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REVIEW ARTICLE

An Evidence-based Review on the Role of *Swarna Bhasma* with Ghee and Honey *(Swarnaprashan)* in Children with Cerebral Palsy: Bridging Scientific Research and Traditional *Ayurvedic* Wisdom

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Abstract

Background: Cerebral Palsy (CP) is a non-progressive neurological disorder resulting from perinatal injury to the developing brain, primarily affecting the upper motor neurons. This condition leads to delayed developmental milestones and abnormal motor function. Globally, CP affects approximately 1.5-2.5 children per 1,000 live births. *Swarnaprashana* (SP), a traditional Ayurvedic practice, is described in classical texts such as the *Kashyapa Samhita* under the category of *Lehana* (electuaries). SP involves the administration of incinerated gold mixed with honey and clarified butter (*ghrita*), which is given orally to children. **Aim:** This review aims to evaluate the therapeutic potential of SP in managing cerebral palsy, with a particular focus on its efficacy in addressing the various health challenges associated with the condition. **Methods:** Evidence was compiled from published *in vitro*, experimental, and clinical studies exploring the multifaceted actions of SP, particularly in relation to health concerns common among children with CP. **Conclusion:** The findings suggest that SP, when used as a supplementary electuary, may offer benefits at multiple levels in the management of cerebral palsy. Research indicates its potential to support brain development and promote physical growth by enhancing appetite, digestion, metabolism, and immune function. Classical Ayurvedic texts also attribute SP with the ability to strengthen *Agni* (digestive and metabolic fire), *Medha* (cognitive function), and *Bala* (strength and immunity). Through its multi-targeted mechanisms, SP may contribute to improving the overall quality of life in children with CP. This review highlights SP's potential as an integrative intervention for the comprehensive management of CP.

Major Findings: SP is a promising Ayurvedic electuary that exhibits a range of pharmacological activities and demonstrates multiple mechanisms of action, influencing cellular, biochemical and physiological regulation. The study indicates that SP can be a cost-effective, harmless, and effective formulation for the management of CP.

Keywords: *Ayurveda*, Cerebral Palsy, Children, Gold Preparation, *Swarnaprashana*

1. Introduction

Cerebral Palsy (CP) encompasses a group of non-progressive neuromotor conditions of cerebral origin caused by any of the perinatal factors leading to any type of insult or injury to the developing brain. It may be accompanied by abnormality in bodily movements, posture, and tonicity[1]. Globally, the incidence of CP is about 1.5-2.5 children per 1000 live births[2]. In India, approximately 33,000 individuals are affected by CP, as reported by the Indian Institute of Cerebral Palsy in 2022. The overall prevalence of CP per 1000 Indian children is estimated to be 2.95[3]. CP puts a big financial load on both the family and the country. As

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per a survey study in the United States, the approximate lifetime financial burden per CP child was anticipated to be $1.2 million per year[4].

Children with CP often face a multitude of challenges, including feeding and swallowing difficulties, poor nutritional and immune status, drooling, speech impediments, mobility issues, digestive problems, epilepsy, vision impairments, learning disabilities, and intellectual deficits. Reduced appetite, sedentary life, along with weak digestion and metabolism, leads to further growth retardation, developmental delay, and poor immunity in CP children, making them more susceptible to various diseases[5].

There is no efficient treatment available for the underlying brain damage to date. Despite advanced research, modern technologies, and expensive therapies, no cure has been found for this disease. In the recent past, many researchers have done research on the rehabilitative requirements of these children to improve their movement, posture, and tone and to reduce the associated problems, such as seizures and feeding difficulties, to provide personalised management to CP children[2]. Management of CP is multidimensional. In the various research studies, it has been found that ayurvedic medications play a key role in the management of various complaints of CP children and consequently improve their quality of life[6-8]. In a cross-sectional survey study done to assess the rates of traditional medicine methods used by 390 mothers of children with developmental disorders, 77.2% reported using at least one traditional medicine. It was reported that 100% of mothers of children with CP and 88.5% with autism were using at least one traditional medicine[9]. Many ongoing research studies are in progress to find out and evaluate natural formulations with minimal untoward effects for CP. One such formulation is SP, described in ancient Ayurvedic texts, as possessing multiple benefits for growing children. SP is a unique practice documented in *Kashyap Samhita*, a treatise of Ayurvedic Paediatrics, in which pure gold is told to be rubbed on a rock and licked by children with ghee (emulsified butter) and honey. SP improves the *Agni* (digestion and metabolism), *Medha* (cognition), *Bala* (strength and immune status), *Varna* (complexion) and *Ayu* (longevity)of children[10]. SP is recommended for children from birth up to 16 years of age[11].

