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Research Article

VALIDATION OF A TRADITIONAL MERCURIAL FORMULATION: XRD ANALYSIS OF CINNABAR PREPARED BY *SIDDHA VAIPPU MURAI*

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ABSTRACT

In Siddha medicine, Cinnabar *(Lingam),* a mercury sulphide mineral, is widely employed after undergoing specific alchemical transformations. Classical Siddha pharmaceutics assert that such processing converts elemental mercury into a stable and therapeutically acceptable form. Scientific validation of these traditional processes is essential for standardization and safety assurance. **Aim of the study:** The present study aimed to prepare synthetic cinnabar using classical *Siddha Vaippu Murai* methods and to characterize the crystalline phases of the prepared products using X - Ray Diffraction (XRD). **Materials and Methods:** Three types of *Vaippu* (synthetic) *Lingam – Bombay Lingam, Cheena (Naattu) Lingam* and *Rumi Lingam* – were prepared using purified mercury, sulphur and arsenic disulphide following procedures described in Anuboga Vaidya Navaneetham. Natural cinnabar was used as a reference. All samples were subjected to XRD analysis, and diffraction patterns were compared with standard reference data for cinnabar (α – HgS), metacinnabar (β – HgS) and sulphur. **Results:** Natural cinnabar exhibited diffraction peaks corresponding exclusively to α – HgS. *Bombay Lingam* showed 100% conversion to cinnabar. Cheena Lingam exhibited a multiphase composition comprising cinnabar (16%), metacinnabar (20%), and residual sulphur (64%). Rumi Lingam contained cinnabar (30%) and metacinnabar (70%). No elemental mercury was detected in any prepared sample. **Conclusion:** Among the three methods studied, *Bombay Vaippu Murai* produced phase – pure cinnabar comparable to the natural mineral. The results demonstrate that traditional Siddha pharmaceutical processes can achieve controlled physicochemical transformation of mercury. XRD proves to be a valuable tool for the scientific validation and standardization of Siddha Mineral Drugs.

INTRODUCTION

Traditional medical systems such as Siddha, Ayurveda and other indigenous healing traditions are found on an integrated understanding of nature, matter, and the human body. Among these systems, Siddha medicine is distinguished by its extensive use of metals and minerals that undergo specialized pharmaceutical transformations rooted in alchemical knowledge. Rather than treating metals as inherently toxic, Siddha scholars conceptualized them as dynamic substances whose properties could be altered through systemic processing to render them therapeutically potent and biologically compatible.

Siddha alchemy, known as Rasa Vatham, represents a sophisticated branch of traditional pharmaceutical science developed through centuries of empirical practice. Classical texts describe process such as purification *(Suddhi),* trituration *(Maranam),* calcination, sublimation, and binding techniques, which aim to detoxify raw substances, enhance therapeutic efficiency and ensure stability. These practices reflect an advanced understanding of material transformation that parallels several principles of modern chemistry and material sciences

In the contemporary biomedical research, there is an increasing need to validate traditional mineral – based medicines using modern analytical methodologies. Such validation is essential not only to enhance the credibility of traditional systems but also

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to enable standardization, quality control and integration into evidence - based healthcare. X - Ray Diffraction (XRD) is a powerful analytical technique for determining crystalline structure and phase composition, providing insight into the transformations described in classical pharmaceutics.

Within Siddha pharmaceutics, *Vaippu Murai* denotes a category of synthetic mineral preparations described in texts such as Bogar Sarakku Vaippu 800, Konganar Sarakku Vaippu 100 and Matchamuni Thirumanthira Vaippu 800. Important drugs prepared by this method include borax, copper sulphate, arsenic sulphide, mercurial compounds, zinc and lead derivatives. Among these, cinnabar (Lingam), a mercury sulphide preparation, occupies a prominent position due to its extensive therapeutic indications. The preparation method adopted in the present study is derived from Anuboga Vaidya Navaneetham Part IV (Hakim Mohammed Abdulah Shahib, n.d).

Cinnabar (HgS) has been historically used across civilizations for medicinal, artistic and ritualistic purposes. In Siddha medicine, cinnabar is considered therapeutically acceptable only after appropriate alchemical processing, which is believed to convert mercury into a stable sulphide form. Classical texts attribute antipyretic, neuroprotective, dermatological and rejuvenative properties to processed cinnabar, including its use in pediatric formulations under strict guidelines. These assertions emphasize the importance of understanding the transformed physicochemical state of cinnabar rather than its elemental form.

