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STANDARDISATION AND OPTIMIZATION OF MERCURY EXTRACTION FROM CINNABAR (HINGULA) USING THE NADA YANTRA METHOD IN AYURVEDIC PRACTICE

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ABSTRACT

The extraction of mercury (*Parada*) from cinnabar (*Hingula*) is a critical process in *Ayurvedic* medicine, particularly for use in metallic and mineral formulations known as *Rasayoga*. Traditional methods for mercury extraction, such as *Urdhva Patana* (upward sublimation), *Adhah Patana* (downward sublimation), and *Tiryanka Patana* (transverse sublimation), face challenges in terms of efficiency and environmental concerns. This research addresses contemporary efficiency, safety, and environmental issues while creating a refined and standardised procedure for extracting mercury (*Parada*) from cinnabar (*Hingula*) utilising conventional *Ayurvedic* techniques. This study aims to refine mercury extraction by applying the *Nada Yantra* method, a specific approach detailed in classical *Ayurvedic* texts. A series of pharmaceutical trials developed a standard operating procedure (SOP) to optimise mercury yield from *Hingula* with and without purification (*Shodhana*). The process involves a series of sublimations following purification steps and a series of sublimations without purification, ensuring effective procurement of mercury for medicinal use. The study successfully standardises and compares mercury extraction from cinnabar with and without purification using the *Nada Yantra* method, yielding approximately 60% and 45

% purified mercury, respectively. This optimised process is efficient, environmentally considerate, and suitable for modern *Ayurvedic* practices, ensuring safe and high-quality mercury for medicinal use without additional purification steps for *Parada Shodhana.* The project aims to create a repeatable standard operating procedure (SOP) for mercury extraction using the *Nada Yantra* technique, which has its roots in ancient writing but has been updated for modern applications. This method offers a reproducible and efficient means of obtaining purified mercury, suitable for modern *Ayurvedic* pharmaceutical practices. Enhancing the quality and yield of mercury for use in *Ayurvedic* medicinal formulations by improved extraction techniques would ensure that the material is safe, effective, and comply with environmental and regulatory requirements.

Keywords: *Ayurveda, Hingula, Parada, Nada Yantra, Patana, Shodhana,* Cinnabar, Mercury

INTRODUCTION

Rasa Shastra, the branch of Ayurveda that deals with the preparation and use of metals, minerals, and toxic substances, has always emphasised mercury (*Parada*) due to its extraordinary therapeutic properties. *Parada*, when properly purified and processed, is believed to act as a potent rejuvenator, increasing the efficacy of *Rasayoga.* However, *Parada* must be prepared according to strict guidelines to prevent toxic effects, as unpurified mercury and its compounds are known to be harmful. *Hingula,* the naturally occurring mineral form of mercuric sulfide (HgS), has been used since ancient times as a primary source of mercury in *Ayurvedic* medicine. Various methods of extracting *Parada* from *Hingula* exist, but they all revolve around the same principle—using heat to liberate mercury from its sulfide form. *Parad* can be extracted from *Hingula* through various *Patana* procedures viz. *Urdhva, Adhah, Tiryaka*.[1] One of the most recommended techniques is the *Urdhva Patana* (upward sublimation) method, typically carried out using the *Nada Yantra*, a traditional *Ayurvedic* apparatus.[2] A critical step in preparing medicinal-grade *Parada* involves the *Shodhana* (purification) of *Hingula*. *Shodhana* helps to eliminate impurities and reduce the toxicity of minerals.[3] The classical texts describe various purification techniques, with *Bhavana* (triturating) in acidic media being one of the most commonly employed methods. This process is believed to enhance mercury quality, making it safer and more potent for therapeutic use. Despite these traditional practices, little scientific comparison has been made to quantify the difference in yield and quality of *Parada* extracted from purified and unpurified *Hingula*. This study aims to provide a detailed comparison, focusing on the differences in yield between the two processes and analyzing the implications of purification on the efficiency of mercury extraction.

