

Review Article

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“NANOMEDICINE PERSPECTIVES OF AYURVEDIC BHASMA: CLASSICAL WISDOM AND MODERN SCIENCE”

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ABSTRACT

Introduction: Bhasma, the herbo-mineral formulations of Ayurveda, are among the most unique contributions of Indian pharmaceutics. Prepared through *Shodhana* (purification) and *Marana* (incineration), Bhasma have been traditionally described as bioavailable, potent, and safe. Recent studies indicate that many Bhasmas exist in nano-size ranges, making them relevant to the field of nanomedicine. **Methods:** A systematic literature review was carried out using classical Ayurvedic texts (*Rasa Ratna Samuccaya*, *Rasatarangini*, *Ayurveda Prakasha*) along with PubMed, Scopus, Web of Science, and Google Scholar. Keywords included “Ayurvedic Bhasma,” “nanomedicine,” “nanoparticles,” and “Rasashastra pharmaceutics.” Inclusion criteria comprised classical descriptions, analytical characterization, pharmacological studies, and clinical evidence on Bhasmas. Exclusion criteria included anecdotal claims and non-peer-reviewed sources. **Results:** Classical tests for Bhasma such as *Rekhapurnatva* and *Varitaratva* align with properties now attributed to nanoparticles, including ultra-fineness, lightness, and enhanced surface activity. Modern analytical studies using SEM, TEM, XRD, and ICP-MS confirm particle size reduction to nano-range in Bhasmas like *Swarna Bhasma*, *Lauha Bhasma*, and *Abhraka Bhasma*. These nano-forms exhibit improved bioavailability, targeted delivery, and reduced toxicity. Pharmacological studies demonstrate immunomodulatory, anti-inflammatory, antioxidant, and adaptogenic effects. Clinical trials validate their therapeutic utility in anemia, arthritis, diabetes, and neurological disorders. **Discussion:** Bhasma preparation techniques may be seen as early nanotechnology processes, where repeated incineration and trituration generate stable nanoparticles functionalized with organic molecules from herbal media. However, gaps remain in standardization, large-scale toxicological validation, and global regulatory recognition. **Conclusion:** Bhasmas represent a bridge between ancient pharmaceutics and modern nanomedicine. Their characterization and validation through contemporary science may establish them as safe, effective, and globally acceptable therapeutic nanomedicines.

KEYWORDS: Ayurveda, Bhasma, Nanomedicine, Nanoparticles, Rasashastra

INTRODUCTION

Bhasma preparations, an integral part of Rasashastra, are unique Ayurvedic formulations made from metals, minerals, and animal derivatives subjected to purification and incineration^[1-2]. They are considered potent medicines for chronic, metabolic, and degenerative diseases. Their therapeutic power lies in their minute particle size, stability, and bioavailability, which were empirically recognized in Ayurveda centuries ago^[3-4].

The advancement of nanoscience has shed new light on Bhasma. Analytical studies reveal that properly prepared Bhasmas contain particles in the nano-size range, exhibiting enhanced surface area, reactivity, and biological assimilation^[5-6]. This aligns remarkably with classical Ayurvedic observations of lightness, quick action, and high potency of Bhasmas^[7-8].

The aim of this review is to analyze Bhasma from a nanomedicine perspective. The objectives are: (i) to explore classical Ayurvedic principles underlying Bhasma preparation, (ii) to summarize modern analytical evidence confirming their nano-properties, and (iii) to critically discuss their potential role in contemporary nanomedicine^[9-10].

MATERIALS AND METHODS

- **Sources:** Classical Ayurvedic texts (*Rasa Ratna Samuccaya*, *Rasatarangini*, *Ayurveda Prakasha*, *Charaka Samhita*, *Sushruta Samhita*), contemporary commentaries, and modern research^[11].
- **Databases searched:** PubMed, Scopus, Web of Science, Google Scholar.
- **Search terms:** “Ayurvedic Bhasma,” “nanomedicine,” “nanoparticles,” “Rasashastra pharmaceutics,” “toxicology of Bhasma.”^[12]
- **Inclusion criteria:** Classical descriptions, analytical characterizations (XRD, SEM, TEM, ICP-MS), toxicological studies, pharmacological reports, and clinical evidence^[13].
- **Exclusion criteria:** Anecdotal reports, non-authentic sources, and studies lacking methodology^[14].
- **Method:** Data were thematically classified into classical foundations, analytical evidence, pharmacological validation, and clinical applications^[15].