In this review, the potential of SP in CP is tried to be evaluated under the light of various Ayurvedic classical texts and recent research studies. The available data was critically analysed with a special focus on its mechanisms of action in regulating different domains of problems in these children. The advantages of SP can be fully achieved when administered in the proper dosage, along with variable contents to work at multiple levels, like low immunity, weak digestive capacity, poor nutritional status, impaired cognition, and memory.

2. Materials and Methods

This study aimed to evaluate the effectiveness of Swarna Bhasma administered with ghee and honey (*Swarnaprashana*) in children diagnosed with cerebral palsy. A narrative review methodology was adopted, incorporating an extensive literature search and screening process to explore relevant contexts from Ayurvedic sciences and contemporary research. A two-fold approach was employed. To understand the role of SP from an Ayurvedic perspective, a comprehensive review was conducted across ten classical Ayurvedic texts, including both fundamental Samhitas and their commentaries. Each text was manually reviewed to identify references to *Swarna Bhasma* (SB) and SP, focusing on their descriptions, indications, and therapeutic applications in pediatric care. Relevant content was extracted and thematically analysed to synthesise traditional insights.

For scientific literature review, A structured search strategy was implemented across electronic databases including PubMed, SCOPUS, Google Scholar, and other internet sources to gather contemporary scientific evidence. Keywords and MeSH (Medical Subject Headings) terms used for google scholar, PubMed and the Cochrane Library in the search included: Cerebral Palsy, *Ayurveda*, Children, SP, *Suvarnaprashana*, and Gold Electuary.

Inclusion criteria were publications in the English language and Studies published between 2001 and 2024. A total of 295 articles were initially identified. After screening based on the inclusion and exclusion criteria, 62 articles were selected for inclusion in the review. All three authors independently reviewed each identified article to ensure relevance and eligibility. Data extraction focused on study design, intervention,

outcomes, and relevance to SP and cerebral palsy. The multidimensional therapeutic roles of SP were then synthesised, drawing insights from both classical Ayurvedic sources and modern clinical, experimental, and *in vitro* studies.

3. Potential Role of SP for Multidimensional Benefits in Children with CP: Evidence from Ayurvedic Classics

Ayurveda emphasises the use of only purified gold for internal administration[12]. According to Acharya Sushruta, SP helps to improve *Buddhi* (intellect) and *Bala* (strength), which encourages a child's proper growth and development[13]. According to Kashyapa, if SP is administered daily for 1 month, then the child becomes highly intellectual. He also acquires immunity against various kinds of diseases. If it is administered for six months, the child can memorise whatever is heard[14]. SP is considered a *Rasayana* (rejuvenating agent) in *Ayurveda*, which means it helps in promoting overall health and lifespan. SP is believed to provide non-specific immunity and numerous additional benefits[14,15]. *Acharya Vagbhata* also advises giving SP to the newborn in *Jatakarma Samskara* (the first ritual for newborns at birth) in combination with other herbs[16]. SP is also mentioned under *Lehana* recipes, which are the electuaries designed especially for children to boost the immunity and intellect, mentioned in Ayurvedic classics. Acharya Sushruta recommends SP with *Vacha (Acorus calamus* L.), *Shankhapushpi (Convolvulus pluricaulis* like Choisy), and *Kushtha (Saussurealappa Clarke*) for one year[17]. Target advantages of SP are *Medha Vrriddhi* (improvement of mental capacity), *Agni Vardhan* (improvement of digestion and metabolism), *Bala Vardhanam* (immunity and physical vigour), *Ayushyam* (improves lifespan), *Mangalam-Punyam* (auspicious), *Vrishya* (Rejuvenating), *Varnya* (improving complexion), and *Grahapaha* (protects from infectious and idiopathic diseases)[14] (Table 1). All these advantages are favourable for the proper growth and development of the child. (Table 2). Target benefits of SP based on the period of administration are mentioned.