Literature Review

The use of mercury in *Ayurvedic* medicine has always been a subject of debate due to the toxic nature of mercury. However, classical *Rasa Shastra* texts like Rasa Ratna Samuchchaya, Rasendra Chudamani, and Rasa Tarangini stress the use of *Shodhana* to detoxify mercury before using it in medicinal preparations. The primary source of mercury in these formulations is *Hingula* (Cinnabar), which is subjected to both physical and chemical processes to extract *Parada*. Rasendra Sara Sangraha [4] and Rasa Tarangini [5] recommend various purification techniques, including triturating *Hingula* with *Nimbu Swarasa* (lemon juice) or other acidic substances. This process of *Bhavana* (triturating) removes harmful components and improves the ability of mercury to be sublimated during the extraction process.

Table 1: *Shodhana* of *Hingula*

S.No.	Procedure	Duration	Source Text
1.	*Bhavana* (Levigation) with *Aardraka Swarasa* (Ginger juice)	7 times	R.T., R.Chu., R.R.S., A.P., R.J.N., B.R.R.S., R.Mi., R.Sa.San.
2.	*Bhavana* with *Lakucha Swarasa* (*Artocarpus lacucha*)	7 times	R.T., R.R.S., A.P., R.J.N., B.R.R.S., R.Sa.San, R.Chu.
3.	*Bhavana* with *Meshidugdha* (sheep's milk)	7 times	R.T., R.R.S., R.J.N., A.K., B.R.R.S., Y.R., R.Chi., R.Sam, R.Bhas., Rasarnava. R.Mi., R.M.
4.	*Bhavana* with *Amlavarga* (citrus group)	7 times	R.T., R.R.S., R.J.N., B.R.R.S., R.Sa.San, R.Chi., A.K, R.Bhas., Rasarnava, R.M.
5.	*Bhavana* with *Kamala Patra Rasa* (lotus petal juice)	3 hours	Y.R.
6.	*Bhavana* with *Nimbuk Rasa* (lemon juice)	7 times	R.T., R.R.S., R.Mi. R.Sam, R.Bhas., Siddha yoga san-graha
7.	*Bhavana* with *Beejapoorak Rasa* (big/wild lemon juice)	3 times	R.R.S.
8.	*Bhavana* with *Mahisha Ksheera* (buffalo's milk)	7 times	R.Sa.San, R.Sam
9.	*Swedana* (sudation) in *Dola Yantra* with *Jambeera Drava*	3 hours	R.R.S, R.J.N.
10.	*Swedana* in *Dola Yantra* with *Jayanti rasa/ Gomutra/ Kaanji*	3 hours	B.R.R.S, R.J.N.
11.	*Swedana* in *Dola Yantra* with *Lakucha Swarasa*	3 hours	R. Pra. Su.

According to the classical texts of *Rasa Shastra*, *Parada* extracted from *Hingula* is free from various impurities (*dosha*) and does not require further purification processes (*Samskara*). It can be used without undergoing the eight *Samskara*. Additionally, texts like Rasendra Chudamani [6] and Rasa Prakash Sudhakar [7] state that mercury derived from *Hingula* may exhibit the same properties as *Shadguna Bali Jarita Parada* (mercury treated with sulfur six times), making it superior to ordinary mercury in terms of purity and potency.

Table 2: Showing the references and methods of *Hingulottha Parada* along with materials used

Sr. No.	References	Media used	*Bhavana*	Principle	*Yantra*
1.	Rasarnav 7/48	*Hingula* + *Gomansa* (meat of cow), *Mahisha Mutra* (Buffalo urine), *Tila Tail* (Sesame oil), *Amla*, *Dadhi* (curd) → *Agni* for 3 days in each *dravya*	*Shikhipitta*	*Patana*	*Patana Yantra*
2.	R.S.S. 1/58. Rasa Paddhati Page 18. R.T. 5/38	*Hingula*	*Paribhadra* (*Erythrina Linn*. Var. *Orientalis*	*Urdhva Patana*	-