OBSERVATION AND RESULTS

1. Classical Ayurvedic Foundations

- *Rekhapurnatva* (ability to enter skin creases), *Varitaratva* (floating on water), *Nischandratva* (absence of metallic luster), and *Apunarbhava* (irreversibility to metal) ensured proper processing and bioavailability.
- Classical scholars emphasized that only well-processed Bhasma are therapeutically safe, predicting the importance of particle size, stability, and assimilation centuries before modern nanoscience.

2. Analytical Characterization

- **SEM/TEM:** Demonstrates nano-sized particles (10–100 nm) in *Swarna*, *Lauha*, *Abhraka*, and *Tamra Bhasma*.
- **XRD:** Confirms crystalline phases such as oxides and sulfides, distinct from raw metals.
- **ICP-MS/EDAX:** Show removal of toxic impurities and controlled elemental composition.
- **FTIR:** Confirms organic coatings from herbal media, suggesting functionalization.

3. Pharmacological Evidence

- *Swarna Bhasma:* Immunomodulatory, antioxidant, neuroprotective.
- *Lauha Bhasma:* Treats anemia via improved iron bioavailability.
- *Abhraka Bhasma:* Adaptogenic, rejuvenative, effective in respiratory disorders.
- *Rasasindura:* Demonstrates Rasayana and antimicrobial properties.
- Nanoparticle nature contributes to rapid absorption, tissue targeting, and efficacy at lower doses.

4. Clinical Applications

- Clinical studies report efficacy in anemia, diabetes, rheumatoid arthritis, asthma, and neurological conditions.
- *Swarna Bhasma* used in immunotherapy shows improved tolerance and response.
- Safety studies confirm reduced toxicity when prepared according to classical methods.

5. Comparisons with Modern Nanomedicine

- Bhasma preparation resembles nanoparticle synthesis: repeated calcination (thermal processing), trituration with herbal juices (functionalization), and stability tests.
- Bhasma demonstrate properties sought in nanomedicine: biocompatibility, stability, targeted delivery, and reduced toxicity.

DISCUSSION

The nanomedicine perspective validates Ayurveda's foresight in pharmaceutics. Processes like *Shodhana* and *Marana* can be equated to modern nanofabrication techniques, producing nanoparticles stabilized with organic moieties. These confer unique therapeutic properties, such as increased bioavailability and reduced toxicity^[16].

Modern studies confirm that Bhasma contain particles in the nanometer range with altered crystalline structures, correlating with their pharmacological potency. For example, *Swarna Bhasma* contains stable gold nanoparticles, while *Lauha Bhasma* exhibits bioavailable iron oxides. Such findings explain classical claims of quick action and high potency^[17].

However, global concerns about heavy metal toxicity in Ayurveda persist. Most safety issues arise from spurious products lacking proper purification or incineration. Authentic Bhasmas, subjected to classical *Samskaras*, demonstrate chemical transformations that reduce free metal content and toxicity^[18].

The gaps lie in standardization, reproducibility, and regulatory recognition. Current evidence, though promising, requires large-scale toxicological evaluations, pharmacokinetics, and randomized controlled trials. Integrative collaborations between Ayurveda experts, nanotechnologists, and regulatory bodies are essential^[19].

Thus, Bhasma should not merely be seen as traditional remedies but as early nanomedicines, whose validation may contribute significantly to global healthcare innovation^[20].

CONCLUSION

Ayurvedic Bhasma exemplify the confluence of traditional pharmaceutics and modern nanomedicine. Classical texts described their unique properties, therapeutic potential, and safety criteria through empirical methods, anticipating concepts now central to nanoscience.

Modern analytical studies confirm that Bhasma are composed of nano-sized particles with altered crystalline structures, functionalized by herbal media. These properties contribute to enhanced bioavailability, stability, and efficacy at smaller doses. Pharmacological and clinical evidence supports their use in conditions like anemia, arthritis, diabetes, and neurological disorders.

However, challenges remain in standardization, toxicological validation, and international regulatory

acceptance. Many reported adverse effects are due to improper preparations rather than authentic Bhasma. Hence, strict adherence to classical methods combined with modern analytical validation is critical.

In conclusion, Bhasma represent a pioneering form of nanomedicine developed centuries ago in Ayurveda. Integrating their classical principles with cutting-edge scientific research offers opportunities for safe, effective, and globally recognized nanotherapeutics.

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