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SWARNA BINDU PRASHANA: BRIDGING ANCIENT AYURVEDA AND MODERN PEDIATRIC HEALTHCARE

E. M. Sunitha [*1], B. Ravi [1], J. V. Ramyasree [1] and Sangeetha Kademani Prabhu [2]

Department of Botany [1], Babu Jagjivan Ram Government Degree College (A), Narayanguda, Hyderabad - 500004, Telangana, India.
Department of Zoology [2], Maris Stella College, Vijayawada - 520008, Andhra Pradesh, India.

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Correspondence to Author:
Prof. E. M. Sunitha

Professor,
Department of Botany,
Babu Jagjivan Ram Government Degree College (A), Narayanguda, Hyderabad - 500004, Telangana, India.

E-mail: sunitha2575@gmail.com

ABSTRACT: Swarna Bindu Prashana (SBP) is a traditional Ayurvedic pediatric formulation that typically consists of Swarna Bhasma (processed gold), ghee, and honey and has been used for centuries as a health-promoting practice. Classical Ayurvedic texts describe SBP as supporting immunity, cognition, growth, and overall well-being in children. In recent years, increasing scientific interest has focused on understanding the biological basis of such traditional practices and exploring the pharmacological properties of gold-containing preparations. This mini-review summarizes the available literature on SBP, its traditional rationale, proposed mechanisms of action, and potential relevance to pediatric healthcare. Particular attention is given to evidence related to Swarna Bhasma, immunomodulatory effects reported in preclinical and clinical studies, and the broader biomedical applications of gold-based nanomaterials. The review also discusses the potential contributions of ghee and honey as traditional adjuvants, while highlighting important considerations regarding safety, standardization, quality control, and age-specific use. Although preliminary findings suggest that SBP may have immunomodulatory and health-supportive properties, current evidence remains limited and heterogeneous, and direct clinical benefits have not been conclusively established. Further standardized characterization studies, safety evaluations, and well-designed clinical trials are required to validate its efficacy and clarify its role in modern pediatric healthcare. This review aims to provide a balanced perspective by integrating traditional Ayurvedic knowledge with contemporary scientific evidence while identifying key gaps for future research.

INTRODUCTION: Swarna Bindu Prashana (SBP) is an Ayurvedic practice in which children swallow a combination of gold (swarna) particles, ghee, and honey. This ancient practice is based on Ayurvedic ideas, which view gold as a pure metal with preventative and curative powers [1].

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When administered at exact dosages, SBP is thought to improve numerous aspects of children's health, including cognition, digestion, metabolism, physical strength, immunity, fertility, and longevity [2].

Recent scientific interest has focused on the therapeutic potential of gold nanoparticles (AuNPs) in modern medicine. AuNPs have high biocompatibility and are synthesized via diverse methods, such as chemical, electrochemical, photochemical, and biological approaches [3, 4]. However, conventional synthesis methods often result in toxic byproducts, prompting the

exploration of biological conjugates such as proteins, peptides, and polysaccharides to reduce toxicity levels. These nanoparticles exhibit significant antibacterial, anticancer, and anti-inflammatory properties, expanding their potential in disease management beyond their traditional use [5]. This diversity in particle characteristics enhances immune responses in infants, potentially allowing them to combat pathogens, cancer cells, and inflammatory agents through activated cellular and humoral immune mechanisms (Ref). SBP is characterized by severe immune responses, including cytokine release syndrome and acute respiratory distress, and has recently re-emerged as a promising ancient immunization strategy against viral diseases. Beyond its immediate therapeutic benefits, this practice holds potential for enhancing generational immunity, contributing to long-term disease resilience within the neonatal population [6, 7]. This mini-review explores the integration of Ayurvedic tradition with modern science in SBP, emphasizing its immune-boosting effects and holistic approach to healthcare strategies.