			(Linn) Merrill) *Swarasa*		
3.	R.S.S. 1/55. R.T. 5/38	*Hingula*	*Changeri* (*Oxalis corniculata* Linn.) *Swarasa*	*Urdhva Patana*	-
4.	R.S.S.1/58. Rasa Paddhati Page 18. R.T.S. Paribhasha. R.T. 5/38	*Hingula*	*Jambir Nimbu* (*Citrus limon* (Linn.) Burm.f.) *Swarasa*	*Urdhva Patana*	-
5.	R.R.S. 1; Anand Kanda Kriyakaran Vishranti 2/193. R.J.N. Part 2, chap 3	*Hingula*		*Patana*	*Patana Yantra*
6.	Rasa Paddhati Page 18	*Hingula* (*Pottali*) + *Snuhikshira* (Latex of *Euphorbia neriifolia* Linn.), *Tila Tail, Kanji* (sour gruel) → *Swedana* for 3 hr	*Ucchha prachalaki* (bile of peacock) 7 *Bhavana*	*Urdhva Patana*	-
7.	Rasendra Chudamani 4/42	*Hingula*	*Adraka* (Zingiber officinale Rosc.) *Swarasa*	*Urdhva Patana*	*Vidyadhara Yantra*
8.	Rasa Ratnakar Ruddhi Khanda 2/48	*Hingula* + *Gomutra* (cow urine), *Mahisha Mutra, Tila Tail, Sura, Amla* → *Kramagni* for 7 days in each dravya	*Mayurpitta* (bile of peacock)	*Patana*	-
9.	Rasa Ratnakar Ruddhi Khanda 2/53	*Hingula*	*Amla rasa* (Acidic media)	*Patana*	-
10.	S.B.M.M. 5/3	*Hingula* + *Siktha* make *Varti*	-	*Patana*	-
11.	S.B.M. 5/4	*Hingula* + *Vastra* in *Sharav*	-	*Patana*	-
12.	S.B.M. 5/5	*Hingula* + *Haridra* (Curuma) in *Vastra*	-	*Patana*	*Sthalika*
13.	S.B.M. 5/6	*Hingula* in *Chaturguna Vastra*	-	*Patana*	*Nada Yantra*
14.	A.P. 2/83	*Hingula*	-	*Patana*	*Damaru Yantra*
15.	A.P. 2/84. Rasendra Vigyan 1	*Hingula*	*Nimbu Swarasa*	*Urdhva Patana*	
16.	A.P. 2/84. R.T.S. Paribhasha;	*Hingula*	*Nimba patra Swarasa*	*Urdhva Patana*	
17.	Rasamrita Pa-	*Hingula*	*Nimbu Swarasa*	Tiryaka	

	rishishta-2			*Patana*	
18.	Rasa Chikitsa Page 43	*Hingula*	*Amaruk Shak Bhavana* + 1 Day *Sthapan*	*Patana*	

The *Nada Yantra* method employed here is a type of *Urdhva Patana.* Siddha Bhaishajya Manimala first described the application of the Nada Yantra for the extraction of Parada. In this method, *Hingula* is placed in a traditional apparatus called the *Nada Yantra* and heated. As the temperature rises, the mercury sublimates and is collected through condensation.

Several previous studies have also shown that different techniques of *Parada* extraction yield varying amounts of mercury. These studies, however, did not emphasize the difference in yield between purified and unpurified *Hingula*. This study fills that gap by focusing specifically on how the purification process affects both the quantity of *Parada* obtained and the efficiency of the extraction process.