Table 1. Target benefits of *SP* based on the period of administration[14]

S. No.	Target Benefits	Duration
1	*Parama Medhavi* (highly intelligent) *Vyadhibhi Na Cha Drusyate* (increased immunity)	Daily for 1 month
2	*Srutadhara* (able to retain whatever is heard)	Daily for 6 months

3.1 Potential Role of SP for Multi-dimensional Benefits in Children with CP: Current Research Evidence

3.1.1 Effect of SP in Prevention of CP

Ayurveda recommends gold preparation for both the prevention and cure of diseases. It is advised for the parents, before conception, to produce a healthy child because of its *Rasayana* (rejuvenator) and *Vajikarana* (aphrodisiac) properties[18]. After conception, it is administered during *Punsavana karma* (a procedure to attain desired qualities and optimum intrauterine growth and development of the fetus)[19]. After birth, gold is administered as SP to the newborn during *Jatakarma Samskara* (purification ritual for newborn)[16] and thereafter as *Lehana* (Supplementary electuaries)[17]. According to Acharya Sushruta, the rationale behind *Jatakarma Samskara* is that there is inadequate lactation during the first 3 days after childbirth. So, this may support the newborn with nutritive aspects also[20].

Table 2. Advantages of *SP* as per Kashyapa Samhita[14]

S. No.	Benefits	Explanation
1	*Medha Vriddhi*	Progress of mental capacity
2	*Agni Vriddhi*	Improves digestion and metabolism
3	*Bala Vriddhi*	Improves strength and immune status
4	*Ayushya*	Increases longevity, improves quality of life
5	*Mangalam-Punyam*	Auspicious, provides a healthy, happy and contented life
6	*Vrishya*	Rejuvenating, enhances growth and development, nourishes organ systems
7	*Varnya*	Improves complexion, promotes skin health, and prevents skin disorders
8	*Graha-paha*	Protects the child from *Graha* affliction, strengthens the immune system, and protects from infectious and idiopathic diseases

Oxidative stress is one of the main causative factors in the pathogenesis of CP. Neonates are exposed to a variable degree of oxidative stress that may result in cellular, tissue, or organ damage due to an low-efficient antioxidant system[21,22]. There is mounting evidence indicating the role of free radicals in the onset of ischaemic brain damage. Therefore, effective antioxidants seem to be a promising strategy for the prevention of CP in infants diagnosed with hypoxic-ischemic encephalopathy. SP is credited with potent antioxidative and free radical scavenging properties. Various studies showed the adaptogenic potential of gold formulations. An experimental study investigated the role of *Suvarna Bhasma* (SB) in cerebral ischemia models of albino rats. Enzymatic parameters (lipid peroxidase, catalase, etc.) were estimated. Significant reversal of altered values to a nearly normal range by SB indicates a potential role of gold formulations in cerebral ischemia, which is the major cause of CP[23]. As per a recent study by Singh *et al.*[24], SP opposes perinatal oxidative stress, seems nontoxic, reduces the incidence of physiological jaundice, and is bio-compatible and non-toxic to the liver and kidneys. Three dosages of SP (15mg/dose) on the first day of life have a role in defying perinatal oxidative stress in healthy neonates by enhancing the SOD activity and reducing the incidence of physiological jaundice clinically without causing significant reno-hepatic enzyme alteration[24]. So, SP should be administered to children with HIE starting from birth and should be given continuously for either 1 or 6 months, as indicated in the ayurvedic classical literature, to improve the outcome[14] (Table 3).

3.1.2 Effect of SP in Management of CP

3.1.2.1 Improves Poor Nutritional Status in CP Children

CP is frequently associated with various co-morbidities, including undernutrition, which affects an estimated 46% to 90% of patients. These individuals may also experience impaired growth and gastrointestinal symptoms such as impaired appetite, constipation, swallowing difficulty, and gastroesophageal reflux[25,26]. Insufficient food intake is a significant factor contributing to malnutrition. Other contributing factors are skeletal abnormalities, muscle spasms, less physical activity, and a deficient fibre diet[27].

SP improves the digestive fire. It helps in maintaining a healthy digestive system and reduces related complaints such as indigestion, bloating, and acidity[10]. Clinical studies on SP showed a significant increment in weight and height in the study group of children taking SP[28].

3.1.2.2 Enhances Brain Function in CP Children

Cognitive impairment is observed in approximately two-thirds of individuals with CP. Additionally, around fifty per cent of these patients experience seizures. Neurologic anomalies, including visual and auditory defects, and abnormal tactile and pain sensations, are frequently reported[29]. Other co-morbidities associated with CP are poor growth, developmental delays, intellectual disabilities, and communication challenges[30].

SP is known to enhance cognitive functions[16]. It shows a positive effect on brain function, perception, retention, analytical skills, and memory recall[10]. It can contribute to the overall mental development of children. In a clinical trial on the effect of colloidal gold on intelligence, significant improvement was observed in IQ levels[31].

