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REVIEW ARTICLE

Bhasma Preparations in *Rasa Shastra*: Safety, Efficacy, and Nanomedicine Perspectives – A Review

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ABSTRACT

The traditional Herbo-metallic/mineral medicines known as *Bhasma*'s are essential to *Rasa shastra* (Ayurvedic metallurgical pharmaceutics). Traditional writings describe *Bhasma's* as therapeutically potent, safe, and long-lasting. They are prepared by a series of steps, including *Shodhana* (purification), *Bhavana* (trituration with herbal medium), and *Marana* (incineration/calcination). The physicochemical changes these materials go through are being examined more and more in contemporary analytical and toxicological research, which reveals conversion to metal oxides/sulphides or nanoparticulate forms that are frequently coated with organic moieties. In order to integrate traditional practice with current pharmaceutical standards, this review synthesizes classical doctrine and current scientific evidence on *Bhasma* manufacture and testing, assesses safety and efficacy data, investigates nanomedicine interpretations of *Bhasma's*, and suggests research and regulatory priorities

Key Words *Nanomedicine, Safety, Effectiveness, Quality control, Marana, Bhasma Parikṣha, Rasa shastra, Shodhana, and Bhasma*

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INTRODUCTION

The field of Ayurvedic pharmaceutics known as *Rasa Shastra* regulates the use of metals, minerals, and their processed forms in medicine. In traditional medicine, *Bhasma*—calcined compounds of metals and minerals—play a significant role in treating a variety of illnesses, such as fevers, anaemia, chronic debility, metabolic abnormalities, and neurological diseases. To guarantee that the material becomes "non-metallic" in character and therapeutically safe, traditional experts recommend particular processing sequences (purification, levigation with herbal media, repeated calcination) and quality checks (*Bhasma parikṣha*).[1]

Rasa Shastra has been used in materials science, analytical chemistry, and toxicology in recent decades to investigate basic questions viz, what structural and chemical changes takes place during classical processing? Are the fineness, phase transition, and lack of free metal ions reported by classical tests verified by contemporary instruments? What are the pharmacological and toxicological ramifications if *Bhasma* are intrinsically nanoparticulate? In order to present an integrative overview and recommend goals for rigorous standards and translational research, this review compiles historical background, classical procedures, contemporary physicochemical characterisation, safety/efficacy evidence, and the growing nanomedicine perspective.

CLASSICAL FOUNDATIONS AND PHARMACEUTIC OBJECTIVES

Bhasma manufacturing techniques are codified in classical treatises like *Rasa Ratna Samucchaya*, *Rasa Tarangini*, and related *Rasa Shastra* texts. These treatises specify the provenance of raw materials, sequences of detoxification, *bhavana* (repeated trituration with herbal juices or media), pelletization, and *puta* (controlled heating/incineration) cycles for *Marana* (calcination) until the product passes a battery of organoleptic and physical tests known as *Bhasma pariksha*[2].

These steps have three stated goals: (1) eliminating toxic principles and extraneous impurities;

(2) transforming the raw metal into a form that is therapeutically active and bio assimilable;

and

(3) creating an ultra-fine, stable powder with repeatable organoleptic and pharmacodynamic properties [3].

Rekha purana, *varitaratva*, *apunarbhava*, *and niruttha* are examples of traditional *Bhasma pariksha* tests that function as low-tech stand-ins for fineness, density, irreversibility, and chemical stability—qualities that contemporary science uses instruments to determine.

MATERIALS AND METHODS

The manufacturing cascade: *Shodhana, Bhavana and Marana*

1.Shodhana (purification / pre-conditioning)

Melting and decantation, repeated washing, boiling in herbal decoctions, or trituration with oils, milk, or plant juices are examples of substance-specific *shodhana* techniques[1,5]. The removal of surface oxides and impurities, partial conversion of labile species (such as surface sulphides/oxides), initial chelation or adsorption of phytoconstituents, and mechanical de-aggregation that prepares the material for effective calcination are some of the likely chemical/physical effects that *shodhana* achieves from a contemporary perspective[7,8].

2. Bhavana (levigation with herbal media)

The refined metal or mineral is repeatedly wet ground using certain herbal juices or liquid media in bhavana. In addition to working as a mechanical comminution, this phase facilitates phytochemical association. Numerous studies demonstrate that organic compounds from the media stick to particle surfaces, serving as stabilizing and capping agents during future heating and preventing agglomeration.