Objectives

The primary objective of this study is to compare the yields of *Parada* obtained from *Hingula* with and without undergoing *Shodhana*. Specifically, this study aims to:

1. Evaluate the difference in *Parada* yield between unpurified *Hingula* and *Hingula* subjected to *Shodhana*.
2. Examine the effects of purification on the quantity of *Parada*.
3. Reaffirm the significance of classical purification practices in increasing the efficacy and safety of *Ayurvedic* formulations.
4. Develop a standardized procedure for *Parada Nishkasana* from *Hingula.*

Materials and Methods

Materials

Hingula (Cinnabar) was procured from the local market of Paprola, and divided into two batches:

1. **Unpurified *Hingula***: Directly used for the extraction process without undergoing any purification.
2. **Purified *Hingula***: *Hingula* was purified according to classical *Ayurvedic* procedures before use in *Parada* extraction.

Other materials included:

- *Nimbu Swarasa* (Lemon juice) for the *Shodhana* process.
- Cotton cloth for wrapping the *Hingula* during *Parada* extraction.
- *Nada Yantra*, an *Ayurvedic* apparatus used for sublimating mercury from *Hingula*.

***Shodhana* Procedure:**

The *Shodhana* (purification) of *Hingula* was performed by triturating (*Bhavana*) it seven times with *Nimbu Swarasa*. The purification process softens the *Hingula* and transforms its crystalline form into a fine powder, making it more suitable for mercury extraction.

- *Hingula*: 1.5 kg divided into 3 batches of 500 g
- *Nimbu Swarasa*: Quantity sufficient
- Each batch of *Hingula* was triturated and dried afterward.

During the *Bhavana* process, the physical properties of *Hingula* change, with the crystalline structure breaking down and the reddish-brown powder becoming softer. The pH of the lemon juice used was measured at 2.0, indicating an acidic medium that aids the purification process by removing impurities.

***Parada* Extraction Procedure**

The *Urdhva Patana* (upward sublimation) method was used for mercury extraction, in which *Hingula* is subjected to high temperatures to sublimate the mercury. The procedure was identical for both unpurified and purified *Hingula* to ensure consistency in comparative study.

Steps involved in the *Parada* extraction:

1. A square piece of cotton cloth (48 cm X 48 cm) was taken, and a layer of cotton was spread over it.
2. *Hingula* powder was spread evenly on cotton cloth.
3. The cloth was then rolled up into a bowl, placed inside an earthen *Sharava* (saucer), and ignited.
4. The *Sharava* with burning bolus was placed in the *Nada Yantra*.

5. Mercury vaporized from the *Hingula* and condensed inside the *Nada Yantra*, from where it was collected.
6. The mercury obtained was washed several times and preserved carefully.

Group 1: Unpurified *Hingula* Extraction

- *Ashuddha Hingula* was divided into three batches
- 500 g of unpurified *Hingula* was used in each batch.
- The mercury yield was calculated after each extraction.

Group 2: Purified *Hingula* Extraction

- *Shuddha Hingula* was divided into three batches
- 500 g of purified *Hingula* (processed with *Nimbu Swarasa*) was used in each batch.
- The mercury yield was calculated similarly after each extraction.

Results

Hingula Shodhana

Over the 7 days, 870 ml *Nimbu Swarasa* was used. The amount of lemon juice used, and the trituration time decreased for all three batches, with lemon juice dropping from 50 ml to 35 ml and trituration time reducing to 20 minutes. Despite these reductions, the amount of *Hingula* obtained increased for each batch, with Batch I am yielding 500 g to 512 g, Batch II rising from 500 g to 515 g, and Batch III going from 501 g to 511 g. This trend suggests that more efficient *Hingula* production is achievable with less lemon juice and shorter trituration times. The average gain was 2.53% possibly due to the addition of Total solids from *Nimbu Swarasa.*

Table 1: *Shodhana* of *Hingula*

Day	Amount of Lemon Juice (ml)			Time Taken in Trituration			*Hingula* Obtained (g)		
	Batch I	Batch II	Batch III	Batch I	Batch II	Batch III	Batch I	Batch II	Batch III
1st	50	48	47	1 hour	1 hour	1 hour	500	500	501
2nd	44	46	45	35 min	30 min	37 min	502	501	503
3rd	42	44	43	32 min	30 min	35 min	505	503	504
4th	41	43	42	30 min	28 min	25 min	506	506	507
5th	40	40	41	28 min	25 min	25 min	509	509	508
6th	38	39	36	20 min	20 min	20 min	510	511	509
7th	35	30	36	20 min	20 min	20 min	512	515	511