Exploring the Synergistic Application of AuNPs: Nanotechnology, a rapidly developing discipline, focuses on the creation, manipulation, and use of nanometer-scale materials, with a specific emphasis on herbal, herbo-metallic, and herbo-mineral research in Ayurvedic nanomedical biology. NPs are synthesized *via* a variety of processes, including chemical, electrochemical, radiation, photochemical, and biological approaches, with chemical methods being the most popular, despite possible health and oxidative stress. The creation of nanoparticles utilizing herbo-mineral and herbo-metal formulations (Rasa Aushadhis) are traditional Ayurvedic preparations that combine purified metals, minerals, and herbs to produce highly potent, fast-acting medicines effective at low doses for chronic diseases. These formulations include preparations such as Bhasmas, which undergo rigorous purification (Shodhana) and calcination (Marana) processes. Through these advanced procedures, potentially toxic raw materials are transformed into bioavailable, therapeutically effective, and safe medicinal products found in Ayurvedic preparations such as ghee and honey has potential for biological applications [8, 9] **Table 1**.

AuNPs are well known for their distinctive visual and physical characteristics. Numerous substances, including polymers, surfactants, ligands, dendrimers, medications, DNA, RNA, proteins, peptides, and oligonucleotides, may be used to functionalize them. Recent breakthroughs have focused on the utilization of herbominerals and metallic compounds in biomedicine and Ayurveda. AuNPshave antibacterial, anticancer, and anti-inflammatory effects [9, 10]. When coupled with ghee and honey in the SBP, these methods improve children's immune and general health, indicating their potential in diagnostics, medicines, and other biomedical uses. Research has shown that AuNPs are efficient against infections and slightly harmful to healthy cells while causing cancer cell death, making them potentially useful in chemotherapy [11]. The cost-effective production of Swarna bhasma nanoparticles using ghee and honey eliminates the need for high temperatures, pressure, or harmful chemicals. The ancient practice of Lehana or Prashana, which includes licking medicinal combinations of gold, ghee and honey, is said to improve children's immunity and health. This technique has major implications for Ayurvedic health care regimens and helps to raise healthy kids.

TABLE 1: NANOMEDICINAL PROPERTIES OF SWARNABINDU PRASHANA

Component/Claim	Reported Property	Evidence Type*	Brief Evidence Summary
Swarna Bindu Prashana (Swarna Bhasma, Ghee, Honey)	Immunomodulatory potential	Traditional use; limited clinical and preclinical evidence	Ayurvedic texts describe SBP as supporting immunity. Limited studies suggest possible immunomodulatory effects; robust clinical evidence remains insufficient.
Swarna Bhasma-containing formulations	Potential anti-inflammatory activity	Preclinical evidence	Experimental studies have reported anti-inflammatory effects of gold-containing preparations; applicability to SBP remains uncertain.
Swarna Bhasma-containing formulations	Potential stress-adaptive (adaptogenic) effects	Traditional use; limited preclinical evidence	Adaptogenic properties have been proposed based on Ayurvedic concepts and limited experimental studies but require further validation.
Gold-based	Experimental	In vitro and animal	Laboratory-synthesized AuNPs have demonstrated

nanomaterials (AuNPs)†	antibacterial activity	studies	antibacterial activity in experimental settings; evidence is not specific to SBP.
Gold-based nanomaterials (AuNPs)†	Experimental antiviral applications	In vitro and preclinical studies	AuNPs have been investigated as vaccine-delivery platforms and antiviral agents in research settings; these findings cannot be directly extrapolated to SBP.
Gold-based nanomaterials (AuNPs)†	Experimental anticancer applications	Preclinical studies	AuNPs have been studied for imaging, drug delivery, and cancer therapeutics; these applications are unrelated to the established clinical use of SBP.

Nanomedicinal Properties:

Immune Stimulants: GNPs may be attached to polysaccharides or proteins before being treated with antigens. They are well known for their capacity to control the immune system. GNPs are used as adjuvants in vaccine development to increase immune responses. As a result, GNPs are highly valuable in biological applications such as immunization, medication administration, and diagnostic monitoring [12, 13].

Adaptogenic: Nanoparticles help the body adapt to stress and maintain homeostasis by improving the intrinsic capacity to handle physical, emotional, and environmental difficulties, increasing overall resilience and well-being. Research has shown that SBP improve stress tolerance by altering stress-related pathways, essentially serving as adaptogens. Cellular survival strategies rely heavily on how cells respond to stresses such as NPs. Prolonged exposure to low concentrations of NPs may cause long-lasting changes in cell physiology, indicating an adaptive response to repeated stimulation. These results demonstrate that cells undergo progressive molecular-level modifications mediated by nanoparticlesto create a new equilibrium in response to prolonged stress [14, 15].

