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"*SWARNA BHASMA*: A CRITICAL REVIEW OF THE IMMUNOMODULATORY, NEUROPROTECTIVE AND *RASAYANA* EVIDENCE"

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ABSTRACT

Background: *Swarna bhasma* (calcined gold) is one of the most valued *rasayana* (rejuvenative) medicines of Ayurveda, used for immunity, cognition, debility and chronic disease, and given to children as *Swarnaprashana*. Its use has expanded rapidly, but the supporting evidence is scattered. **Objective:** To review the evidence on the immunomodulatory, neuroprotective, antioxidant and anticancer effects of *Swarna bhasma*, together with its composition, bioavailability and safety. **Methods:** A critical narrative review of physicochemical, in vitro, animal and clinical studies of *Swarna bhasma* and *Swarnaprashana*. **Results:** *Swarna bhasma* consists of nanocrystalline metallic gold, often in micron-sized aggregates, with large variation between commercial products (gold content 32–98 wt%). Gold is absorbed to a measurable degree in rats and humans. Animal studies report augmentation of non-specific immunity, Th1-type responses with reduced parasite load in experimental leishmaniasis, attenuation of stress-induced neurochemical changes, protection in ischaemia models, and nootropic effects. Clinical studies of *Swarnaprashana* in infants and a prospective study in cancer exist but are small and heterogeneous. Safety studies are reassuring in the short term but limited in duration. **Conclusion:** Preclinical evidence for immunomodulatory and neuroprotective effects is consistent but comes from few laboratories and poorly characterised products. Well-designed clinical trials with characterised products and gold pharmacokinetics are needed before *rasayana* claims can be considered established.

KEYWORDS: *Swarna bhasma*; Gold; *Rasayana*; *Swarnaprashana*; Immunomodulation; Neuroprotection; Ayurveda

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INTRODUCTION

Gold has been used in medicine across many traditions, from Chinese and Arabic medicine to the gold salts used for rheumatoid arthritis in the twentieth century[1]. In Ayurveda, *Swarna* (gold) is regarded as the foremost of metals for *rasayana* therapy. *Swarna bhasma* is prescribed for *ojas* (vitality), *bala* (strength), *medha* (intellect), *vrishya* (reproductive vigour) and the prevention of disease, and *Swarnaprashana*, gold given with honey, ghee and herbs, is administered to infants and children to promote immunity, growth and intellect[2,3].

The modern interest in gold nanoparticles has given *Swarna bhasma* new visibility, and several research groups have characterised it and tested its biological effects[4]. At the same time, *Swarnaprashana* camps for children have become widespread. This combination of rising use and fragmented evidence calls for a critical review. This article examines what *Swarna bhasma* is, how much gold reaches the body, what effects have been shown and how strong the evidence is.

METHODS OF THE REVIEW

This is a critical narrative review. Literature was identified through PubMed, PubMed Central, Crossref-indexed records, DOAJ and publisher databases using the terms *Swarna bhasma*, *Suvarna bhasma*, gold ash, calcined gold, *Swarnaprashana*, *Swarna bindu prashana*, immunomodulation, neuroprotection, cognition, stress and cancer. Reference lists of retrieved reviews were screened. Physicochemical, in vitro, animal and clinical studies were included and grouped by biological domain.

COMPOSITION AND CHARACTERISATION

Characterisation studies consistently identify *Swarna bhasma* as metallic gold with face-centred cubic structure. Crystallite sizes calculated from X-ray diffraction range from about 28 to 60 nm, while the powder itself consists of particles and aggregates from tens of nanometres to several micrometres[5-7]. Electron microscopy of one commercial product showed particles from 20 nm to 1 µm, mostly spherical, and aggregates of 100 nm to 10 µm[8]. *Suvarna bhasma* prepared with mercury (*Parada marit*) has also been characterised[9].

The most important finding for clinical interpretation is variability between products. Five commercial *Suvarna bhasma* products contained between 32 and 98 wt% gold, one contained 5.4 wt% arsenic, and their surface area and morphology differed considerably[10]. A study that used one manufacturer's product therefore cannot be generalised to *Swarna bhasma* as a category.

1. Classical preparation and its consequences

Classical texts describe several routes for preparing *Swarna bhasma*. Gold foil or leaf is first purified by heating and quenching, and then incinerated either with mercury (*Parada marita*), with *kajjali* or other mineral media, or with herbal media alone, through repeated *puta* until the classical tests are passed. Each route leaves a different footprint. Mercury-based routes raise the question of residual mercury, mineral routes may add arsenic or other elements, and herbal routes may leave carbonaceous residues. The arsenic found in one commercial product[10] and the characterisation of *Parada marita Suvarna bhasma*[9] illustrate why the method of preparation must be stated in every research report and on product labels.