The present study was undertaken to prepare synthetic cinnabar using traditional *Siddha Vaippu Murai* methods and to characterize the prepared samples using XRD analysis. By correlating classical pharmaceutical principles with modern crystallographic characterization, this study aims to provide scientific validation for Siddha mineral preparations and contribute to their standardization and safety evaluation.

MATERIALS AND METHODS

Collection and Authentication of Raw Materials

Mercury *(Rasam),* sulphur *(Gandhagam),* arsenic disulphide *(Manosilai)* and natural cinnabar *(Lingam)* were procured from a reputed raw drug store in Chennai, Tamil Nadu, India. All materials were authenticated by experts from the Department of Gunapadam (Siddha Pharmacology), Government Siddha Medical College, Chennai. Voucher specimens were assigned reference numbers 197–200/ PGG/GSMC–CH/2023-2026 and preserved in the departmental repository.

Preparation Protocol

All the preparations were carried out in the Gunapadam Laboratory, Government Siddha Medical College, Chennai, following the procedure described in Anuboga Vaidya Navaneetham, Part IV (Hakim Mohammed Abdulah Shahib, n.d).

Three types of *Vaippu Lingam* (Synthetic Cinnabar) - *Bombay Lingam, Cheena (Naattu) Lingam* and *Rumi Lingam*– were prepared using purified mercury, sulphur and arsenic disulphide in specific proportions (Table 1).

Table 1: Composition of raw materials used for preparation

Type of *Vaippu Lingam*	Mercury (g)	Sulphur (g)	Arsenic disulphide (g)
Bombay Lingam	70	20	-
Cheena (Naattu) Lingam	35	35	-
Rumi Lingam	120	80	50

Purification of raw materials

Mercury: Purification was performed in three stages: trituration with brick and turmeric powders, boiling with *Acalypha indica* leaf juice; followed by washing, drying and storage.

Sulphur: Sulphur was melted with unsalted butter and poured into *Plantago major* stem juice. This process was repeated ten times. The product was washed, shade – dried and stored.

Arsenic disulphide: The material was soaked in sour buttermilk and exposed to sunlight for three days, washed, dried and stored (Sarakkugalin Suddhi Seimuraigal, 2008).

Preparation of *Vaippu Lingam*

Purified ingredients were triturated to form *Kajili* (a black coloured powder form), transferred into sealed glass containers, and placed within a Vaaluga Iyanthiram (Sornamariyammal, 2022). The apparatus was subjected to controlled combustion for 48 hours, followed by natural cooling. The resulting *Vaippu Lingam* was collected, weighed and stored in airtight containers (Figure 1).

Figure 1

X – Ray Diffraction Analysis

X – Ray Diffraction Analysis was performed at Siddha Central Research Institute, Chennai, Tamil Nadu, India. XRD was done on natural cinnabar and the three prepared *Vaippu Lingam* samples. Diffraction patterns were recorded and compared with standard reference data for cinnabar (α–HgS), metacinnabar (β–HgS) and elemental sulphur to determine phase composition.

RESULTS

X – Ray Diffraction analysis was performed for natural cinnabar *(Lingam)* and the three laboratory – prepared *Vaippu Lingam* samples – *Bombay Lingam, Cheena (Naattu) Lingam* and *Rumi Lingam* – to determine their crystalline phase composition.