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3.Marana (calcination / puta cycles)

With re-trituration, Classical protocols vary in the number of puta, temperature control and fuels used; cumulative heating drives oxidation, sulfidation or other phase conversions and substantial particle size reduction, ultimately producing the fine ash known as *Bhasma*. The repeated thermal shocks and mechanical grinding can fragment crystalline domains to the nano-scale and promote formation of metal oxides or stable sulphides depending on the atmosphere and adjuncts present.[10]

4. Bhasma Parikṣha:

Classical tests and modern counterparts

Simple empirical checks are part of classical *Bhasma parikṣha*:

Rekhapuraṇatva: the ability to penetrate skin folds (fineness)

Varitara: the capacity to float on water due to low density and lightness

Apunarbhava: irreversibility, or the inability to return to parent metal when heated or subjected to a chemical challenge.

Nirdhuma, Nispanda, and Nischandratva: lack of aggregation, smoke, or metallic sheen.

Particle size distribution (TEM/SEM/DLS), density and porosity (BET), phase identification (XRD), elemental and trace impurity profiling (ICP-MS/AAS), and surface chemistry (FT-IR, Raman, XPS) are the analytical characteristics that modern laboratories convert these into. Research frequently reveals that processed *Bhasma* are made up of metal oxides or sulphides, frequently forming nanoparticulate clusters contained within an organic matrix obtained from processing media [11]. These findings serve as instrumental correlates for the traditional tests.

Physicochemical characterization: what modern tools reveal

Recurring characteristics across *Bhasma* types are described by a number of independent characterization studies using X-ray diffraction (XRD), transmission electron microscopy (TEM), scanning electron microscopy (SEM), Fourier-transform infrared spectroscopy (FT-IR), thermogravimetric analysis (TGA), and inductively coupled plasma mass spectrometry (ICP-MS):

Phase transformation: Depending on the media and climate, elemental metals often change into oxides ($Fe \rightarrow Fe_2O_3/Fe_3O_4$) or sulphides ($Hg \rightarrow HgS$)[12].

Nano structuring: Although measurements vary depending on techniques and sample preparation, particle sizes reported in numerous research often fall within the sub-micron/nano range (typically tens to a few hundred nanometres). Organic residues: FT-IR and TGA indicate presence of organic moieties—proteins, polysaccharides and polyphenols—from herbal media that may coat or intercalate the inorganic phases .

Surface chemistry and charge: published zeta potential and XPS studies indicate surface alterations that are compatible with phytochemical capping. When combined, these results confirm that complex inorganic–organic hybrid materials, as opposed to simple residual bulk metal, are produced by traditional processing.

Pharmacology and putative mechanisms of action

In traditional medicine, *Bhasma* are used for micronutrient supplementation, chronic illness management, and rejuvenation. Several mechanistic reasons for reported bioactivity are been forth by recent investigations: Micronutrient supply and controlled ionic release: thermally transformed oxides and sulphides can release bioavailable metal ions gradually, acting as long-term supplies of micronutrients (such as iron from *Lauha Bhasma*)[13].

Cellular interactions mediated by nanoparticles: cells can internalize nanostructured particles through endocytosis, interact with intracellular targets, and modify signalling pathways, oxidative stress, and immune responses—possible mechanisms for immunomodulatory and antioxidant effects reported in some preclinical studies [15].

Synergy with phytochemicals: organic coatings derived from *bhavana* media may have direct biodistribution and lessen acute metal ion toxicity, or they may have pharmacological qualities of their own .

Surface reactivity and catalytic effects: Nanoparticulate *Bhasma*'s large surface area and particular surface chemistries may allow for redox interactions with biological substrates, impacting metabolic and inflammatory processes. Nevertheless, there is still a dearth of high-quality clinical evidence, such as randomized, controlled trials with reliable objectives and consistent formulations. Thorough translational studies are required because many efficacy claims are based on tiny clinical series, conventional usage data, or preclinical models.

Safety, toxicology and contamination risk

Safety is the critical concern in Herbo-metallic therapeutics. Two major safety aspects arise: (A) intrinsic toxicity of metals and

(B) contamination/adulteration during manufacture or marketing

1 Intrinsic toxicity vs transformed species

According to classical theory, poisonous metals can be transformed into non-toxic, therapeutically useful forms with correct shodhana and Marana. According to contemporary toxicology, nanoparticulate metal oxides and sulphides frequently have different toxicity profiles from soluble metal salts; they may be less harmful to the body if particle absorption and dissolution are restricted, but they have special biodistribution and long-term persistence issues[16]. Although preclinical research on specific *Bhasma*'s reports adequate acute and sub chronic toxicity margins at conventional doses, generalizations are hampered by interstudy heterogeneity, inconsistent manufacturing quality, and the absence of standardized dosimetry.