In an experimental study on the forced immobilisation model of stress in rats, the therapeutic potential of two gold preparations, SB, was investigated. Rats were pretreated with the two gold formulations before exposure to restraint stress. The levels of brain catecholamines, serotonin, and corticosterone were measured after one, two, and four hours of restraint stress using High-Performance Liquid Chromatography (HPLC) and luminescence spectrophotometry. The administration of gold preparations was found to significantly restore the elevation of brain catecholamines, 5-HT, and corticosterone to nearly normal levels. The significant restoration of altered values shows the potential of these gold formulations in mitigating stress-induced alterations in brain catecholamines[32].

In a study by Warad[33], pretreatment with SP in an oral dosage of 30 mg/kg demonstrated a significant enhancement in learning and memory ($p<0.01$). Additionally, it resulted in a significant reduction in whole-brain acetylcholinesterase activity ($p<0.001$). These findings indicate that SP possesses both nootropic and anti-AChE properties, suggesting its potential application in memory enhancement[33].

In an experimental study done to evaluate the neuroprotective efficacy of SB on cognitive impairment induced by sleep deprivation in rats, behavioural assessments were done by using radial arm maze and elevated plus maze methodologies. The animals were kept on sleep restriction for the induction of cognitive impairment. Cognitive performance was assessed on the 7th, 14th, and 20th days. Treatment with SB resulted in a reversal of cognitive deficits, as evidenced by improved memory, increased correct arm entries, reduced errors, decreased time to complete tasks, and a reduction in transfer latency[34]. Numerous researches suggest that SP improves brain power[33]. It improves normal synaptic communication in the brain. It also reduces the impact of depression along with enhancement of the ability to focus[31], because of its anti-anxiety and antidepressant activity[35].

In an experimental study, a behavioural abnormality was induced in zebra fish by rotenone exposure. Research on zebrafish brains indicated that the group pre-treated with SB did not show significant effects from rotenone exposure. Insignificant change in dopamine levels in the brains of SB-treated fish confirmed SB's role against behavioural abnormalities induced by rotenone in zebrafish. This research highlights the neuroprotective action of SB[36]. In another study, a group of children in which SP was given monthly for 6 months showed significant improvement in the scores of eating habits, behaviour, temperament, and morbidity status. There was also a significant improvement in the IQ scores of children[37].

3.1.2.3 Improves Immune Status of CP Children

The morbidity of children with CP is mainly because of recurrent respiratory and gastrointestinal infections[38,39]. Recurrent infections cause malnutrition, which leads to the depletion of body fat reserves and muscle mass. This again results in poor immunity, with a subsequent increase in various infections. Thus, immunity-boosting therapies are always suggested to children with CP to prevent various infections and complications[40].

Furthermore, Wu and Li[41] discovered that children with CP exhibited double the levels of pro-inflammatory TNF-α than healthy children, indicating that inflammation might continue later in life in these children. In addition, the research conducted by Pingel *et al.*,[42] revealed elevated IL-6 levels and eight times higher CRP levels in children with CP.

SP is believed to improve the immune status of children, making them less prone to common infections and illnesses[10]. It helps in building resistance against various diseases. Pharmacological research revealed significant immune responses in SB-treated mice. It is also found to stimulate peritoneal macrophages, thereby helpful in fighting against various infections[15,43]. In a clinical trial on newborns SP-Vacha combination has shown a positive response in humoral antibody formation. Total proteins and serum IgG levels also rose, showing their effect on the immune system[44]. Pharmacological reviews of SB reveal that it possesses immunomodulatory and cognitive functions. SB inhibits the numerous cell-mediated immune responses to various mitogens and antigens[45]. SB, the principal ingredient of SP, enhances immunity through phagocytosis. It is effective in motor neuron diseases in small doses[32]. SB has been incorporated in *Ayurveda* for rejuvenation and immunomodulation in many chronic disorders[46]. In a randomised controlled open-label study SP group showed significant improvement in morbidity features as compared to the control group, which reveals that SP works as an immunomodulator that decreases the morbidity rate and therefore can be a simple remedy to bring down the morbidity score in children[47]. In a randomised controlled open-label study SP group showed significant improvement in appetite and reduction in severity and frequency of recurrent illnesses as cough, rhinitis, fever, sneezing, sore throat, pain abdomen, vomiting, diarrhoea, *etc*[43,48]. It enhances specific and nonspecific immune responses[43,49].

