Extraction from *Hingula*

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ABSTRACT

Introduction: Hingula is an important mineral source for the extraction of mercury (*Parada*) in Ayurvedic pharmaceutics. Classical texts of *Rasa Shastra* describe various methods for the extraction of mercury from Hingula. Comparative pharmaceutical evaluation of these methods is essential for understanding their efficiency, yield, and practical applicability.

Materials and Methods: In the present study, mercury extraction from Hingula was carried out by two different methods, namely *Urdhwa Patana Yantra* and *Nada Yantra*. Before extraction, Hingula shodhan was done as triturated with *Nimbu Swarasa* for 3 h and dried. In the *Urdhwa Patana yantra* processed Hingula was subjected to intense heating with continuous cooling of the upper chamber using *Jaladhara*. The remaining Hingula was processed using the *Nada Yantra* method as described in Siddha Bheshaja Manimala. Pharmaceutical observations, yield, and practical aspects of both methods were recorded and compared.

Results: During *Bhavana*, Hingula became soft, fine, and dull in color with approximately 1.5% increase in weight. In the *Urdhwa Patana* method, 1300 g of Hingula processed in five batches yielded 434 g of mercury. The method was found to be laborious, time-consuming, and associated with a higher processing cost. In contrast, the *Nada Yantra* method processed 1700 g of Hingula in seven batches and yielded approximately 1117.5 g of mercury (65.71%). The method proved more economical, efficient, and practically convenient.

Conclusion: Both methods were effective for the extraction of mercury from Hingula; however, the *Nada Yantra* method proved more efficient, economical, and suitable for pharmaceutical processing due to higher yield and operational convenience. The study supports the scientific and pharmaceutical relevance of classical Ayurvedic extraction techniques described in *Rasa Shastra*.

1. INTRODUCTION

Hingula is an important mineral drug extensively described in Ayurvedic literature, particularly in the field of *Rasa Shastra*. It is primarily composed of mercuric sulphide (HgS) and is considered one of the chief natural sources for the extraction of mercury (*Parada*).[1] Owing to its therapeutic significance and pharmaceutical utility, Hingula has been widely used in the preparation of various mercurial formulations described in classical Ayurvedic texts.[2]

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Mercury (*Parada*) occupies a supreme position in *Rasa Shastra* because of its unique properties, such as *Yogavahitva*, *Rasayana*, and broad therapeutic applicability. However, mercury obtained directly from mineral sources is not considered suitable for medicinal use without proper pharmaceutical processing. This type of extracted *Parada* is equal to *Asta Sanskarita Parada,* further used in the extraction of *Swarna*, *Rajata or Rasa Sindoor* preparation.[3] Therefore, ancient Ayurvedic scholars described several extraction and purification procedures to obtain therapeutically acceptable mercury with improved efficacy and safety.[4]

Classical texts such as Rasa Ratna Samuccaya and Rasendra Chudamani mention different methods for mercury extraction from Hingula, including *Urdhvapatana*, *Adhahpatana*, and heating techniques employing specific apparatus and processing

conditions.[5] These methods may differ in terms of pharmaceutical procedure, yield, duration, and quality of the extracted mercury. Comparative pharmaceutical evaluation of such methods is essential for understanding their practical applicability and standardization potential in contemporary Ayurvedic pharmaceutics.

Hence, the present study aims to evaluate and compare two different methods of mercury extraction from Hingula with respect to pharmaceutical procedure, yield, organoleptic characteristics, and practical utility. The study may contribute toward the scientific validation and standardization of classical methods described in *Rasa Shastra*.

1.1. Justification of Selected Methods

Among various types of Mercury extraction methods from *Hingula* mentioned in Rasa Shastra texts, through Urdhapatan Yantra mentioned in A.F.I., Part 1, app-2; (Rm-.1/16–17) was selected as its a commonly adopted method and compared with *Parada Niskashan* through *Nada Yantra* mentioned in *Siddha Bhaishajya Manimala* 5/4 to compare though both are based on *urdapatan* principle but differ due to difference in methodology.