2 Contamination and quality lapses

Unacceptable quantities of lead, mercury, and arsenic have occasionally been found in surveys of commercial Ayurvedic items; these findings are typically due to non-standard manufacture, contamination, or adulteration rather than canonical *Bhasma* made by skilled artisans[17]. The necessity of strict GMP, batch testing, supply-chain controls, and consumer awareness has been highlighted by case reports of heavy metal poisoning connected to *Ayurvedic* treatments[18].

3 Regulatory and toxicological frameworks

Comprehensive datasets are necessary for modern safety frameworks, including elemental profiling (ICP-MS), in vitro cytotoxicity, genotoxicity, acute/sub chronic and chronic toxicity studies (OECD recommendations), biodistribution and excretion investigations, and clinical safety monitoring. To guarantee consumer safety while upholding traditional ways, such regulations must be adopted and matched to the hybrid inorganic–organic nature of Bhasma's.

***Bhasma*'s as ancient "green" nanomedicine: opportunities and cautions**

According to the nanomedicine viewpoint, *Bhasma's* are empirical, centuries-old formulas that result in nanoscale inorganic materials with organic capping; this is comparable to the creation of contemporary "green" nanoparticles utilizing plant extracts. Among the benefits mentioned are: Low-dose potency: therapeutic benefits at microgram–milligram doses are made possible by nanosizing, which enhances surface area and interaction potential. Biocompatibility: phytochemical coatings can alter immune recognition and reduce acute metal ion toxicity. Stability and shelf life: calcined inorganic phases frequently exhibit a high degree of stability. However, using frameworks for nanomedicine calls for caution: Standardization of characterization: proven techniques must be used to reliably report nanoparticle characteristics (size, shape, aggregation state, and surface chemistry). Pharmacokinetics and long-term fate: thorough ADME (absorption, distribution, metabolism, excretion) investigations are essential since nanoparticles may persist in organs (such as the liver or spleen) or dissolve slowly.

Dose standardization and bio equivalency: pharmacokinetic bridging studies are required to determine therapeutic windows; standard dose definitions are complicated by conventional units and varied puta cycles. *Bhasma*'s may inspire bioinspired synthesis methods and guide innovative nanotherapeutic design if properly investigated, but only after thorough preclinical and clinical validation.

Analytical standardization, quality control and regulatory integration

A contemporary QC framework for *Bhasma*'s should comprise the following in order to ensure safe commercialization and worldwide acceptance: Verification and traceability of raw materials (mineral provenance, mining techniques). SOPs with regulated critical parameters (temperatures, durations, medium composition, number of puta) for *Marana*, *Bhavana, and shodhana*. Batch testing includes microbiological limits, ICP-MS/AAS for elemental and hazardous trace analysis, FT-IR/XPS for surface chemistry, TEM/SEM and DLS for particle size and morphology, and XRD for phase identification. Studies on stability and shelf life in ICH circumstances.

OECD-compliant preclinical toxicology dossier and focused clinical studies for safety and efficacy outcomes.

Regulatory harmonization includes aligning conventional medicines with international frameworks and creating monographs within national pharmacopoeias.

These guidelines are being developed by a number of research facilities and regulatory agencies; more extensive multi-stakeholder partnerships involving *Ayurvedic* scholars, materials scientists, toxicologists, and regulators will hasten agreement and acceptance.

CONCLUSION

Bhasma preparations of *Rasa shastra* are an interesting example of how current material science and ancient pharmaceutics can come together. The complex inorganic–organic hybrid materials produced by the traditional purification, levigation, and calcination processes are often recognized by contemporary instruments as nanoscale oxides/sulphides with organic capping. Strong toxicology frameworks, standardized manufacturing, and excellent clinical trials are necessary before widespread modern adoption, even though preliminary physicochemical and preclinical data support theories of improved bioavailability and possibly decreased toxicity (in comparison to soluble metal salts). The safe, evidence-based integration of *Bhasma* therapies into modern healthcare will be made possible by embracing rigorous analytical science in addition to respect for classical expertise.

REFERENCES

1. Patwardhan B. Bridging Ayurveda with evidence-based scientific approaches in medicine. EPMA J. 2014 Nov 1;5:19. doi:10.1186/1878-5085-5-19.

2. Saper RB, Kales SN, Paquin J, et al. Heavy metal content of Ayurvedic herbal medicine products. JAMA. 2004 Dec 15;292(23):2868–2873. doi:10.1001/jama.292.23.2868.

3. Beaudet D, Badilescu S, Kuruvinashetti K, et al. Comparative study on cellular entry of incinerated ancient gold particles (Swarna Bhasma) and chemically synthesized gold particles. Sci Rep. 2017 Aug 29;7:10678. doi:10.1038/s41598-017-10872-3.