3.1.2.4 Antimicrobial Effect against Pathobionts while Sparing Gut Symbionts

Ayurveda recommends SP for children to protect them from various diseases[10]. Because of their low immune status, CP children are always prone to various infections[38,39]. As per a recent study by Singh *et al.*[50], SP manifests anti-pathobiont properties at specific dosages targeting neonate-specific gut bacteria. SP showed remarkable zones of

inhibition- ten mm for both Plasmodium aeruginosa and Salmonella typhi. The finding exhibits its potent antibacterial effect against pathobionts while sparing gut symbionts. This suggests a targeted inhibition mechanism and efficacy for protection against gut-specific infections.

3.1.2.5 Antioxidative Effect

Oxidative stress is implicated in many neurological diseases, including CP and therapies employing antioxidant properties as SP, can play a promising role in mitigating their effects. *In vitro* and animal studies support the potential of antioxidants in countering cell damage, including mitochondrial dysfunctions. Thus, strengthening the antioxidant defence system holds therapeutic potential for neurological disorders, including CP[51].

Antioxidant therapy might serve as an effective treatment to prevent harmful changes to lipids, proteins, and nucleic acids caused by oxygen-derived free radicals, thereby protecting against neurological damage[52]. Increased oxidant power has been shown to play a role in neurodegeneration, and there was a correlation between serum antioxidant levels and neural function[53]. Lack of vitamins and nutrition, environmental factors, and seizures may further elevate oxidative stress in children with CP[54].

SP possesses significant antioxidant properties owing to its ingredients, gold, honey, and ghee. These components potentially help in neutralising free radicals and support overall health in children[55]. Conventional gold formulations have amazing rejuvenating and antioxidant properties[23].

SB exhibits significant Antioxidant activity, as determined by the DPPH method. In this study, 58.72% efficacy was found at a concentration of 0.1mg/ml, indicating its efficacy in combating oxidative DNA damage. This suggests that SB might play a role in repairing host cell DNA under diseased conditions[56]. In another study, it was suggested that high aspect ratio gold nanorods hold promise as potent antioxidants and antibacterial agents[57]. An experimental study on albino mice showed no toxicity as evaluated by liver and kidney function tests. SB-treated mice presented significantly augmented superoxide dismutase and catalase activity[46].

3.1.2.6 Enhances Physical Growth and Development

SP is well appreciated in *Ayurveda* for promoting growth and development in children[10]. Recent clinical research studies also support the classical text showing that SP is helpful in improvising physical growth, including height and weight gain of children. It promotes healthy body development and improves stamina, enabling children to engage in physical activities[28]. SP can stimulate the growth and development of various organ systems of the body. In a research study, a notable stimulating effect of gold chloride was observed on the reproductive activity of immature female rats[58-60].

In a randomised parallel-group, comparative, pilot study on the efficacy of SP in Preterm infants, administered monthly for a year, it was found that in the SP group, the recurrence of diseases was merely 10% whereas 25% in the control group. The weight and height gain achieved in the SP group was in the 25-50 percentile range, while it was in the 3-25 percentile range in the control group. The severity of signs and symptoms in the control group was higher as compared to the SP group. The gradation of total relief in the SP group was excellent (60%), in contrast to just 20% of the control group[61]. In randomised controlled clinical trials, significant improvement was observed in the anthropometry of children belonging to the SP group[44,62].

3.1.2.7 Delayed Speech

Children with CP often encounter a range of challenges, including speech impairment and delayed speech[5]. Children suffering from speech delays and language disorders require long-term intervention. *Ayurveda* presents a viable option for managing these conditions, particularly through the help of SP. A controlled clinical trial demonstrated that the children with delayed speech and language disorder exhibited significant improvement when receiving a combination of speech-language therapy and SP intervention compared to those who received speech and language therapy alone. Therefore, SP can be used effectively as a therapeutic tool for children experiencing delays in speech and language development[63]. Another Clinical study showed that SP therapy results in significant improvement in delayed speech in children up to 7 years[63,64].

