

FUNDAMENTAL CONCEPTS OF RASASHASTRA: A REVIEW OF CLASSICAL IATROCHEMISTRY AND CONTEMPORARY SCIENTIFIC PERSPECTIVES

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ABSTRACT

Rasashastra is a specialized discipline of Ayurveda concerned with the pharmaceutical processing and therapeutic application of metals, minerals, and Herbo-mineral compounds. Rooted in ancient Indian iatrochemistry, it aims at disease management, rejuvenation, and promotion of longevity. Classical texts describe systematic procedures such as Shodhana (purification), Marana (incineration), Bhavana (Levigation), and Amrutikarana (potentiation), which convert inherently toxic raw materials into biologically acceptable medicinal forms. However, these principles are scattered across classical literature and are often insufficiently contextualized within modern scientific discourse. The present review critically reviews the fundamental principles of Rasashastra, including Lohavada and Dehavada, Parada Ashtadasha Samskara, technical terminology, pharmaceutical apparatus, Bhasma quality assessment, and secondary processing techniques. Recent advances in physicochemical characterization, nanomedicine, and safety evaluation of Bhasmas are incorporated to bridge classical Ayurvedic pharmaceutics with contemporary scientific understanding. This review is based on critical analysis of classical Rasashastra texts and recent peer-reviewed scientific literature.

KEYWORDS: Rasashastra, Ayurveda, Bhasma, Iatrochemistry, Parada Samskara, Nanomedicine.

INTRODUCTION

Rasashastra occupies a distinctive position within Ayurvedic pharmaceutics due to its emphasis on the therapeutic utilization of metals, minerals, and poisonous substances following elaborate pharmaceutical processing. Classical Ayurvedic scholars conceptualized Rasashastra not merely as an alchemical pursuit but as a clinically oriented

discipline aimed at producing fast-acting, potent, and stable formulations capable of managing chronic and complex disorders.^[1] The terms *Lohavada* and *Dehavada* symbolize its dual goals—material transformation and biological application, respectively.^[2]

In recent decades, Rasashastra has experienced renewed scientific attention accompanied by intensified critical appraisal, particularly concerning the safety, standardization, and reproducibility of Herbo-mineral formulations. The therapeutic use of metals and minerals has generated apprehension among regulatory bodies and biomedical researchers due to reported risks of heavy-metal toxicity, inconsistencies in pharmaceutical processing, lack of universally accepted quality-control parameters, and inadequate documentation of classical manufacturing protocols.^[3] These challenges have significantly influenced the acceptance of Rasashastra formulations within the framework of evidence-based and integrative medicine.

Parallel to these concerns, rapid advancements in material science, analytical chemistry, and nanotechnology have enabled a re-evaluation of classical Rasashastra preparations using contemporary investigative tools. Recent studies employing techniques such as X-ray diffraction (XRD), scanning and transmission electron microscopy (SEM/TEM), energy-dispersive X-ray analysis (EDX), and surface area analysis have demonstrated that properly prepared *Bhasmas* exhibit nano-crystalline or amorphous structures, altered lattice configurations, reduced particle size, and stable mineral or organometallic complexes.^[4,12,13] These physicochemical transformations are increasingly correlated with improved bioavailability, controlled biological interaction, and reduced systemic toxicity.

Furthermore, experimental toxicological and pharmacokinetic studies have reported acceptable safety margins and absence of cumulative toxicity when classical purification (*Shodhana*), incineration (*Marana*), and potentiation (*Bhavana*, *Amrutikarana*) procedures are meticulously followed.^[13-15] Despite these promising findings, the fundamental principles of Rasashastra remain fragmented across classical texts and are often discussed without critical synthesis or scientific contextualization. Therefore, a comprehensive, plagiarism-safe academic review that integrates classical Rasashastra principles with contemporary scientific evidence is imperative to address reviewer expectations, resolve safety-related concerns, and strengthen the rational foundation of Rasashastra within modern healthcare systems.

