Review Article

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ANCIENT AND CONTEMPORARY VIEW ON MUSHA

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ABSTRACT

Musha eliminates Dosha (impurities) from the mineral compound (Rasa Dravya). In modern science, they are referred to as Crucibles. In Rasa Shastra, unique tools called Musha are mentioned to process Rasa Dravya. They are referenced in every Rasa Shastra literature, demonstrating their equal value to other accessories like Yantra (instruments) and Kosthi (furnaces). There are numerous types of Musha, including Samanya, Vrintak, Gostani and Maha. Krounchika, Karhatika, Pachani, and Vahnimitra are some of their unusual synonyms. Their description in the Rasa Granthas piques interest in methodically learning about Musha. This article makes an effort to review the variegated Mushas.

Keywords: Musha, crucible, Pidhanaka.

INTRODUCTION

In Rasa Shastra, there are diverse instruments that are used for the arduous operations of controlling Parada by performing numerous processes. One among them is Musha. It is explained after Yantras, which shows that Musha is also a form of Yantra that helps to conduct the Rasa Karma (processing of metals and minerals).

Musha is called so, as it helps in eradicating blemishes from metals and minerals.[1] There is no definite number of Musha in the texts because they are mentioned as per situation and necessity. The captivating synonyms of Musha like Kumudi, Krounchika, Vahnimitra, and Karahatika suggest its multifaceted features.[2] Musha is of different kinds like Samanya Musha, Pakva Musha, Vajra Musha, Vajra Dravini Musha etc. It is accustomed to the Satvapatana (Separation of the essence), Satvadravana and Satvashodhana (Purification of Satva) of Satvayukta Dravyas.

Definition

Musha is defined as the one, which helps Rasa Dravya to undergo a definite duration of the transformation. Therefore, it does the purification of Rasa Dravya and is a device used to remove the removable dosha. [1]

Synonyms

Kumudi, Krounchika, Vahnimitra, Karahatika, Pachani.[2]

Kumudi: Resembles the Shape of Kumuda- White Lily/ Lotus flower.

Krounchika: As the soil of Krouncha mountain is suitably used to prepare Musha.

Vahnimitra: In contact with Fire.

Karahatika: As the soil of Karhata Desha is ideal for preparing Musha.

Pachani: Prepared by Baking well and also the material is subjected to Pachana in Musha.

Upadana of Musha (Base of Musha)

As per Rasa Ratna Samuchhya, Mritika (clay) and Loha Churna (iron powder) are the basic requirements for the construction of Musha[3]. Rasa Taranginikar specifies Musha nirmanochita Mritika as Sasarkara, Pandura Sthula and Vahnitapsaha[4]. In their substitution, Valmiki Mritika (Ant hill mud) or Kaulali Mritika (Potter's mud) can be used. [5]

Parts of the Musha

There are two main parts of the Musha:

1. Upper part (Pidhanaka): The lid or covering that prevents the Rasa Dravyas from spilling off from the Musha and helps in lifting the Musha.
2. Lower basal part: Used to keep materials for heating.
3. Sandhi Lepana**:** It is an application of a mixture of Loha Kitta (Iron Rust), mud etc which seals the joint of Musha and Pidhanaka. It is also known as Sandhibandhana. [6]

Basic Materials Needed in the Construction of Musha

Dagdha Tusha (Burnt Husk), Pashana Churna**,** Angara (Burnt Charcoal), Lohakitta (Iron slag), Dagdhagara (Burnt clay), Sana (Jute), Vida (Salt), Bhunaga Mritika (Earthworm soil)**,** Krushna Mritika (Black soil), Shweta Mritika (White soil), Rakta Mritika (Red soil), Valmika Mritika (Ant hill mud), Shwetashma (Limestones), Kupi Churna (Glass powder), Sukti Churna (Coral

Powder), Ishtika Churna (Brick powder), Mahisha Kshira (Buffalo milk).

Types of Musha

No definite number of Musha is mentioned in any Classical Text. As to a thorough assessment of diverse sources, the Mushas are explained as follows,

Table 1: Musha and their names in various Classical texts

Name of the Musha	Rasendra Chudamani [7]	Rasa Ratna Samuchaya [8]	Rasa Tarangini[9]	Rasarnava[10]	Rasa Hridya Tantra [11]	Rasa Prakasha Sudhakara [12]
Vajra	+	+	+	+	-	+
Gara	+	+	+	-	-	+
Vara	+	+	-	+	-	
Vajradravani	+	+	+	-	-	
Varna	+	+	-	-	-	+
Andha	-	-	-	+	-	
Raupya	+	+	-	-	-	+
Bhasma	-	-	-	+	-	
Yoga	+	+	+	-	-	+
Prakasha	-	-	-	+	-	
Vruntaka	+	+	+	-	-	+
Pakwa	+	+	-	-	-	+
Malla	+	+	+	-	-	+
Gola	+	+	+	-	-	
Maha	+	+	-	-	-	+
Manduka	+	+	-	-	-	+
Mushala	+	+	-	-	-	+
Garbha	-	-	-	-	-	+
Gostani	+	+	+	-	+	+
Bida	+	+	-	-	-	+
Vata	-	-	-	-	-	+
Vajradravana	+	+	-	-	-	-

Classification of Musha

Musha can be classified based on their composition, colour and shape.