1.2. Aims and Objectives

- To extract *Parad* from *urdapatan* method as per classical references
- To extract *Parad* as per classical references through *Nada Yantra* to develop SOP and SMP
- To compare the two extraction processes pharmaceutically.

2. MATERIALS AND METHODS

2.1. Procurement of Drugs

All these drugs were procured from the Jaipur market and were subjected them for genuinity. Raw drugs *Hingul* were procured from NIA pharmacy. *Nimbu* were purchased from the local market of Jaipur, and all the pharmaceutical studies were carried out in the laboratory *Rasashastra* and *Bhaishajya Kalpana* laboratory.

2.2. Pharmaceutical Process

For the convenience of the pharmaceutical process, the study has been divided as follows:

1. *Hingul shodhana*
2. *Parada nishkashan.*

2.3. Experiment No. 1

2.3.1. Hingulotha parada (Extraction of Mercury from Hingula)

In the Rasashastra, the extraction of Mercury from Hingula is considered the best one, and it is not required for the further shodhana process. The whole process was followed by adopting the following two steps:

1. *Hingula Shodhana*
2. *Parada Nishkashana.*

Name of the practical	*Hingul Shodhan*[6]
Reference	A.F.I., Part 1, app-2; (Rm-.1/16–17)
Principle	*Mardana*
Equipments	Knife, Juice extractor, Glass beaker, Kharal with mortar and weighing machine.

2.3.2. Procedure

Ashuddha Hingula (500 g.) was taken into Kharal and ground with a mortar for 5 min to make fine powder, then added lemon juice, and *Mardana* was done till complete drying of the liquid portion. The paste was pasted inside the earthen pot and allowed to dry. 10 g of the sample was preserved for further analysis (Table 1).

2.3.3. Observations

- The Hingula was made into fine powder initially
- After *Bhawana*, the color of *Hingula* was changed from bright red to dull red
- *Hingula* was seen softer and finer after *Bhawana*
- Shining of *Hingul* lost after *Bhawana*.

2.4. Results

The same process was repeated five more times and used for the extraction of mercury (Table 2).

2.4.1. Final results

Total Ashuddha Hingula – 3000 kg

After Shodhana Hingula Obtained- 3,046 Kg.

2.5. Experiment No. 2

Name of the practical	Extraction of Mercury from Hingula
Reference	A.F.I., Part 1, app-2; (Rm-.1/16–17)
Principle	*Urdha patana*
Equipments	Two earthen pots, weighing machine, heating apparatus (stove)

2.5.1. Procedure

Hingula was placed inside the earthen pot. The Mouth of one pot was sealed with another mouth of the pot and prepared in the shape of *Damaru yantra*, finally sealed with cotton cloth using multani mud and dried in the sunlight. Then the hingula contained pot was kept on fire and continuously heated. During the process, the upper one was kept cool by using a wet cloth. Strong heat was given for about 6 h, thereafter, it was kept for self-cooling. The next day, the seal was removed, and the mercury was collected from the upper portion of the upper pot. The sticky part of mercury was collected by scraping with a brush. Finally, the obtained mercury was filtered through a double-layered cloth and obtained mercury.

2.5.2. Observations

- Hingula was kept in the lower portion of the pot
- The Damaru yantra was sealed properly to prevent Mercury
- Upper pot was maintained cool during the entire process
- The upper pot appeared black and gray in color
- Heat was maintained as Teevragni for proper extraction temperature
- Mercury was obtained from the upper portion of the pot
- The obtained residue was mixed with Hingula and subjected to extraction.

2.6. RESULTS

The same process was repeated 5 times, 4 times and the results were shown in Tables 3 and 4.

2.6.1. Final results

- Total *Hingul* used - 1300 g
- Total yield - 434 g
- % Yield - 33.38%.