Memory Booster: Swarna Bindu Prashana is well known for its memory-enhancing properties, which are especially useful throughout early development to improve cognitive function, attention, and mental clarity [13, 16]. AuNPs have been proven to increase synaptic plasticity and neurogenesis, which contributes to cognitive enhancement and memory improvement. *In-vivo* studies have investigated the effect of AuNPs on H3K9 histone acetylation *via* the activation of the histone acetyltransferase Kat2a, which improves genome accessibility in adult NSCs and promotes hippocampal neurogenesis. Importantly, electromagnetic stimulation has been shown to trigger hippocampal regeneration in old and progeria mice, hence improving cognitive skills, including learning and memory. Given the loss of adult neurogenesis with age, which corresponds with cognitive and memory decline, studies have shown that electromagnetized AuNPs may stimulate adult hippocampal neurogenesis, eventually boosting cognitive function and memory consolidation in aged mice [17].

Anti-inflammatory Effects: Nanoparticle also can act as carriers of drug and have several uses, including vaccine development, anti-infective and anti-inflammatory medicine delivery, and pathogen and inflammation detection [18]. They improve medication bioavailability, stability, and targeted administration, increasing the effectiveness of therapies for infections and inflammatory diseases while maintaining safety and efficacy. Swarna bhasma has anti-inflammatory characteristics that help decrease inflammation in the body, assisting in the treatment of illnesses such as arthritis and increasing general health via reduced inflammatory reactions. AuNPs provide significant anti-inflammatory effects by reducing pro-inflammatory cytokines and pathways, hence amplifying the anti-inflammatory benefits of SBP [8, 13].

Anticancer Effects: AuNPs show potential in cancer treatment by decreasing cancer cell growth and metastasis, strengthening the body's natural cancer defenses, and lowering cancer risk. AuNPs have shown promise in cancer therapy by triggering apoptosis in cancer cells and improving the efficiency of traditional therapies, therefore complementing Swarna Bindu Prashana's anticancer characteristics. AuNPs have various advantages for tumor diagnostics and therapy, including their tiny size for deep tissue penetration, selective accumulation in tumor areas, protein- and drug-binding ability, targeted drug delivery capabilities, and superior biocompatibility. While research on AuNPs for tumor imaging and radiosensitization has focused mostly on cellular

and animal models, they provide innovative methodologies and insights for early cancer diagnosis and accurate radiotherapy [19, 20].

Antibacterial Activity: The form, size, charge, and conjugated components of AuNPshave considerable influences on their accumulation in organs and removal from the circulation. Efforts have been directed at improving GNP pharmacokinetics by increasing the circulation half-life and physical size while decreasing clearance via the mononuclear phagocytosis system. This provides antibacterial defense to prevent and treat bacterial diseases. It strengthens the body's natural defenses and improves general health. AuNPs have significant antibacterial action because they damage bacterial cell walls and hinder biofilm formation, which enhances the antibacterial properties of Swarna Bindu Prashana [16, 21].

Antivirals: AuNPs exhibit exceptional biocompatibility and chemical inertness, enabling safe interaction with biological systems without inducing toxicity. These properties, combined with their surface adaptability and stability, make them highly suitable for antiviral applications by facilitating virus binding, inhibition of viral entry, and modulation of host immune responses. AuNPs may effectively merge into virus-like particles by expressing viral structural genes, leading to significant progress in vaccine development. Antivirals are used after infection to suppress viral replication and limit disease progression, whereas vaccines are administered before exposure to train the immune system for long-term protection. Together, antivirals provide immediate therapeutic control, while vaccines offer preventive immunity to reduce infection, transmission, and severity. Furthermore, AuNPs may be coupled with polysaccharide or protein linkers prior to antigenic functionalization, allowing them to use their well-documented improve the immunomodulatory properties [22].

Importance and Administration of Swarna Bindu Prashana: Swarna Bindu Prashana (SBP) is an oral Ayurvedic medication that is indicated for children aged one to sixteen. Dosages vary according to age. SBP may be administered early in the morning on an empty stomach for 30 consecutive Pushya Nakshatra days or daily for up to 180 days [23]. SBP improves immune function, memory, IQ, appetite, and skin tone. According to Kashyapa Samhita, it increases intelligence, strength, digestive fire, lifespan, and complexion. Clinical investigations have established that SBP is nontoxic (ref) and has very minimal adverse effects, such as occasional vomiting due to taste. Swarna bhasma, a significant component, is moisturizing, renewing, detoxifying, and medicinal and has antioxidant, depressive, anticancer, antibacterial, and antirheumatoid qualities [23]. However, limited peer-reviewed research is currently available on the safety and efficacy of SBP; its use is primarily supported by extensive historical documentation and traditional medical literature [13, 16].