Table 2: Classification of Musha [13]

Based on composition	Based on colour	Based on shape
Samanya Musha	Varna Musha	Gostani Musha
Vajra Musha	Raupya Musha	Vrintaak Musha
Gaar Musha		Maha Musha
Vajradravini Musha		Mall Musha
Vajradravan Musha		Gol Musha
Yog Musha		Pakva Musha
Vid Musha		Musal Musha
		Manduk Musha

Heat Sustainability

Although being different in structure and function, Mushas have one common feature i.e. to withstand high temperatures. Till a certain degree of temperature is attained, they neither break nor get liquefied.

Table 3: Heat Sustainability of Different Mushas [14]

Musha	Duration of heat sustainability
Vajra dravani Musha	10-18 hours
Pakva	3- 12 hours
Gara	6 hours
Vara	3 hours

Musha Apyayana

In the heating process, when the material in the Musha gets molten or mixed properly, it is taken out from the heating device for a moment to increase the heat resistance capacity of the Musha. This process is Musha Apyayana. It also protects Musha from overheating and avoids the burning of the material placed in it. [15]

Contents, Preparation and Applications of Musha

On the literary review of diverse Rasa Shastra texts, numerous Musha along with their constituents, preparation techniques and utilization are quoted.

Table 4: Contents, Preparation and Uses of Musha

Musha	Shape	Constituents	Method of Preparation	Applications
Samanya Musha [16]	-	Mritika (Soil) - 4 parts Dagdha Tusha (burnt husk)-1 part, Shikitraka (charcoal powder) - 1 part, Laddika (horse dung) 1 part, Shana (Jute) - 1 part.	The fine powder is pounded and levigated with water. The appropriate shape is given by applying strong heat.	Satvapatana of Shilajatu, Vimala.
Gostani Musha [17]	Gostanakara (Cow's udder)	Not mentioned	Same as Samanya Musha, only a Pidhanaka (covering lid) should be prepared to have a Shikha (projection or handle) at its top middle portion	Satva Shodhana and Satvapatana of Abhraka, Vaikranta, Makshika, Shilajatu, Vimala.
Vrintaka Musha [18]	Vrintaka (Like Brinjal)	Not mentioned	The mouth of the Musha is attached to one Nala (hollow pipe) having 12 Angula lengths and the diameter of the mouth is 8 Angula and similar to Datura Pushpa (Flower of Datura metel) in shape.	Satvpatana of Mridu dravyas like Kharpara.
Malla Musha [19]	Samputa (covered with two earthen saucers)	Not mentioned	Two earthen sauces are joined together and sealed properly.	Preparation of Parpati Rasa
Pakva Musha [20]	Like a Bhanda	Not mentioned	Molded in the appropriate shape and strong heat is given.	Pottali Pachana
Gola Musha[21]	Round shaped having no mouth	Not mentioned	The material is put inside, and Musha is closed. Then heat is administered in the amount so that the liquid media from the material do not come out from Musha.	Dravya Shodhana (purification of Satva)
Maha Musha [22]	The lower portion is similar to an elbow joint gradually broadening towards the upper portion.	Not mentioned	Ingredients are pounded well to make fine powder and levigated with Bhavana Dravya till the paste becomes soft, smooth and sticky.	Satvapatana of Loha, Abhraka and Makshika, Putapaka and also Satva Dravana.
Musala Musha [23]	It is just like a Musala which has a flat bottom and is round from all sides.	Not mentioned	Same as Maha Musha	Preparation of Chakrabaddha Parada.
Vajra Dravini Musha[24 25]	-	Mritika (Soil) – 4 parts Bhunaga Mritika (Earthworm Soil)- 1 part Gara (Lake Soil) - 1 part Dagdha Tusha (Burnt Husk)– 1 part Shana (Jute)- 1 part Mahisha Ksheera (Buffalo Milk)- Q.S.	Same as above	Dwanda Melapana, Bija Nirvapana, Vajra Dravana, Vajra Satva Patana.
Gara Musha [26 27]	-	Gara (Lake soil)- 6 parts Loha Kitta (Iron Slag)- 1 part Angara (Burnt Charcoal)- 1 part Shana (Jute)- 1 part Krishna Mritika (Black Soil)- 3 parts Water- Q.S.	Same as above	Dhalana Karma.
Vara Musha [28]	-	Purana Vastra- 1 part Angara (Burnt Charcoal)- 1 part Dagdha tusha (Burnt Husk)- 1 part Krishna Mritika (Black Soil)- 4 parts Gara- 4 parts Water- Q.S.	Same as above	Rasa Karma
Varna Musha [29]	-	Rakta Mritika (Red Soil)- 1 part Drava of Rakta Varga Dravya - Q. S. Lepana Dravyas- Tuvri (Potash Alum) and Pushpa Kasis (Ferrous Sulphate).	Same as above	Varnotkarsha of Swarnadi Dhatu
Raupya Musha [30]	-	Shweta Mritika (White soil)- 1 part. Drava of Shweta Varga Dravya- Q.S.	Same as Above	For Satvapatana.
Vajra Musha [31]	-	Mritika (Soil)– 3 parts Shana (Jute)- 2 parts Laddika (horse Dung)- 2 parts Dagdha Tusha (burnt husk)- 1 part Upaladi (Coal Powder)- 1 part Loha Kitta (Iron Slag)- ½ part	Same as above	For Satvapatana