2.7. Experiment No. 3

Name of the experiment	Parada Niskashan through Nada Yantra
Reference	*Siddha Bhaishajya Manimala* 5/4
Principle	Extraction
Equipments	Cotton cloth (for Nada yantra), weighing machine,

2.7.1. Procedure

A. Preparation of Nada Yantra: Clean cotton cloth was taken and spread uniformly with fine powder of shuddha Hingula. The cloth was rolled tightly from both ends in opposite directions to make a bolus-like structure, which was further tied with cotton strips (Fig. no.), and it was placed at the center of a stainless steel plate and covered with a smooth surfaced lid. Thus, the Nadayantra was prepared and kept ready for the extraction of Mercury.

B. Extraction of mercury: Now, the bolus was ignited using small red hot charcoal pieces, and it was exposed to air for a few minutes to catch fire, then after, it was closed with Nada. The next day after self-cooling, the *Nada* was carefully removed, and mercury was procured from the inner surface of Nada, and the sticky portion was obtained by using a brush. Finally, the collected Mercury was filtered through double-folded cotton cloth.

2.7.2. Observation

- Nada Yantra was prepared as per the classical text
- The hingula was placed uniformly on the cloth
- Bolus prepared, such as a ball, and tied properly so as not to escape the hingula
- It was ensured that the Bolus was burnt completely.

2.8. Results

The same process was repeated for 6 times to develop SoP and SMP shown in Tables 5 and 6.

2.8.1. Final results

- Total Hingul used - 1700 g
- Total obtained Mercury - 1,117.5 g
- % of Yield - 65.71%.

The obtained mercury was filtered through a double-layered cloth and stored in a glass bottle, subjected to samskaras.

4. DISCUSSION

In Ayurvedic pharmaceutics, the final preparation of a drug requires several preliminary pharmaceutical procedures to ensure safety, efficacy, and therapeutic acceptability. In the present study, Hingulottha Parada was selected for pharmaceutical evaluation because classical texts consider it comparatively free from *Kanchuka Doshas* and therapeutically equivalent to *Samaguna Gandha Jarita Parada*. Extraction of mercury from Hingula was carried out using two different methods, namely *Urdhwa Patana Yantra* and *Nada Yantra* method, to evaluate their pharmaceutical utility, yield, and practical applicability.

In the first method, Hingula was triturated with *Nimbu Swarasa* for approximately 3 h before heating. The process of *Bhavana* with lemon juice appears to play an important role in facilitating the extraction of mercury. Lemon juice contains citric acid along with minerals such as calcium, phosphorus, iron, potassium, sodium, sulfur, folic acid, and pantothenic acid. Citric acid and other organic acids may act as chelating agents and facilitate weakening of the Hg–S bond present in mercuric sulfide (HgS). Mechanical trituration during *Bhavana* reduces particle size, increases surface area, and ensures uniform exposure of Hingula particles to acidic media, thereby facilitating easier dissociation and sublimation of mercury during heating.

The probable mechanism involved may include partial chemical detoxification and complex formation with metallic impurities such as lead (*Naga*) and tin (*Vanga*), which may contribute toward the purification of mercury. During trituration, Hingula became soft, finer in consistency, and dull in color, indicating pharmaceutical transformation due to the processing. A slight increase of approximately 1.5% in weight was observed after *Bhavana*, possibly due to the incorporation of solid contents from *Nimbu Swarasa*.

After drying, the processed Hingula was subjected to *Urdhwa Patana* using a specially designed *Urdhwa Patana Yantra*. In this method, *Teevragni* was applied to facilitate the sublimation of mercury. The upper pot of the apparatus was continuously cooled using *Jaladhara* to maintain a lower temperature for condensation of mercury vapors. New earthen pots were used for each batch, which probably facilitated the escape of free sulfur gases through micropores present in the earthen material. This may have enhanced the separation and condensation of purified mercury.

Pharmaceutically, the extraction process can be explained on the basis of sublimation and thermal decomposition reactions. Upon heating in a closed system, the weakened Hg–S bonds dissociate. Sulphur undergoes oxidation and escapes mainly as sulfur dioxide gas, whereas mercury vaporizes due to its lower boiling point and condenses in the cooled upper chamber. Impurities such as lead and tin possess comparatively higher boiling points and therefore remain at the bottom of the apparatus without sublimation. This may explain why *Hingulottha Parada* is considered devoid of *Kanchuka Doshas* in Ayurvedic literature.