2. Why characterisation matters for interpreting biological studies

The biological activity of metallic gold particles depends on size, shape, surface chemistry and aggregation state. A powder with 30–60 nm crystallites aggregated into micrometre-sized clusters will present a very different surface to cells than a dispersion of free nanoparticles. The fine fraction of *Swarna bhasma* behaves like synthetic nanoparticles in cells, while the aggregates do not[6]. Studies that report only "nano" size, without dispersion state and a measured gold content, cannot be compared with each other, and many of the older pharmacological studies reviewed below fall into this category.

BIOAVAILABILITY

Gold from *Swarna bhasma* is absorbed. In rats given five different commercial products at 0.8 mg/kg, peak blood gold ranged from 4.66 to 8.55 µg/L, with significant differences in pharmacokinetics between products[10]. In zebrafish, gold accumulation correlated closely with the product of surface area and gold content. A pilot study has assessed the bioavailability of gold *bhasma* in human participants[11]. At the cellular level, *Swarna bhasma* particles enter cells through actin-dependent and clathrin-mediated pathways, with fine fractions behaving differently from aggregates[6], and approaches to enhance internalisation of *Swarna bhasma* in human cells have been explored[12]. These data show that the claimed effects are pharmacologically possible, but they also

mean that gold exposure must be considered in safety assessment, particularly in children.

Table 1. Selected preclinical and clinical studies on the immunomodulatory and related effects of *Swarna bhasma*

Domain	Model	Main findings
Non-specific immunity	Mice	Gold preparations used in traditional medicine augmented non-specific immunity
Antigen presentation and Th1 response	RAW 264.7 macrophages; BALB/c mice infected with *Leishmania donovani*	Reduced parasite uptake; increased nitric oxide, IFN-γ, TNF-α, IL-12 and MHC I/II expression; lower liver and spleen weights and splenic parasite load; more IFN-γ^+ and TNF-α^+ $CD4^+CD44^+$ T cells; fewer IL-10^+ cells
Antioxidant activity	Chemical and in vitro assays	Free-radical scavenging activity of *Swarna bhasma* reported with analysis of chemical constituents
Immunity in infants (*Swarnaprashana*)	Clinical study in infants	Immunological, biochemical and quality-of-life parameters evaluated
Immunity in infants (*Swarna bindu prashana*)	Review	Evidence for an ancient approach to improve infant immunity summarised
Chronic safety (*Swarna bindu prashana*)	Animal study	Safety on chronic administration assessed

IMMUNOMODULATORY EVIDENCE

The most detailed mechanistic study used experimental leishmaniasis. *Swarna bhasma*, alone or as a ghee emulsion, increased antigen-presenting function in macrophages, raised nitric oxide, pro-inflammatory cytokines and MHC expression, and in infected mice reduced liver and spleen weights and splenic parasite load. It also shifted $CD4^+$ T cells towards a Th1 phenotype, with more IFN-γ^+ and TNF-α^+ cells and fewer IL-10^+ cells[8]. Earlier work showed that gold preparations used in traditional medicine augmented non-specific immunity in mice[13].

These results suggest that *Swarna bhasma* can enhance cell-mediated immune responses. They also raise a question for *Swarnaprashana*: a shift towards Th1 responses may be beneficial against intracellular infections, but the consequences of repeated immune stimulation in healthy infants have not been studied. The study also had limitations: one commercial product, one parasite strain, one mouse model, and some inconsistencies between text and figures in the reporting of T-cell subsets[8].

For *Swarnaprashana*, a critical appraisal of the classical basis and practice[3], a review of *Swarna bindu prashana*[16], a clinical study of immunological and quality-of-life parameters in infants[15] and a chronic safety study[17] have been published, and a recent review has summarised the evidence as promising but limited[2]. Large, controlled trials with prespecified infection outcomes are still lacking.

NEUROPROTECTIVE AND ADAPTOGENIC EVIDENCE

Several animal studies support neurological effects. Calcined gold preparations attenuated stress-induced changes in brain catecholamines, serotonin and plasma corticosterone in rodents[18], and showed antioxidant and restorative effects in global and focal models of cerebral ischaemia[19]. *Swarna bhasma* protected against cognitive impairment induced by sleep deprivation in rats[20], and a *Swarnaprashana* preparation was screened for nootropic activity[21]. In zebrafish, behavioural assessment was part of a toxicity profiling study of *Suvarna bhasma*[22].

These findings are consistent with the classical *medhya* (intellect-promoting) use of gold, and with the known antioxidant properties of gold nanoparticles. However, most studies were small, used short exposure, and did not report the gold content or characterisation of the product, and none measured brain gold levels. Whether the effects arise from gold, from co-administered herbs, or from the vehicle has rarely been tested.

