Research Proposal

Swarna Bhasma: Repurposing Ayurvedic Gold Nanoparticles for Blinding Ocular Diseases

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ABSTRACT

The convergence of traditional medicine and modern nanotechnology offers a promising frontier for developing novel therapeutics. *Swarna Bhasma* (SB), a calcined gold ash used in Ayurvedic medicine for centuries, is a quintessential example of an innate nanomaterial. Recent characterization studies have confirmed that SB consists of spherical and crystalline gold nanoparticles (AuNPs) in a size range (10-80 nm) ideal for biomedical applications. This review article suggests *Swarna Bhasma* as a potent tool for nanotechnology-based interventions in Ophthalmology by exploring its physicochemical properties, including its nanoscale dimension, bioavailability, and unique biological activities such as anti-angiogenic, anti-inflammatory, and antioxidant effects. Also, propose the mechanistic pathways through which these properties can target the pathophysiological underpinnings of major eye diseases, including Age-related Macular Degeneration (ARMD), Diabetic retinopathy, Cataracts, and Uveitis. The article concludes by discussing the challenges and future directions for translating this ancient nanomedicine into a standardized, evidence-based therapeutic agent for modern ophthalmic practice, highlighting its potential for targeted, safe, and multi-factorial treatment of complex ocular pathologies.

Keywords: *Swarna Bhasma*, Ayurveda, Nanomedicine, Gold Nanoparticles, Ophthalmology, Age-Related Macular Degeneration, Diabetic Retinopathy, Ocular Drug Delivery, *Rasayana*

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INTRODUCTION

The global burden of eye diseases is immense, with conditions like Age-related Macular Degeneration (ARMD), Diabetic retinopathy, Glaucoma, and Cataracts being leading causes of irreversible vision loss. Modern treatments, including anti-VEGF injections for wet AMD and Diabetic macular oedema, have revolutionized care but are fraught with limitations: high cost, invasive intravitreal administration, limited efficacy in certain patient cohorts, and potential for complications[1]. There is a pressing need for safer, more effective, and multifunctional therapeutic agents.

Simultaneously, nanotechnology has emerged as a transformative force in medicine. Engineered nanoparticles, particularly gold nanoparticles (AuNPs), are prized for their unique optical properties, biocompatibility, and ease of functionalization for targeted drug delivery. Interestingly, the ancient Indian medical system of Ayurveda has been utilizing a nanometric form of gold for millennia. Swarna Bhasma (SB), literally "gold ash," is a traditional medicine prepared through a complex process of purification and incineration. It is classically prescribed as a *Rasayana* (rejuvenator) for a wide range of conditions.

The Bhavaprakasha Nighantu explicitly states its efficacy in *Netra roga* as follows:

स्वर्णं हन्ति तृषा श्वासं मदभ्रमरकाज्वरान्।

कासं पाण्डुअरुच्यर्शो नेत्रामयांश्च घोरांश्च॥

"svarnaṃ hanti tṛṣā śvāsaṃ mada-bhramara-ka-jvarān | kāsaṃ pāṇḍu-aruci-arśo netra-amayāṃśca ghorāṃśca" **(**B.P.Ni.Swarna Varga-7)

Gold alleviates excessive thirst, asthma, intoxication, giddiness, fevers, cough, anemia, anorexia, piles, and even terrible diseases of the eye[3].

Advanced analytical techniques have revealed that the traditional preparation protocol effectively breaks down bulk gold into a fine powder composed of AuNPs [4]. This serendipitous creation of a nanomaterial presents a fascinating hypothesis: Could Swarna Bhasma serve as a naturally derived, multi-functional nanotherapeutic agent for modern eye diseases? This article synthesizes existing evidence on Swarna Bhasma's nanoscale properties and biological activities to build a rationale for its application in ophthalmic nanomedicine.

METHODOLOGY

A comprehensive literature review was conducted using major scientific databases, including PubMed, Scopus, Web of Science, and Google Scholar. Search terms included "*Swarna Bhasma*," "gold nanoparticles,"

"Ayurvedic nanomedicine," "Ophthalmology," "anti-angiogenic," "ARMD," "Diabetic retinopathy," and related terms. Both modern scientific literature and authoritative translations of classical Ayurvedic texts were consulted to provide a holistic view of the subject, from traditional use to modern scientific validation. The focus was on identifying studies detailing the physicochemical characterization of *Swarna Bhasma* and its documented pharmacological activities relevant to ocular pathophysiology.

RESULTS

Bhasmikarana (The Process of Incineration)

Raw gold is considered as biologically inert and non-bioavailable in its metallic form. The intricate process of Bhasmikarana (purification - *Shodhana* and incineration - *Marana*) transforms it into a therapeutically active, bioavailable form. This process reduces the particle size to the nanoscale, alters its physicochemical properties, and eliminates potential toxicity.