The probable chemical reactions may be represented as follows:

$$HgS + \text{Organic acids} \rightarrow \text{Weakening of Hg–S bond}$$

$$2HgS + 3O_2 \rightarrow 2HgO + 2SO_2$$

$$2HgO \rightarrow 2Hg + O_2$$

The process of sublimation employed in this study resembles modern pharmaceutical purification techniques, wherein volatile compounds are separated from non-volatile impurities under controlled heating conditions. The condensed mercury obtained after sublimation can therefore be considered pharmaceutically purified and therapeutically superior.

In the present study, a total of 3 kg of Hingula was initially processed with *Nimbu Swarasa*. Out of this, 1300 g of Hingula was subjected to *Urdhwa Patana* in five batches, each containing approximately 250 g of material. The total yield obtained was 434 g of mercury. The relatively lower yield observed in this method may be attributed to incomplete sublimation, shorter duration of *Teevragni*, possible loss of mercury vapors during processing, and adherence of mercury to the apparatus. It was observed that prolongation of intense heating beyond 6 h might improve the yield; however, this would further increase fuel consumption, processing cost, and environmental pollution.

Considering the comparatively low yield, high processing cost, labor-intensive nature, and time-consuming procedure of *Urdhwa Patana*,

the remaining 1700 g of Hingula was processed using the *Nada Yantra* method as described in Siddha Bheshaja Manimala. The material was processed in seven batches and yielded approximately 1117.5 g of mercury, corresponding to about 65.71% yield. This method proved to be more practical, economical, and efficient compared to *Urdhwa Patana*. Higher yield, lower fuel consumption, reduced processing time, and easier collection of mercury were the major advantages observed in the *Nada Yantra* method.

Thus, comparative pharmaceutical evaluation of both methods indicates that although *Urdhwa Patana* provides purified mercury through classical sublimation principles, the *Nada Yantra* method appears superior from the practical and pharmaceutical perspective due to its higher yield, cost-effectiveness, and operational convenience. The study also highlights the scientific basis underlying classical Ayurvedic pharmaceutical procedures and supports their relevance in contemporary standardization studies.

4.1. Comparative Aspects of Both Methods of Mercury Extraction from Hingula

Comparative evaluation of the *Urdhwa Patana Yantra* and *Nada Yantra* methods revealed significant differences with respect to pharmaceutical procedure, yield, cost-effectiveness, processing time, and practical applicability. Both methods are based on the principle of thermal decomposition and sublimation of mercury from Hingula; however, the efficiency and practicality of the procedures varied considerably.

In the *Urdhwa Patana* method, Hingula processed with *Nimbu Swarasa* was subjected to intense heating in a closed apparatus with continuous cooling of the upper chamber through *Jaladhara*. The method produced comparatively purified mercury and effectively separated non-volatile impurities such as *Naga* and *Vanga*. The use of fresh earthen pots in every batch facilitated the escape of sulfur fumes through micropores and aided the condensation of mercury vapors. However, the procedure was highly laborious, time-consuming, and expensive due to repeated setup requirements, prolonged heating, and higher fuel consumption. In addition, only 434 g of mercury was obtained from 1300 g of Hingula, indicating a comparatively lower yield.

In contrast, the *Nada Yantra* method described in Siddha Bheshaja Manimala proved to be more efficient and economical. A total of 1700 g of Hingula processed through this method yielded approximately 1117.5 g of mercury, corresponding to around 65.71% yield, which was significantly higher than the *Urdhwa Patana* method. The procedure required comparatively less fuel, a shorter duration of heating, and reduced operational complexity. The collection of mercury was also easier and more convenient in this method. From a practical pharmaceutical perspective, the *Nada Yantra* method demonstrated better feasibility for large-scale processing and minimized material loss during extraction.