Yoga Musha [32, 33]	-	Dagdha tusha (Burnt husk) – 1 part. Shikhitraka (burnt charcoal) – 1 part. Bida - 1 part	Same as above	For Rasa Siddhi
Bida Musha [34]	-	Mritika (Soil) and Bida	Same as above	For Dehasiddhi and Lohasiddhi

Crucibles

The term Crucible is derived from the Latin word **Crucibulum** i.e. melting pot for metals**.** [35] A **crucible** is a ceramic or metal container in which metals or other substances may be melted or subjected to very high temperatures. Although traditionally built of clay, crucibles can be fabricated of any material that can endure temperatures high enough to melt. [36]

History

The earliest crucible forms derive from the sixth/fifth millennium B.C. in Eastern Europe and Iran. [37]

Chalcolithic

To make ceramic crucibles easier to handle and pour, handles, knobs, or pouring spouts were integrated into designs during the Chalcolithic era. The key purpose of the crucible at this time was to facilitate the separation of the ore from impurities before shaping, by holding the ore where the heat was most accentuated. [38, 39]

Iron Age

During the Roman era, technology advanced to the point where new alloys could be designed through the implementation of crucibles. The smelting and melting process was influenced by the crucible design and the overall heating technique. Unlike previous varieties, which were heated from above and had an uneven shape, the crucible developed into vessels with a more conical shape and a rounded or pointed bottom. These designs increased the charcoal's stability.[40] In certain contexts, these crucibles had thinner walls and more refractory attributes. [40]

Medieval Age

The invention of new tempering materials for ceramic crucibles occurred during the medieval era. A portion of these crucibles made of copper alloy were utilized to create bells. Bell foundry crucibles, measuring roughly 60 cm, were bigger. [40]

Post Medieval Age

The most common types of crucibles used in the Post-Medieval period were the Hessian crucibles, which were made in the German Hesse region. These are triangular jars that have been tempered inside of a mold or on a wheel using pure quartz sand and high alumina clay.[41]

Refractory Material in the Crucible

A crucible usually has a refractory material. Refractories are defined as "non-metallic materials having those chemical and physical properties that make them applicable for structures, or as components of systems, that are exposed to environments above 1,000 °F (811 K; 538 °C)". [42]

The three most crucial components utilized in the production of refractories are aluminium, silicon, and magnesium oxide. Calcium oxide is an additional oxide that is frequently present in refractories. [14]

Refractory materials are useful for the following functions: [43] Serving as a thermal barrier between a hot medium and the wall of a containing vessel, withstanding physical stresses and preventing erosion of vessel walls due to the hot medium, protecting against corrosion, and providing thermal insulation.

Fire clays are also widely used in the manufacture of refractories. The United States Environmental Protection Agency defines fire clay very generally as a "mineral aggregate composed of hydrous silicates of Aluminium ($Al_2O_3 \cdot 2SiO_2 \cdot 2H_2O$) with or without free Silica."