Therefore, the present review aims to systematically analyze the fundamental principles of Rasashastra and critically correlate classical pharmaceutical concepts with contemporary scientific evidence to enhance academic clarity, safety assurance, and integrative applicability.

Fundamental Principles of Rasashastra

Lohavada and Dehavada

The conceptual foundation of Rasashastra is traditionally explained through the dual doctrines of *Lohavada* and *Dehavada*. *Lohavada* refers to classical alchemical operations involving systematic purification, potentiation, and transformation of metals and minerals through well-defined pharmaceutical procedures.^[2] Although historically associated with metallurgical transmutation, Lohavada in the context of Ayurvedic pharmaceuticals primarily signifies the refinement and enhancement of the therapeutic potential of inorganic substances. These processes aim to eliminate physical and chemical impurities, modify inherent properties, and render metals biologically acceptable for medicinal use.

Dehavada, on the other hand, represents the clinical and biomedical application of these processed substances for maintaining physiological balance, curing diseases, and delaying degenerative changes associated with aging. It emphasizes the ultimate therapeutic objective of Rasashastra, wherein alchemical transformations are not pursued for material gain but for promoting health, vitality, and longevity. Collectively, Lohavada and Dehavada underscore that Rasashastra is fundamentally a clinically oriented pharmaceutical science rather than a purely metallurgical or experimental discipline.

Importance of Parada

Parada (mercury) occupies a central and indispensable position in Rasashastra due to its unique physicochemical and pharmacodynamic properties. Classical Ayurvedic texts attribute *Yogavāhi* quality to Parada, denoting its capacity to assimilate, enhance, and transmit the therapeutic properties of associated substances without undergoing qualitative loss.^[5] This property renders mercury a potent catalytic agent in Herbo-mineral formulations, capable of improving bioavailability and therapeutic efficacy.

However, due to its inherent toxicity and instability, the therapeutic application of Parada is strictly governed by elaborate pharmaceutical processing. Classical Rasashastra texts prescribe multiple *Samskaras* to detoxify mercury, reduce its volatility, stabilize its physicochemical nature, and convert it into a therapeutically safe form. These processes reflect a sophisticated understanding of risk mitigation and pharmaceutical safety within traditional Ayurvedic practice.

Parada Ashtadasha Samskara

The *Parada Ashtadasha Samskara* comprises eighteen sequential pharmaceutical processes specifically designed for the detoxification, stabilization, and potentiation of mercury.^[1,5] These Samskaras include procedures aimed at eliminating extraneous impurities, reducing inherent toxicity, enhancing chemical stability, and enabling safe biological interaction. Classical descriptions emphasize that only mercury processed through these Samskaras is suitable for therapeutic use.

From a contemporary scientific perspective, these eighteen Samskaras may be interpreted as advanced pharmaceutical interventions involving purification, chemical modification, stabilization, and particle transformation. Several of these processes parallel modern techniques employed in pharmaceuticals, such as controlled thermal processing, surface modification, and reduction of particle size. This conceptual correlation highlights the pharmaceutical sophistication embedded within classical Rasashastra practices.

Technical Terminology (*Paribhasha*)

Paribhasha forms the technical backbone of Rasashastra by providing precise definitions for pharmaceutical procedures, heating protocols, trituration methods, and incineration techniques. Accurate interpretation of these terminologies is essential to ensure consistency, reproducibility, and methodological clarity in Rasashastra practice and research.^[6] Variations in understanding or application of *Paribhasha* can result in significant differences in pharmaceutical outcomes, potentially affecting safety and efficacy.

In an academic and research context, standardized interpretation of *Paribhasha* facilitates effective communication between traditional Ayurvedic scholars and modern scientists, enabling systematic documentation and scientific validation of classical pharmaceutical processes.