Role of SBP as an Immune Modulator: Swarna Bindu Prashana (SBP) is at the crossroads of Ayurveda and nanomedicine and has developed nanoscience and nanotechnology. Owing to their historic therapeutic and preservation characteristics, AuNPs, recognized for their distinctive electrical structure, have been exploited in a variety of scientific domains. Surface-functionalized Swarna strains show promise in biomedical applications such as drug targeting, photothermal treatment, immune system regulation, and gene therapy. Classical Ayurvedic literature, such as the Kashyapa Samhita, stresses its advantages in terms of intelligence, digestion, lifespan, and complexion, as well as infection protection. Integrating lectin-capped GNPs into SBP might lead to new vaccine development opportunities by improving immune responses and targeting particular diseases [13, 24]. These nanoparticles, which have minimal toxicity and immunogenicity, are ideal for safe and effective therapeutic uses in children. SBP incorporates nanotherapy and nanochemistry concepts, using biodegradable nanoparticles such as polymethyl methacrylate and chitosan to reduce environmental effects while increasing product efficacy. This method ensures that nanoproducts produced from SBP meet high safety criteria while improving immune responses and clinical results. SBP, by merging Ayurvedic principles with current nanotechnology, has made important contributions to the development of next-generation theranostics and vaccines.

As research into the immunomodulatory and therapeutic potential of Swarna ash continues, exciting advances in pediatric health and disease management *via* Ayurvedic practices are expected [9, 13, 16, 25]. These particles have a variety of forms (nanorods, nanowires, and nanoflowers), sizes, charges, and biomolecular compositions. The special characteristics of SBP stem mostly from its preparation, which involves combining gold particles with ghee and honey **Fig. 1.**

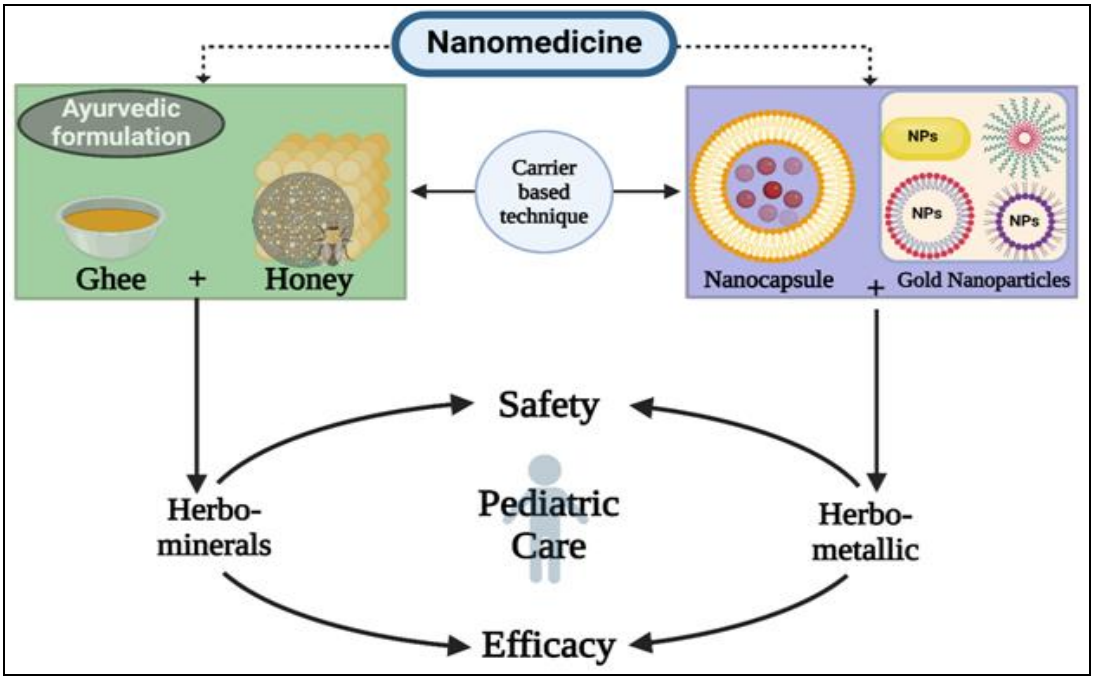

FIG. 1: SWARNA BINDUPRASHANA PREPARATION AND ITS PEDIATRIC CARE BENEFITS AS AN AYURVEDIC IMMUNE BOOSTER COMBINING GHEE, HONEY, AND GOLD NANOPARTICLES