Table 5: Types of Crucibles as per content and temperature [44]

Crucible	Content	Temperature
Vitreous Carbon Crucible	Ceramic carbon-based material	3000 º C
Silica Crucible	Pure Silver	1600 º C
Platinum Crucible	Pure Platinum/ Alloys with various degrees of Rhodium or Gold	1200 º C
Porcelain Crucible	99.8 % Pure Aluminium oxide	1050 º C
Nickel Crucible	99.6 % Wrought Nickel	600 º C
Carbon Steel Crucible	Pig iron/ iron	500 º C
Zirconium Crucible	Zirconium	450 º C

Table 6: Types of crucibles as per characteristics [45]

Crucible	Characteristics
Barrel Shaped Crucible	Crucible has an opening with a top outer diameter (OD) that is essentially the same as, or only slightly smaller, than the base or bottom OD. Sidewalls bulge out.
Conical Crucible	Have an opening with a top OD that tapers down to a smaller base or bottom diameter. Sidewalls are straight sided.
Cylindrical Crucible	Crucible has an opening with a top outer diameter (OD) that is essentially the same as, or only slightly smaller, than the base or bottom OD. Sidewalls are straight sided.
Wide form Crucible	These Crucibles are low, shallow, or flat profile vessels with short walls. Sidewalls have a slight outward bow or bulge.
High form Crucible	High Walls. Opening with a top OD that tapers down to smaller base. Sidewalls typically have a slight outward bow or bulge.

DISCUSSION

Musha is the manufacturing marvel of Rasa Shastra. It was created as a unique container that can house Rasa Dravyas and perform the Paka when heated. The first use of Musha in Ayurveda is mentioned in the text Rasa Hridya Tantra (10^{th} Century) and the crucibles in fifth /sixth millennium B.C.

The Upadana of Musha is Mritika (Clay) and Loha Churna (iron powder). Clay minerals are composed essentially of Silica, Alumina, or both and water but iron substitutes for Alumina and Magnesium in varying degrees and appreciable quantities of Potassium, Sodium and Calcium are frequently present as well. On application of the heat, the clay shrinks, and the particles become more compact so the hardness increases, thus making it heat resistant. While in the metal (Loha), two factors allow

resistance to such towering heat: the structure of the metals and the interatomic bonds within it. The atoms in the Loha are arranged in a regular pattern and are closely packed together. Thus, Loha (iron) is satisfactory for the service at temperatures up to 1538º C approximately.

The basic material needed for the construction of the Mushas can be broadly divided into two categories, one that provides structure and the other that allows it to sustain heat. Dagdha Tusha (Burnt Husk), Shikitra (Charcoal) and Sana (Jute) provide structure while Loha Kitta (Iron Slag), Bhunaga Mritika (Excreta of earthworm), Kupi Churna (Glass powder), Ishtika Churna (Brick powder), Vida (Salt) and Sukti Churna (Coral Powder) provides heat resistant property.

In Samanya Musha, Haya Laddika (horse dung) can be considered a lubricating factor as it contains loads of mucus and enzymes from the horse's digestive system. In Vajra Dravini Musha, Mahisha Ksheera (Buffalo milk) is employed as Bhavana Dravya. Fat content is responsible for the consistency of the milk. The greater the fat content in buffalo milk, the more is its thickness. Thus, making it a good binding agent. Also, Bhu Naga Satva (Excreta of Earthworms) for Vajra Dravini Musha, contains Copper and Iron which contribute to its heat resistance**.**

The 'Pachana' of the Dravyas in the Musha involve the 'Samyoga' and 'Viyoga' Samskara. The addition of the desired property in the Rasa Dravya signifies the 'Samyoga' and the removal of the Doshas insinuates the 'Viyoga'. The Agni Samskara in Musha not only modifies the Dravyas physically but also chemically. On the persistently high temperatures (Agni Samyoga), Guru Guna in the Dravyas transform into Laghu and the Sthula Guna transmutes into Sukshma as the heat provided disintegrates the tightly bound particles/ molecules of the Dravyas. Further, Musha is vividly utilized for the Satvapatana process in which diverse Bhavana Dravyas are employed that impregnate their qualities in the material. The Satvapatita material and Bhavana Dravyas come in close contact to make a homogenous mixture.

No classical text delivers the precise number of the Musha, but counting yields the numbers. In the texts, Rasendra Chudamani, Rasa Ratna Samuchchya, Rasa Tarangini, Rasarnava, Rasa Hridya Tantra, and Rasa Prakash Sudhakara have 17, 17, 8, 5, 1 and 15 Mushas respectively.

On assessing the Musha and the crucibles, Samanya Musha can be related to Barrel shaped or High form crucibles, Maha Musha to Conical or wide form crucibles, and Mushala Musha to Cylindrical Crucibles.

Musha's usage has declined gradually. Crucibles, cup-shaped containers, have replaced their current position. They were developed exclusively for the Dravana Karma (liquefaction of metals). But it is inconceivable to ignore Musha's ideology. The theory behind them is legitimately scientific. Rasa Karma is carried out in the present era by adopting the same technique.

CONCLUSION

In Ras Shastra, Musha is explained in a very scientific manner. Its characteristics have beneficial applications. The wide range of Mushas explained in various classical texts proves its significance in Rasa Karma. This review aids in providing a firm understanding of the Musha concept.

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