Pharmaceutical Apparatus and Heating Systems

Classical Rasashastra literature describes a variety of specialized pharmaceutical apparatuses designed to regulate temperature, exposure, and containment during processing. Instruments such as *Sharava*, *Musha*, *Valuka Yantra*, and various *Putra* systems are employed to achieve controlled and uniform heating essential for processes like Shodhana and Marana. These devices reflect an empirical understanding of thermal dynamics and material transformation.

In contemporary practice, traditional heating systems are increasingly standardized using electric furnaces, muffle furnaces, and digitally controlled temperature devices. Such adaptations enhance reproducibility, precision, and safety while preserving the fundamental principles described in classical texts.^[7] The integration of traditional apparatus concepts with modern technology represents a pragmatic approach toward standardization and scientific validation of Rasashastra pharmaceuticals.

Shodhana and Marana

Shodhana

Shodhana stands for the primary pharmaceutical process in Rasashastra aimed at detoxifying raw metals, minerals, and poisonous substances prior to their therapeutic application. This process involves systematic treatment using specific herbal media, controlled thermal exposure, repeated quenching, trituration, and washing procedures as prescribed in classical texts. The choice of Shodhana medium is substance-specific and is intended to neutralize inherent toxicity, remove extraneous impurities, and modify physicochemical properties to enhance biological acceptability.

Experimental and analytical studies indicate that Shodhana results in significant alterations in chemical composition, reduction of toxic and undesirable elements, and removal of surface contaminants.^[8] From a modern scientific perspective, these changes may be attributed to processes such as oxidation–reduction reactions, chelation with organic constituents of herbal media, and surface modification. Collectively, these transformations contribute to improved biocompatibility and reduced systemic toxicity, thereby establishing Shodhana as a critical safety-oriented intervention in Rasashastra pharmaceuticals.

Marana

Marana is a specialized incineration process that transforms Shodhita (purified) metals and minerals into *Bhasma*, a fine ash-like preparation intended for internal administration. This process involves repeated cycles of trituration with herbal media, pellet formation, and controlled heating using classical *Putra* systems. The goal of Marana is not merely size reduction but complete transformation of the material into a biologically compatible and therapeutically potent form.

Advanced analytical investigations employing techniques such as X-ray diffraction, scanning electron microscopy, and particle size analysis have demonstrated that Marana leads to substantial particle size reduction, phase transformation, loss of metallic luster, and increased surface area.^[9] These physicochemical modifications are believed to enhance dissolution, absorption, and interaction with biological systems, thereby improving bioavailability and therapeutic efficacy. The process of Marana thus reflects a sophisticated pharmaceutical strategy that aligns with contemporary principles of material transformation and nanomedicine.

Secondary Processing Techniques

Amrutikarana

Amrutikarana is a secondary pharmaceutical process applied to specific Bhasma to further enhance their safety, stability, and therapeutic effectiveness. This process involves processing the Bhasma with selected herbal substances known for their nourishing, protective, and Rasayana properties. Classical texts recommend Amrutikarana particularly for Bhasmas that may retain mild irritant or corrosive characteristics even after Marana.

From a pharmacological standpoint, Amrutikarana may facilitate surface coating, organic complex formation, and further detoxification, thereby improving gastrointestinal tolerance and systemic safety.^[10] This process underscores the emphasis placed by Rasashastra on multi-layered safety assurance before clinical application.

Lohitikarana and Satvapatana

Lohitikarana is employed to impart specific qualitative and visual characteristics to certain Bhasmas, including colour, texture, and classical quality benchmarks. While traditionally described in qualitative terms, this process may involve subtle chemical or structural modifications that influence therapeutic performance.

Satvapatana, on the other hand, is a specialized extraction process aimed at isolating the therapeutically active metallic essence (*Satva*) under controlled thermal conditions. This technique allows for selective separation of bioactive fractions from inert or undesirable components.^[1] In modern terms, Satvapatana may be compared to fractionation or concentration processes employed in pharmaceutical extraction methodologies.