This combination leads to particles with great stability and low toxicity, which is crucial for their safe usage in medical settings. Sugars, amino acids, proteins, lipids, and vitamins are among the molecular elements found in ghee and honey, and they not only provide nutritional advantages but also help to stabilize AuNPs [13].

They operate as capping agents, keeping the particles from aggregating and increasing their biocompatibility. These elements enable gold particles to engage well with membrane receptors on antigen-presenting cells (APCs), such as dendritic cells, which play an important role in the immune system by functioning as messengers between innate and adaptive immune responses. They collect antigens from infections and deliver them to T-cells, triggering a specific immune response. In the context of SBP, gold particles are intended to interact with dendritic cells to promote this process. Dendritic cells absorb particles *via* receptor-mediated endocytosis, pinocytosis, and phagocytosis. Once within dendritic cells, gold particles stimulate maturation, resulting in the production of maturation markers such as CD83 and CD86. During this maturation process, dendritic cells undergo morphological changes that prepare them to transmit antigens to T cells. The processed antigens are presented on the surface of dendritic cells *via* major histocompatibility complex (MHC) molecules, which are required for T-cell detection and activation [26].

The numerous characteristics of SBP particles, such as size, shape, charge, and composition, contribute to their capacity to be transported into dendritic cells [26, 27]. This variety enables the particles to efficiently display various antigens, hence maximizing the immune response. Activated dendritic cells increase the number of T cells, which are required for adaptive immunity. The production of soluble cytokines such as IL-7, IL-6, IL-10, IL-12, IL-23, TNF, and IFN facilitates the interaction between dendritic cells and T cells, which is critical for increasing the immunogenic response and improving the body's capacity to fight infections and disorders [28]. SBP has considerable immunomodulatory uses.

Swarna Prashana, known to enhance immune responsiveness, may support both preventive and therapeutic vaccination by modulating innate and adaptive immune pathways, enhancing antigen recognition, and promoting immunological memory, similar to adjuvant-based vaccine mechanisms [16, 27]. These vaccines may exploit the unique physicochemical properties of AuNPs to enhance antigen delivery, increase immunogenicity, and improve overall vaccine efficacy. However, more research on animal models and cell lines is needed to elucidate the relationships between swarna particles and human biological processes. Additional clinical studies are needed to confirm the effectiveness and safety of SBP in human populations. While early evidence seems encouraging, further scientific review is needed to develop standardized methods for preparation and delivery.

CONCLUSION: Swarna Bindu Prashana is a traditional Ayurvedic pediatric practice that has been used for centuries with the aim of promoting overall health, immunity, and cognitive development in children. The growing interest in SBP has led to attempts to understand its potential benefits through the lens of modern biomedical and nanoscience research. However, it is important to recognize that the current scientific evidence supporting SBP remains limited, heterogeneous, and largely based on traditional knowledge, observational reports, and preclinical studies. While studies on Swarna Bhasma and gold nanoparticles have demonstrated various biological activities, these findings cannot be directly extrapolated to SBP without rigorous characterization and validation of the formulation. At present, there is insufficient high-quality clinical evidence to conclusively establish the efficacy, safety, optimal dosage, or long-term effects of SBP in pediatric populations. Challenges related to formulation standardization, quality control, particle characterization, and potential contamination also require careful consideration. Therefore, claims regarding immune enhancement, cognitive improvement, or disease prevention should be interpreted cautiously. Future research should focus on standardized preparation methods, comprehensive safety assessments, and well-designed clinical trials to generate robust evidence. A balanced integration of traditional Ayurvedic knowledge with modern scientific investigation may help clarify the potential role of SBP in pediatric healthcare while ensuring safety, efficacy, and evidence-based application.

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