Parad Extraction

Group 1: Yield of *Parada* from Unpurified *Hingula*

In this group, the extraction of *Parada* from unpurified *Hingula* yielded an average of 45% *Parada*. Out of 1500 g of unpurified *Hingula*, approximately 675 g of mercury was obtained. Some pieces of *Hingula* were found unburnt. This indicates that a significant portion of the mercury could not be extracted, potentially due to impurities or the inefficiency of the extraction process with unpurified materials.

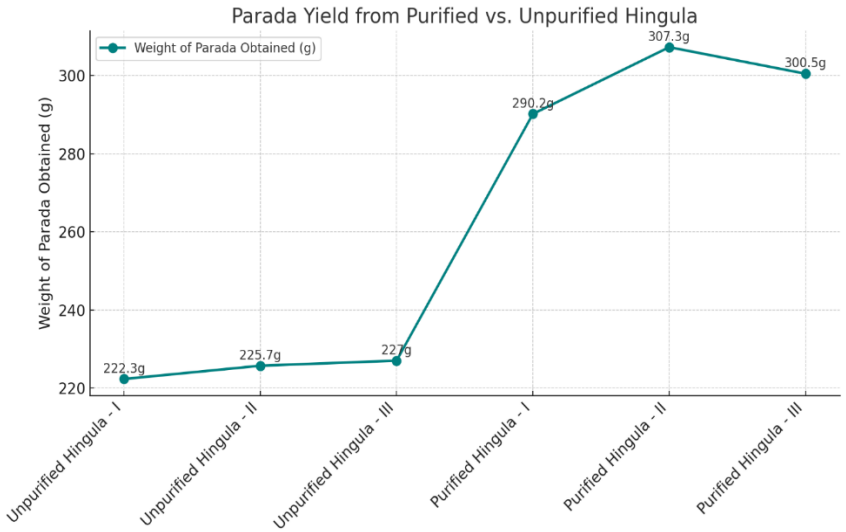
Group 2: Yield of *Parada* from Purified *Hingula*

In contrast, the extraction from purified *Hingula* yielded a higher percentage of mercury. On average, the yield was 60%, with 898 g of *Parada* extracted from 1500 g of *Hingula*. The higher yield demonstrates the effectiveness of the *Shodhana* process in enhancing mercury extraction.

Table 2: Results of *Parada* extraction

Group	Weight of *Hingula* Used	Weight of *Parada* Obtained	Time Taken	Percentage Yield
Unpurified *Hingula* -I	500 g	222.3 g	6 Hours	44.46%
Unpurified *Hingula* -II	500 g	225.7 g	6 Hours	45.14%
Unpurified *Hingula* -III	500 g	227 g	6 Hours	45.40%

Purified *Hingula* -I	500 g	290.2 g	8 Hours	58.04%
Purified *Hingula* -II	500 g	307.3 g	8 Hours	61.46%
Purified *Hingula* -III	500 g	300.5 g	8 Hours	60.10%



DISCUSSION

The extraction of *Parada* (mercury) from *Hingula* (cinnabar) is a vital process in *Ayurvedic Rasa Shastra*, using *Shodhana* to purify toxic materials for medicinal use. This study confirms *Shodhana's* effectiveness, yielding 60% *Parada* from purified *Hingula* compared to 45% from unpurified material.

Factors Influencing Yield:

1. **Impurities in Unpurified *Hingula*:** Natural *Hingula* contains minerals that bind with mercury, reducing extraction efficiency.
2. **Chemical Changes via *Shodhana*:** Acidic *Bhavana* with *Nimbu Swarasa* (pH 2.0) breaks down impurities and facilitates mercury release.
3. **Structural Changes:** Acidic treatment softens the *Hingula*, ensuring uniform heat distribution during sublimation and higher mercury yield.