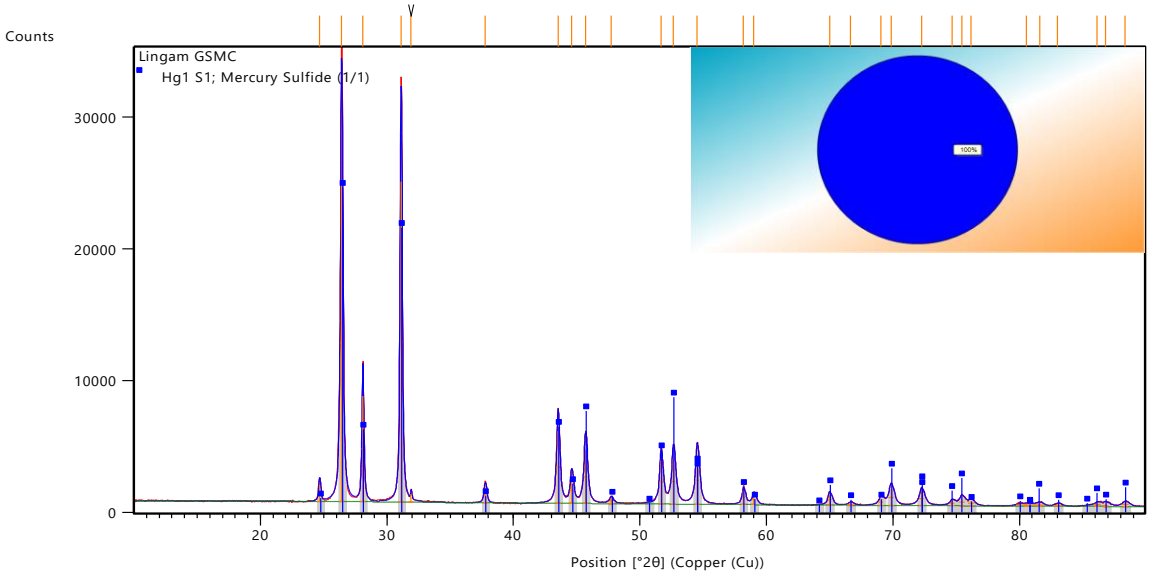

Figure 2

The XRD pattern of natural cinnabar exhibited diffraction peaks corresponding exclusively to hexagonal α – HgS (cinnabar), confirming that the reference sample consisted of 100% cinnabar with no detectable secondary phases (Figure 2).

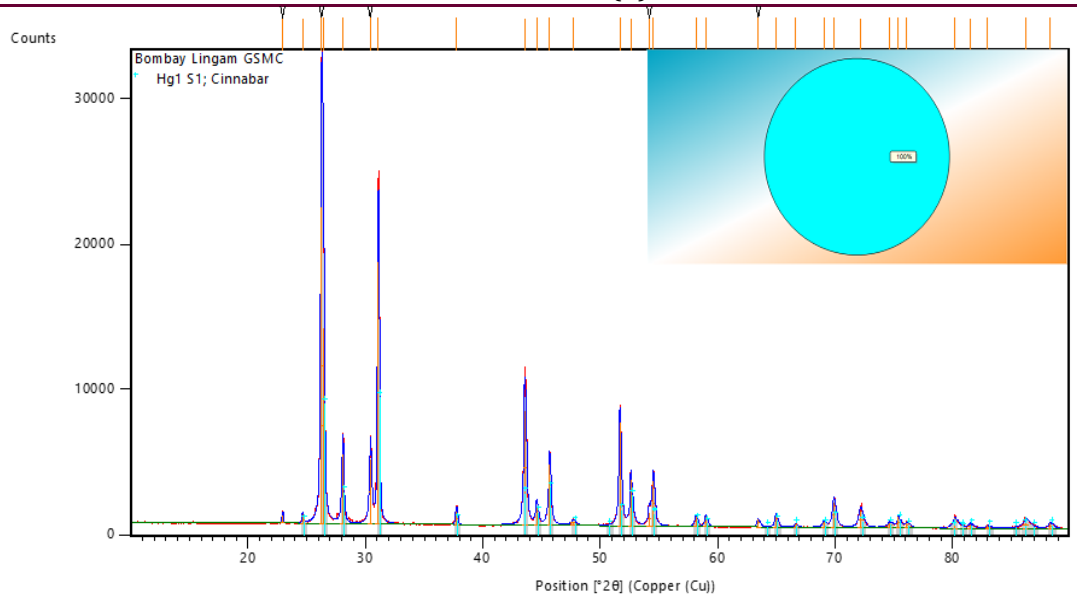

Figure 3

The diffraction pattern of *Bombay Vaippu Lingam* showed characteristic peaks matching those of α – HgS alone. No reflections corresponding to metacinnabar (β – HgS), elemental mercury or free sulphur were detected. This indicates complete transformation of mercury into cinnabar, yielding 100% phase – pure α – HgS (Figure 3).