Pharmaceutically, both methods achieved extraction of mercury based on sublimation principles, but the *Nada Yantra* method showed superior efficiency with respect to yield, cost-effectiveness, ease of operation, and time management. Nevertheless, *Urdhwa Patana* remains important from the classical and purification viewpoint because it provides a highly controlled sublimation process traditionally considered useful for obtaining mercury devoid of *Kanchuka Doshas*.

Therefore, the comparative study suggests that although both methods are scientifically and pharmaceutically valid, the *Nada Yantra* method appears more suitable for practical and large-scale pharmaceutical applications, whereas the *Urdhwa Patana* method retains classical significance in Ayurvedic pharmaceutics.

5. CONCLUSION

The present pharmaceutical study demonstrated that both *Urdhwa Patana Yantra* and *Nada Yantra* methods are effective for the extraction of mercury from Hingula based on the principle of thermal decomposition and sublimation. Processing of Hingula with *Nimbu Swarasa* before extraction facilitated particle size reduction, weakening of Hg–S bonds, and enhanced sublimation of mercury during heating.

The *Urdhwa Patana* method yielded pharmaceutically purified mercury considered free from *Kanchuka Doshas*; however, the procedure was laborious, time-consuming, expensive, and produced comparatively lower yield. In contrast, the *Nada Yantra* method provided significantly higher yield with reduced fuel consumption, lower processing cost, easier operation, and better practical applicability.

Comparative evaluation revealed that although both methods are pharmaceutically significant and scientifically justified, the *Nada Yantra* method proved to be more efficient, economical, and suitable for large-scale pharmaceutical processing of mercury from Hingula. The study also highlights the scientific basis and pharmaceutical relevance of classical Ayurvedic metallurgical procedures described in *Rasa Shastra*.

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7. AUTHORS' CONTRIBUTIONS

All authors give equal contribution in making of this manuscript.

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9. ETHICAL STATEMENT

This study does not require Institutional Ethical Committee approval as it is an experimental study.

10. CONFLICT OF INTERESTS

The authors declare no conflicts of interest regarding the publication of this paper.

11. DATA AVAILABILITY STATEMENT

The data analyzed in this review were obtained from publicly available sources, including peer-reviewed articles, observational studies, and surveys accessible through databases.

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Table 1: Results of *Hingula Shodhana*

S. No.	Batch	Ashddha Hingul (g)	Lemon Juice (mL)	Weight of Shuddha Hingula (g)
1.	AH1	500	80	508

Table 2: The Results of Hingula Shodhana of Different Batches

S. No.	Batch	Ashddha Hingul (g)	Nimbu Swaras (mL)	Weight of Shuddha Hingula (g)
1	H1	500	80	511
2	H2	500	75	510
3	H3	500	60	505
4	H4	500	60	504
5	H5	500	70	508

Table 3: Observations of the extraction of Mercury (Urdha Patana)

S. No.	Batch	Amount of HgS	Amount of Hg extracted (%)	Residue in lower pot
1	P1	250 g	79 g (31.6)	2 g

Table 4: Observations of the extraction of Mercury in Different Batches (Urdha Patana)

S. No.	Date	Amount of HgS	Amount of Hg extracted (%)	Residue in lower pot
1	P2	250 g	52 g (20.8)	4.52 g
2	P3	250 g	75 (30)	-
3	P4	300	139 g (46.33)	12 g
4	P5	250 g	54 g (16.36)	Nothing left

Table 5: The results of *Hingulottha Parada* (Nada yantra)

Sr. No.	Batch	Shuddha Hingula (g)	Cotton Cloth (g)	Obtained Parada (g)	Obtained Parada %
1	NP1	200.0	200.0	111	55.50

Table 6: The results of *Hingulottha Parada* (Nada yantra) in Different Batches

Sr. No.	Batch	Shuddha Hingula (g)	Cotton Cloth (g)	Obtained Parada (g)	Obtained Parada %
1	NP2	250.0	250.0	182.5	73.00
2	NP3	250.0	250.0	128.0	63.20
3	NP4	250.0	250.0	170.0	68.00
4	NP5	250.0	250.0	167.65	67.06
5	NP6	250.0	250.0	175.0	70.00
6	NP7	250.0	250.0	183.0	73.20