Table 3. Effect of SP on various problem domains of CP Children as evidenced by human, animal and *in vitro* studies

S. No.	Type of study/ animal model	Experimental design and treatments	Results	Trial length/dose	References
Human Studies					
1	Randomised, controlled trial.	Randomised, controlled trial. 90 full-term appropriate for gestational age newborns	Showed potential role in defying perinatal oxidative stress in healthy neonates by enhancing the SOD activity and reducing the incidence of physiological jaundice clinically without causing significant reno-hepatic enzyme alteration.	Three dosages of SP (15mg/dose) on the first day of life	24
2	Randomised, controlled trial.	Randomised, controlled trial 120 children, dose 1 mg/kg body weight	SP group showed an increase in weight more than normal growing children. SP also showed a slight increase in height	14 times on the 27th day of the month	28
3	Randomised, controlled trial.	Randomised, controlled trial (20 in each group)	Children in the SB group demonstrated a significant decrease in their scores related to eating habits, behaviour, mood, and temperament. Additionally, there was a significant rise in IQ levels.	16 mg gold monthly for 6 months with butter milk and honey	37
4	Randomised, controlled trial	Evaluation of the effectiveness of SP on growth parameters in preterm infants.	Evaluation of the effectiveness of SP on growth parameters in preterm infants. The weight and height gain achieved in the trial group were in the 25-50th percentile range, while it was in the 3-25 percentile range in the control group.	4 drops of SP given monthly for 6 months.	61
5	Randomised, controlled trial	Evaluation of the efficacy of SP on growth parameters in children.	SP showed a significant increase in the weight of children of both sexes as compared to the control group and the standard group.	120 children of 0-12 years. Once a month for 1 year.	62
6	Randomised, controlled trial	Evaluation of the efficacy of SP on growth and development in toddlers.	SP group showed significant change in anthropometrical parameters, development quotient, and deviation quotient in comparison to the control group.	Four drops of SP for 9 consecutive months.	64
7	Pilot study	Pilot study on 21 subjects to assess the efficacy of colloidal gold on brain functions.	Metallic gold, given at a dosage of 30 mg per day for 1 month, resulted in a significant increase in I.Q. level.	Daily dosage of 15 mg of colloidal metallic gold for one month.	31
8	Comparative clinical study	Research on the combination of *Madhu-ghrita,* and *Suvarna-vacha* in infants.	Increase in total protein and serum IgG levels.	2 mg dose	44
9	Comparative clinical study	Evaluation of the role of SP on recurrent illness in children: A comparative clinical study- 40 children.	Significant improvement in the morbidity status of children in group A as compared to children in group B.	1mg of *SB*, up to 5 years. For >5 years, 2 mg of *SB* along with purified butter and honey.	48
10	Comparative clinical study	Evaluation of SP and speech-language therapy in the paediatric population with delayed speech and language disorder.	Children experiencing delayed speech and language disorders exhibited significant progress when receiving speech-language therapy combined with SP intervention, in contrast to those who only received speech-language therapy.	50 participants with early diagnosed delayed speech and language	63

Table 3. Continued...

S. No.	Type of study/ animal model	Experimental design and treatments	Results	Trial length/dose	References
Animal Studies					
11	Study on Albino rats	Effect of SB on cerebral ischemia utilising models of ischemia in albino rats. (25 mg/kg, orally)	Substantial restoration of modified values to nearly normal levels of enzymatic assay as lipid peroxidase, catalase, *etc*.	10 days	[32]
12	Study on Albino rats	Rats were pretreated with gold in the form of SB and *Kushta Tila Kalan* before being subjected to restraint stress.	Significant restoration of altered values of stress-induced increases in brain catecholamine, 5-HT, and cortisol to almost normal levels indicates the potential benefits of gold preparations in addressing stress.	25 mg per kg, oral for ten days	[23]
13	Study on Swiss albino mice	SP was administered to mice. Elevated plus-maze and Morris water maze models were utilised. The activity of acetylcholinesterase is measured to evaluate brain activity. Piracetam was utilised as a reference nootropic compound.	The pretreatment with SP showed a significant enhancement in learning and memory and a significant reduction in AChE activity. This leads to the conclusion that SP possesses nootropic properties. It may be utilised to improve a child's memory.	30 mg per kg, for fifteen days	[33]
14	Study on male albino rats	Evaluation of the neuroprotective effects of SB on sleep-deprived rats. The rats, apart from those in the normal group, underwent daily sleep restrictions of eight to nine hours to induce cognitive impairment.	Treatment with SB enhanced performance by improving spatial memory, increasing correct arm entries, reducing errors, minimising completion time, and shortening transfer latency. Additionally, biochemical markers of the SB-treated animals indicated a stronger antioxidative effect.	25 ms/kg/ day for 20 days	[34]
15	Study on Swiss albino mice	Evaluation of untoward effects and the free radical scavenging potential of SB.	The administration of SB demonstrated no signs of toxicity based on SGPT, SGOT, serum creatinine, and urea levels. Animals treated with SB exhibited improvement in superoxide dismutase and catalase levels.	1 ml per 20 gm body weight.	[46]
16	Study on albino rats	Assessment of conventional gold formulations for anti-cataleptic, anti-anxiety, and antidepressant activity.	Conventional gold formulations utilised in *Ayurveda* have demonstrated anxiolytic, antidepressant, and anti-cataleptic properties while providing a significant safety margin.	2 g/kg, p.o	[15]
17	Study on Zebra fish	Changes in behaviour, proteomic, and dopamine levels were assessed after induction of rotenone in the SB pre-treated zebrafish.	The neuroprotective effect of SB against a rotenone-induced model in zebrafish was validated by the prevention of changes in dopamine levels in the brains of fish treated with SB.	60 mg/kg body weight	[36]
18	Study on male mice	Animals were evaluated for non-specific immunity when administered with gold in the form of SB and *Kushta Tila Kalan*.	Both gold formulations remarkably enhanced the number of peritoneal macrophages and improved their phagocytic index.	2 g/kg, p.o orally for 10 days	[43]