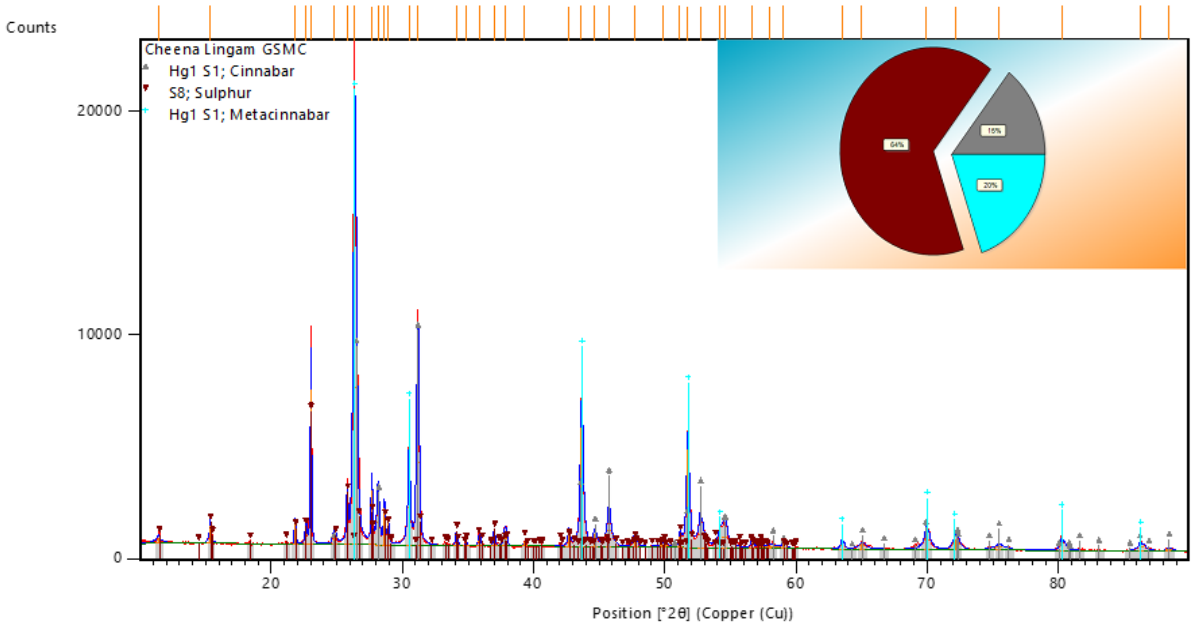

Figure 4

In contrast, the *Cheena (Naattu) Vaippu Lingam* sample exhibited a multiphase composition. Quantitative phase analysis revealed the presence of cinnabar (16%), metacinnabar (20%) and residual sulphur (64%). The presence of substantial unreacted sulphur suggests incomplete reaction and partial conversion of mercury into mercury sulphide (Figure 4).

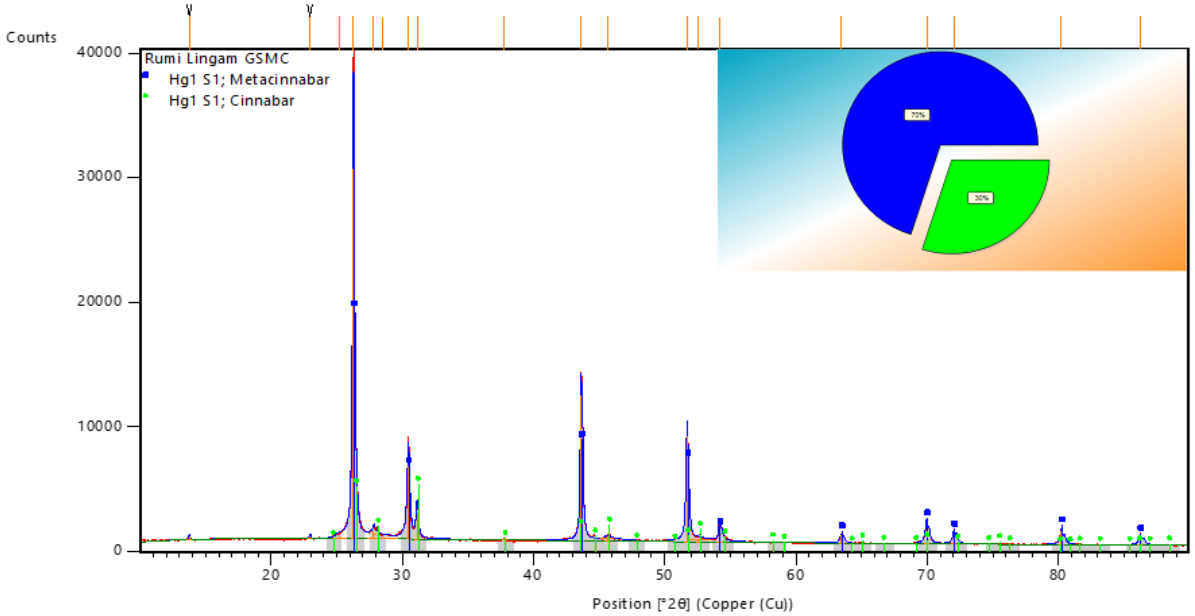

Figure 5

The *Rumi Vaippu Lingam* sample demonstrated a biphasic composition consisting of cinnabar (30%) and metacinnabar (70%). Although elemental sulphur was not detected, the predominance of the metastable β – HgS phase indicates incomplete transformation into thermodynamically stable α – HgS form (Figure 5).