1. Nanoscale Characterization of Swarna Bhasma:

Analytical techniques including Transmission Electron Microscopy (TEM), Scanning Electron Microscopy (SEM), and Dynamic Light Scattering (DLS) have confirmed that Swarna Bhasma comprises well-dispersed, spherical, and polycrystalline gold nanoparticles (AuNPs). Their size typically ranges from 10 to 80 nanometers.[4,5] X-ray Diffraction (XRD) confirms the crystalline nature of the gold, while Energy-Dispersive X-ray Spectroscopy (EDX) reveals the presence of other elements like calcium, Sulphur, and Carbon from the herbal precursors used in its synthesis.[5,6]

2. Relevant Pharmacological Activities:

- **Anti-Angiogenic**: Research indicates that AuNPs exhibit intrinsic anti-angiogenic properties, inhibiting VEGF-induced phosphorylation of VEGFR2 and downstream signaling pathways in endothelial cells[7].
- **Anti-inflammatory and Antioxidant**: SB has been documented to scavenge free radicals and downregulate pro-inflammatory cytokines such as TNF-α, IL-6, and NF-Kb.[8,9]
- **Neuroprotective:** Preliminary studies on neurological models suggest SB has significant neuroprotective and nootropic effects, likely by modulating neurotransmitter levels and protecting neurons from oxidative damage [10].

3. Proposed Ocular Applications: The nanoscale size and multifaceted biological activities of SB align with the treatment

needs of major ocular pathologies, as summarized in Table 1.

Table 1: Proposed Mechanisms of Swarna Bhasma in Ocular Diseases

Ocular Disease	Proposed Mechanism of Swarna Bhasma
Wet ARMD	Inhibition of VEGFR2 signaling; suppression of endothelial cell migration and tube formation (Anti-angiogenesis).
Diabetic Retinopathy	Anti-angiogenic effect to counter neovascularization; antioxidant activity to protect retinal cells; anti-inflammatory cytokine modulation.
Dry ARMD & Geographic Atrophy	Potent ROS scavenging to protect RPE and photoreceptors; anti-inflammatory action to slow disease progression
Cataracts	Antioxidant activity preventing protein aggregation and maintaining lens transparency.
Uveitis	Downregulation of pro-inflammatory pathways (NF-κB, TNF-α, IL-6) to control inflammation and preserve ocular structures.

DISCUSSION

The pharmacology of *Swarna Bhasma* is a perfect example of how ancient processing techniques can create a bio-enhanced nanomedicine. Its wide range of properties—anti-inflammatory, antioxidant, immunomodulatory, neuroprotective, and anti-angiogenic—make it a compelling multi-targeted therapeutic agent. Modern research into its mechanisms focuses on the role of its gold nanoparticles and their interaction with biological systems, providing a scientific basis for its traditional use as a rejuvenating tonic. Raw gold, in contrast, possesses none of these properties and is not used therapeutically.

The results position *Swarna Bhasma* as a uniquely versatile candidate for ophthalmic nanomedicine. Its structure as a natural nanoparticle conglomerate allows it to function as a multi-targeted therapeutic platform, capable of simultaneously addressing angiogenesis, inflammation, oxidative stress, and neurodegeneration—the core pathological pillars of complex eye diseases like ARMD and Diabetic retinopathy.

The anti-angiogenic potential of its AuNPs could offer a natural complementary approach to current anti-VEGF therapies, potentially reducing treatment burden. Its antioxidant and anti-inflammatory properties directly counter the oxidative stress and

chronic inflammation central to dry ARMD, Uveitis, and Cataract formation. Furthermore, its neuroprotective potential, hinted at in neurological studies, is particularly compelling for preserving retinal neurons in Glaucoma and Geographic atrophy. However, the translation of this promise into clinical reality faces significant challenges. The primary hurdle is the standardization of the traditional preparation method to ensure batch-to-batch consistency in particle size, distribution, and purity using Good Manufacturing Practices (GMP)[5]. While the traditional use provides a foundation for safety, rigorous preclinical and clinical evidence from randomized, placebo-controlled trials specifically for ophthalmic indications is absolutely essential.[1,10] Furthermore, developing optimal delivery formulations (e.g., nano-emulsions, hydrogels for topical or intravitreal administration) that maintain the stability and efficacy of the *Swarna Bhasma* nanoparticles is a crucial area for future research.

CONCLUSION

Swarna Bhasma represents a remarkable bridge between ancient wisdom and cutting-edge nanotechnology. Its characterized structure as a natural gold nanoparticle conglomerate, combined with its documented multi-targeted pharmacological properties, positions it as a promising candidate for addressing the multifactorial nature of ocular diseases. By applying the rigorous tools of modern science to standardize, validate, and formulate this ancient medicine, we can unlock its significant potential to provide safe, effective, and holistic treatment options for millions of patients suffering from vision-threatening eye diseases worldwide. The future of ophthalmic therapeutics may well be illuminated by the golden legacy of Ayurveda.

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Nil

CONFLICT OF INTEREST

No conflict of interest

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