1. Plausible mechanisms

Several mechanisms could link gold to these effects. Gold nanoparticles can scavenge reactive oxygen

species and modulate inflammatory signalling, and antioxidant activity of *Swarna bhasma* has been reported[14]. Gold also interacts with thiol-containing proteins, which underlies the anti-inflammatory action of the gold salts once used in rheumatoid arthritis[1]. In the immune system, particulate gold taken up by macrophages can enhance antigen presentation, as shown in the leishmaniasis model[8]. These mechanisms are plausible, but none has yet been directly linked to a measured tissue level of gold after oral dosing of a characterised product.

ANTICANCER EVIDENCE

Swarna bhasma has been studied in a prospective clinical study in cancer[23]. A gold nanoparticle formulation derived from the *Swarna bhasma* tradition (nano *Swarna bhasma*) slowed tumour growth in mice in a dose-dependent manner after oral administration, and a pilot study in metastatic breast cancer reported clinical benefit when it was given alongside standard care[24]. These studies are preliminary. The nano formulation differs from classical *Swarna bhasma*, and the pilot clinical data are too limited to support any recommendation for cancer treatment.

SAFETY

Short-term safety data are reassuring. *Swarna bhasma* showed very low haemolysis and minimal effects on complement and platelet activation in blood-compatibility tests[5], and a toxicity profiling study in rats and zebrafish has been reported[22]. A chronic administration study of *Swarna bindu prashana* has also assessed safety[17]. The main safety concerns are the variability of commercial products, including unexpected arsenic in one product[10]; the lack of long-term data on gold accumulation; and the use of the medicine in infants, in whom any accumulation would occur over a lifetime.

OVERALL ASSESSMENT OF THE EVIDENCE

Table 2. Strength of evidence for the main claims made for *Swarna bhasma*

Claim	Type of evidence	Assessment
Composition is nanocrystalline metallic gold	Multiple characterisation studies	Well supported, with large variation between products
Gold is absorbed after oral administration	Rat pharmacokinetics; human pilot study	Supported; extent depends on product
Immunomodulatory effect	Animal and cell studies; small clinical studies in infants	Consistent preclinical support; clinical evidence limited
Neuroprotective and adaptogenic effect	Several animal models	Consistent preclinical support from few groups; no adequate clinical trials
Anticancer effect	One prospective clinical study; nano formulation in mice and pilot patients	Preliminary
Safety	Short-term animal and in vitro studies	Reassuring in the short term; long-term and paediatric data lacking

1. Sources of bias in the existing literature

Three sources of bias deserve attention. First, publication bias is likely: small positive studies of *rasayana* drugs are more readily published than negative ones, particularly in specialised journals. Second, many studies were conducted by groups associated with manufacturers, which does not invalidate them but makes independent replication more important. Third, clinical studies of *Swarnaprashana* often rely on parent-reported outcomes such as frequency of illness, which are vulnerable to expectation effects when the intervention is not blinded. Placebo-controlled designs with objective outcomes, such as laboratory-confirmed infections or antibody responses to routine vaccines, would reduce these risks.

2. Dose and duration

Classical doses of *Swarna bhasma* for adults are small, in the order of tens of milligrams per day, and *Swarnaprashana* doses for children are smaller still. At these doses, daily gold intake is low, but with prolonged or repeated courses the cumulative exposure is not trivial, and gold has no physiological elimination pathway that would prevent accumulation. Studies should therefore report both the dose of the formulation and the corresponding dose of elemental

gold, and safety studies should match the duration of real-world use.

RESEARCH PRIORITIES

- Characterise every product used in research: gold content, phase, particle size distribution, surface area and impurities.
- Conduct gold pharmacokinetic studies in humans at therapeutic doses, with and without the classical vehicles.
- Run adequately powered randomised controlled trials of *Swarnaprashana* in children with prespecified clinical outcomes, such as incidence of respiratory infections, and long-term follow-up of gold levels.
- Test neuroprotective claims in clinical populations with validated cognitive end-points.
- Compare *Swarna bhasma* with herb-only formulations to separate the effect of gold from that of the herbs and vehicle.

CONCLUSION

Swarna bhasma is nanocrystalline metallic gold that is absorbed to a measurable, product-dependent extent. Preclinical studies consistently suggest immunomodulatory, neuroprotective and antioxidant effects that are in keeping with its classical *rasayana* indications, but the evidence comes from few groups, often with poorly characterised products, and clinical data are limited. The widespread use of *Swarnaprashana* in children makes product standardisation, pharmacokinetic studies and controlled clinical trials especially urgent.

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