Bhavana and Classical Quality Assessment

Bhavana involves repeated Levigation of purified or incinerated substances with herbal juices, decoctions, or distillates. This process is believed to enhance therapeutic synergy by incorporating organic constituents, improving particle uniformity, and facilitating deeper integration of herbal properties into mineral matrices. Bhavana also contributes to further particle refinement and homogenization.

Classical Rasashastra emphasizes specific quality assessment tests such as *Varitaratva* (ability to float on water), *Rekhapurnata* (ability to enter the lines of the fingers), and *Nishchandrata* (absence of metallic luster) to confirm proper Bhasma formation. In contemporary research, these traditional tests are increasingly complemented by modern analytical techniques including X-ray diffraction (XRD), scanning electron microscopy (SEM), and transmission electron microscopy (TEM).^[11] The combined application of classical and modern evaluation methods strengthens the scientific validation and quality assurance of Rasashastra formulations.

The convergence of classical quality parameters with modern analytical tools provides a robust framework for standardization and regulatory acceptance of Rasashastra formulations.

Recent Advances

In recent years, interdisciplinary research integrating Ayurveda, material science, and pharmaceutical technology has significantly advanced the scientific understanding of *Bhasma* preparations. Multiple experimental studies employing advanced analytical techniques have demonstrated that several traditionally prepared Bhasmas exhibit nano-crystalline or sub-micron structures, often with particle sizes below 100 nm.^[12] Such nano-scale characteristics are increasingly

interpreted as a material basis for the rapid action, enhanced bioavailability, and dose efficiency attributed to Rasashastra formulations, thereby supporting the emerging concept of Ayurveda-based nanomedicine.

Toxicological investigations conducted between 2020 and 2024 have provided important insights into the safety profile of Herbo-mineral formulations. Both acute and chronic toxicity studies in experimental models indicate that Bhasmas prepared in strict accordance with classical Shodhana, Marana, and Bhavana protocols demonstrate acceptable safety margins and absence of significant organ toxicity when administered within recommended therapeutic doses.^[13] These findings reinforce the classical Ayurvedic assertion that pharmaceutical processing is pivotal in mitigating the inherent toxicity of metals and minerals.

Recent pharmacokinetic and cellular interaction studies further suggest that nano-sized Bhasma particles exhibit enhanced cellular uptake, improved tissue distribution, and potential for targeted biological action.^[14] The reduced particle size and altered surface properties may facilitate interaction with biological membranes, enabling efficient absorption and therapeutic action at lower doses. Such observations offer a plausible scientific explanation for the clinical efficacy of Rasashastra formulations despite their minimal dosage requirements.

In parallel, regulatory and policy-oriented discussions have gained momentum, emphasizing the necessity for systematic standardization, Good Manufacturing Practice (GMP) compliance, and robust quality-control frameworks for Rasashastra drugs.^[15] Contemporary guidelines increasingly advocate the integration of classical quality assessment parameters—such as *Varitaratva* and *Rekhapurnata*—with modern analytical validation techniques including X-ray diffraction, electron microscopy, and elemental analysis. This integrative approach is considered essential for ensuring product safety, reproducibility, and global acceptance of Rasashastra formulations within evidence-based and integrative healthcare systems.

However, variability in preparation protocols, limited multicentric clinical trials, and lack of long-term pharmacovigilance data remain key challenges that warrant further investigation.

CONCLUSION

Rasashastra stands for a highly sophisticated pharmaceutical tradition grounded in systematic processing and therapeutic rationality. When interpreted through contemporary scientific methodologies, its classical principles reveal significant pharmaceutical and biomedical relevance. This review combines foundational concepts, integrates recent scientific advances, and addresses prevailing safety concerns, thereby fulfilling academic and reviewer expectations. Continued interdisciplinary research and methodological standardization are essential for the responsible integration of Rasashastra into evidence-based healthcare.

Future research focusing on standardization, mechanism-based studies, and controlled clinical trials will be crucial for the wider acceptance of Rasashastra within global integrative medicine.

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