Supporting Evidence:

Results align with previous studies reporting up to 70% mercury yield from purified *Hingula*, validating *Shodhana's* benefits across studies despite variations in raw material purity.

Practical Implications:

Higher mercury yield reduces raw material use, cutting costs and environmental impact in *Ayurvedic* pharmaceutical production. Purified *Parada* ensures safer and more effective formulations.

Role of *Nimbu Swarasa*:

Nimbu Swarasa enhances purification by dissolving impurities, increasing surface area through trituration, and optimizing heat distribution during sublimation. Various processes, such as thermo- and photochemistry, physicochemical reactions, and mechanochemical changes, appear to occur during wet grinding.[8]

Challenges and Future Directions:

Mercury vapor loss and toxicity require improved extraction techniques, advanced equipment, and strict safety measures to ensure sustainable and safe practices.

This study reinforces *Shodhana* as a scientifically sound and sustainable method for enhancing mercury extraction.

CONCLUSION

In summary, this study underscores the crucial role of *Shodhana* in optimizing the extraction of *Parada* from *Hingula*. Purification processes significantly enhance the yield, improving it from 45% in unpurified *Hingula* to 60% in purified *Hingula*. This increase not only validates classical *Ayurvedic* practices but also highlights the importance of meticulous puri-

fication in achieving high-quality, effective medicinal preparations. The improved yield from purified *Hingula* supports the traditional *Ayurvedic* view that purification is essential for ensuring the safety and efficacy of medicinal mercury.

The practical implications of these findings include more efficient and cost-effective pharmaceutical production. The study also suggests that integrating modern safety standards with traditional *Ayurvedic* techniques could further enhance extraction efficiency and ensure the safe handling of mercury. Overall, the research reaffirms the value of classical *Ayurvedic* methods and provides empirical support for their continued use in contemporary pharmaceutical practices, emphasizing the need for ongoing refinement and adherence to both traditional and modern safety protocols.

Abbreviations

R.T.- Rasa Tarangini, R.R.S.- Rasa Ratna Samucchaya, R.J.N.- Rasa Jala Nidhi, A.K.- Ananda Kanda, B.R.R.S.- Brihat Rasa Raja Sundara, Y.R.- Yoga Ratnakara, R.Chi.- Rasendra Chintamani, R.Sam-Rasendra Sambhava, R.Bhas.- Rasendra Bhaskar, R.Mi.- Rasa Mitra, R.M.-Rasa Manjari, R.Pra.Su.- Rasa Prakash Sudhakar, R.Sa.San- Rasendra Sara Sangrah

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Fig. 1: Ashuddha Hingula

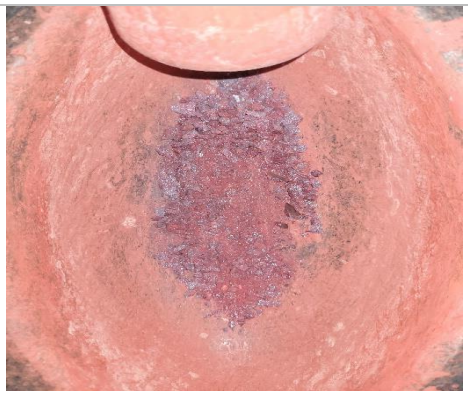

Fig. 2: Pounded Hingula in Kharal

Fig. 3: Nimbu Swaras Bhavana

Fig. 4: Drying after Bhavna

Fig 5: Spreading Powdered Hingula on Cloth

Fig. 6: Rolling the cloth

Fig. 7: Prepared bolus

Fig 8: Igniting the bolus

Fig. 9: *Nada Yantra* covering bolus

Fig. 10: Parad Globules in *Nada Yantra*

Fig. 11: Parad collected from *Nada Yantra*

Fig 12: Parad after washing

Fig 13: Collected Hingulotha Parad