Table 3. Continued...

S. No.	Type of study/ animal model	Experimental design and treatments	Results	Trial length/dose	References
19	Study on male mice	Evaluation of Ayurvedic gold preparation SB and Unani preparation *Kushta Tila Kalan* on cell-mediated immunity.	The best results were observed at 25 mg/kg. The high dosage of 50 mg/kg demonstrated inhibitory effects on immune responses.	06.25, 12.50 and 25 mg per kg	[15]
20	Study in Charle's Foster Albino Rats	To assess the Immunomodulatory Effect of SP in experimental animals.	The platelet number was significantly higher in the SP-treated group in comparison to the control. Histopathological examinations revealed that SP enhanced the cellularity in both the spleen and lymph nodes. This study indicates that SP induces humoral immunity.	Administered for 10 days.	[49]
21	Study on Albino Rats	Antioxidant activity of calcined gold preparations models of ischemia in albino rats.	Significant improvement of altered levels of enzymes by Ayurvedic SP (25 mg per kg, oral administration for ten days), indicating anti-oxidative potential of SP in modulation of ischemic brain damage	Enzymatic parameters employed for assessment.	[23]
***In vitro* Studies**					
22	Study for antimicrobial activity	Evaluation of Antimicrobial activity of SP on gut pathobiont and symbiont.	SP exhibited both bactericidal and bacteriostatic effects on gut pathobionts, with remarkable inhibitory zones for *Plasmodium aeruginosa* and *Salmonella Typhi*. It had no impact on the chosen beneficial gut bacteria.	Antibacterial Susceptibility Testing (AST) was performed.	[50]
23	Study the antioxidative and antibacterial potential	Assessment of antioxidative and antibacterial potential of gold (Au) nanoparticles.	A study shows Au nanoparticles with a high aspect ratio can serve as potent antioxidative and antibacterial agents.	Investigated using 1,1-diphenyl-2-picrylhydrazyl (DPPH) and Agarwell diffusion assay.	[57]

4. Discussion

SP refers to the administration of incinerated gold along with honey and purified butter in the form of an electuary. The role of SP in children is mentioned by Acharya Kashyapa a thousand years ago. Analysing the mentioned classical and modern research, a conclusion can be drawn that SP can be a promising formulation for children with CP. It acts in multiple dimensions. Figure 1 clearly defines the mode of action of SP in CP Children. It helps in improving *Agni* (appetite, digestion, and metabolism), thereby imparting better growth, development, physical strength, immunity, intellect, and memory to these children. Infancy is the right period from which it can be started and can be administered up to 16 years in children, with multiple benefits. SP has significant potential to provide *Bala* (immunomodulator, adaptogen). It thereby promotes growth and development, improves immunity and reduces oxidative stress. SP has great potential to provide *Medha* (nootropic benefits) for children with CP, thereby enhancing mental health, intellect and memory, resulting in overall health and vitality in these children.