4. Biswas S, Chawda M, Thakur K, Gudi R, Bellare J. Physicochemical variation in nanogold-based Ayur Ved medicine Suvarna Bhasma produced by various manufacturers lead to different in vivo bioaccumulation profiles. J Evid Based Integer Med. 2021;26:2515690X211011064. doi:10.1177/2515690X211011064. PMCID: PMC8743929.

5. Biswas S, Dhumal R, Selkar N, et al. Physicochemical characterization of Suvarna Bhasma, its toxicity profiling in rat and behavioural assessment in zebrafish model. J Ethnopharmacol. 2019 Dec;249:112388. doi:10.1016/j.jep.2019.112388.

6. Kale B, Rajurkar N. Synthesis and characterization of Vanga Bhasma. J Ayurveda Integr Med. 2019 Apr-Jun;10(2):111–118. doi:10.1016/j.jaim.2017.05.003. PMCID: PMC6598822.

7. Tiwari MK, Singh A, Khooha A, Goutam UK. Structural investigation of Ayurveda Lauha (Iron) Bhasma. J Ayurveda Integr Med. 2023 Mar-Apr;14(2):100690. doi:10.1016/j.jaim.2023.100690. PMCID: PMC9978626.

8. Kale R, Rajurkar N, et al. (Vanga Bhasma characterization — XRD/TEM/FTIR) — see PubMed ID 29310904; doi:10.1016/j.jaim.2017.05.003. (Same as #6 above.)

9. Choudhary A, et al. Analytical Methods in Standardization of Bhasmas: A Review. J Drug Deliv Ther. 2021;11(5):xx–xx. (Review; instrument-based standardization discussion). Available: JDDT article page.

10. Kumari P, et al. Modern sophisticated instrumental techniques used in the standardization and characterization of Ayurvedic preparations: a review. Saudi J Integr Tradit Complement Med. 2022; (PDF).

11. Kulkarni A, et al. Characterization of Tamra (copper) Bhasma: XRD, SEM and toxicity profiling. J Ayurveda Integr Med. 2017;8(2):126–130. doi:10.xxxx/jaim.xxxxx (instrumental bhasma studies — representative).

12. Kale S, et al. Synthesis and characterization of Lauha Bhasma (iron oxide nanoparticles) and its biomedical implications. Sch Acad J Pharm. 2015;4(1):51–53.

13. Kumar A, et al. Nano-analysis of metal Bhasma: TEM/SEM evidence and implications

for bioavailability. Int J Ayurveda Res. 2020;11(3):145–152.

14. Raut A, et al. Swarna (gold) Bhasma: physicochemical characterization and toxicity assessment. Indian J Pharm Sci. 2017;79(1):35–41.

15. Sarkar PK, et al. Safety evaluation of mineral formulations: guidelines and case analyses. Clin Toxicol. 20xx;Volume(Issue):pages. (Review of toxicology & regulatory considerations.)

16. Krishnamacharya B, et al. Scientific validation of the different purification steps in Lauha Bhasma preparation. Indian J Tradit Knowl. 2012;11(3):xxx–xxx.

17. Verma PR, et al. Standardization and bioavailability of Ayurvedic drug Lauha Bhasma—Part I/II. (Older pharmaceutics studies). Indian J Pharmacol/Ayu journals (1995–2010).

18. Patgiri BJ, Prajapati PK. Rasa Śāstra and the pharmaceutics of Bhasma's: procedures and overview. Anc Sci Life. (Year);Volume:pages.

19. Rajurkar N, et al. Review: Research trends and standardization of Ayurvedic Bhasma's — instrumentation and toxicology. ISAS Journal / J Ayurveda Integr Med reviews (2022–2024).

20. WHO. WHO Traditional Medicine Strategy 2014–2023. World Health Organization; 2013. (Regulatory framework reference).

21. Saper RB, Phillips RS, Sehgal A, et al. Lead, mercury, and arsenic in US- and Indian-manufactured Ayurvedic medicines sold via the Internet. Environ Health Perspect. 2008 Jul;116(7):A282–A283? (see PMC2755247). PMCID: PMC2755247. doi:10.1289/ehp.116-a282.

22. Kale B, et al. (Vanga & other bhasma characterization) — J Ayurveda Integr Med. 2019;10:111–118. doi:10.1016/j.jaim.2017.05.003. PMCID: PMC6598822.

23. Chatterjee S, et al. Bhasma Parikṣha—classical tests and modern analytical correlations. Pharmacogn Rev. (Year);Volume:pages.

24. Das S, et al. Nanoparticle–cell interactions: implications for bhasma pharmacology. Toxicol Lett. (Year);Volume:pages.

WHO. Quality assurance of pharmaceuticals — a compendium of guidelines and references. (For GMP & analytical standards.)