Table 2: Phase composition of natural cinnabar and prepared *Vaippu Lingam* samples on XRD analysis

Phase	**Natural Cinnabar**	***Bombay Lingam***	***Cheena Lingam***	***Rumi Lingam***
Cinnabar (α – HgS)	100%	100%	16%	30%
Metacinnabar (β – HgS)	-	-	20%	70%
Sulphur	-	-	64%	-

Overall, the XRD results demonstrate that the *Bombay Vaippu Murai* is the most effective technique for producing phase - pure cinnabar. The *Cheena* and *Rumi* methods resulted in incomplete phase transformation, yielding mixtures of cinnabar, metacinnabar and residual sulphur.

DISCUSSION

The present investigation demonstrates that traditional Siddha alchemical procedures are capable of inducing specific and reproducible physicochemical transformations in mercurial systems. XRD analysis revealed that the method of preparation decisively influences the crystalline phase of mercurial sulphide formed.

Among the three *Vaippu Murai* methods evaluated, the *Bombay Lingam* preparation achieved complete conversion of mercury into thermodynamically stable α – HgS phase, identical to natural cinnabar. This observation validates the precision of the classical protocol described in Anuboga Vaidya Navaneetham and supports the Siddha premise that appropriate processing transforms potentially toxic metals into stable and therapeutically acceptable forms.

The absence of elemental mercury in all prepared samples is of considerable toxicological relevance. Elemental and organic mercury species are primarily responsible for adverse biological effects, whereas α – HgS exhibits markedly reduced solubility and bioavailability. Previous studies have shown that cinnabar is significantly less toxic than other mercury compounds due to its low dissolution rate in biological media (Shi et al., 2011; Clarkson and Magos, 2006). The complete conversion observed in Bombay Lingam therefore represents a critical pharmaceutical achievement in the context of safety.

Cheena (Naattu) Lingam exhibited incomplete transformation, with substantial residual sulphur and the presence of β – HgS. Metacinnabar is a cubic polymorph considered an intermediate phase that can transform into α– HgS under optimized thermal and mechanical conditions. The persistence of sulphur suggests that the reaction parameters – such as stoichiometry, trituration efficiency or heating dynamics– were sufficient to drive the reaction to completion.

Rumi Lingam showed partial conversion, dominated by metacinnabar. The inclusion of arsenic disulphide *(Manosilai)* may alter reaction kinetics and

thermal behaviour, influencing phase stability. While mercury sulphide formation was initiated, the system did not reach equilibrium toward α – HgS. These findings highlight the sensitivity of Siddha alchemical processes to ingredient composition and processing parameters.

From an ethnopharmacological perspective, these results substantiate the Siddha doctrine that not all preparations bearing the same name are pharmaceutically equivalent. Classical texts emphasize precise proportions, sequences and heating regimens; deviations can lead to altered material states and potentially, altered biological behaviour. The integration of XRD into Siddha pharmaceutics provides a robust framework for understanding these transformations, enabling scientific validation, reproducibility and quality control.

Concerns raised regarding heavy metals in traditional medicines (Ernst, 2002) often arise from inadequate processing or lack of standardization. The present findings demonstrate that when classical Siddha procedures are meticulously followed, mercury can be transformed into a stable crystalline phase comparable to natural cinnabar, supporting the argument for scientifically guided standardization as advocated in recent Siddha research (Rajalakshmi and Velpandian, 2018).

From a broader perspective, mercury is a persistent environmental contaminant with significant ecological implications (Wang et al., 2004). Transforming mercury into a stable sulphide form through controlled pharmaceutical processing not only has therapeutic relevance but also aligns with principles of chemical stabilization recognized in environmental science.

CONCLUSION

This study successfully prepared three forms of synthetic cinnabar using classical Siddha pharmaceutical methods and evaluated their crystalline characteristics through X – Ray Diffraction analysis. Among the methods studied, the *Bombay Vaippu Murai* produced phase – pure cinnabar (α – HgS) comparable to natural cinnabar. *Cheena* and *Rumi* preparations resulted in incomplete transformation, yielding mixtures of cinnabar, metacinnabar and residual sulphur.

The findings scientifically validate the Siddha principle that precise alchemical processing is essential for converting mercury into a stable and therapeutically acceptable form. The study highlights XRD as a valuable tool for standardization and quality assurance of Siddha mineral formulations and provides a foundation for further pharmacological and toxicological investigations.

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