The precise mention of SP for children is due to some specific action of gold in the pediatric age group. In research, traces of gold were detected in the placenta and the liver of a newborn baby at the time of birth[65]. It was also detected in the hair of newborns[66]. It can be said that the benefits of SP can be attained from infancy to adolescence, with a wide range of actions influencing the growth and development of a child. The advantages of SP can be experienced from early childhood to teenage years through various activities that impact a child's growth and development. The first year of life is viewed as the most critical period for brain

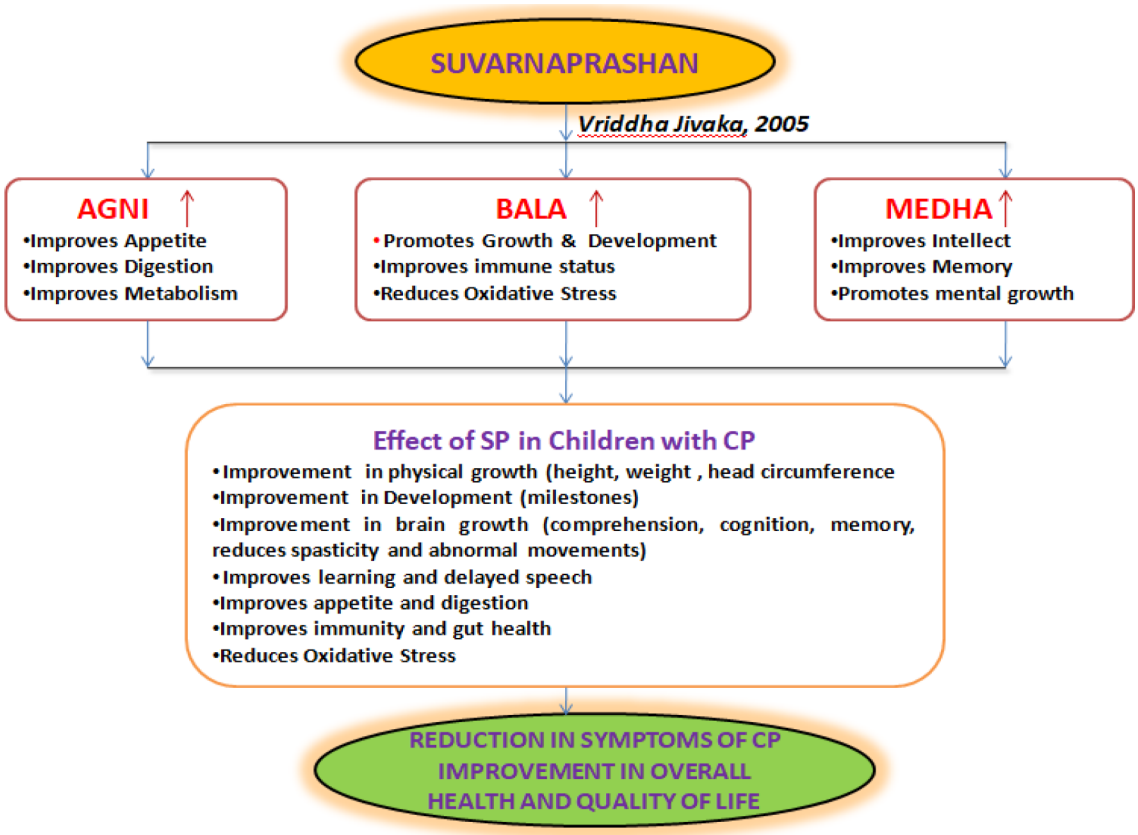


Figure 1. The mode of action of SP in CP children.

development and vulnerability to infections in infants because of their underdeveloped immune systems. So, as an immunomodulator, SP can be given to children with CP at an early age.

Acharya kashyapa has mentioned that pure gold should be triturated with water, honey, and purified butter[10]. The theory behind this might be that at that time, gold was available in its purest form. It could be given directly by rubbing it on a rock. Microparticles of gold could be attained. Later, with the progression of pharmacology in *Ayurveda Rasasastra* (metallurgy), SB (incinerated gold) became the preferred form for internal administration because of its purity and better bioavailability. SB is said to possess gold nanoparticles, which are globular in shape with an average size of 56-57 nm [67]. In another study, it was found that SB contains gold nanoparticles with a crystallite size of 28-35 nm. It was detected as 90% pure gold and was not found to cause any blood cell aggregation or protein adsorption. It was found to be non-cytotoxic and has the ability to open intercellular tight junctions[68]. In another study on chronic toxicity of SP, no cytotoxicity was detected[69]. Chronic toxicity was also assessed by liver function tests, kidney function tests, and histopathological studies, which suggest it is completely safe. In an experimental study, SB-treated mice showed remarkably increased levels of superoxide dismutase and catalase shows its anti-oxidative potential[23,46,70].

Based on the mentioned references, it can be concluded that the effects of this noble metal can be attained on various levels in children with CP, serving as a general health enhancer or specifically contributing to improvements in intelligence, metabolism, immunity, physical strength, complexion, and more[71].

5. Conclusion

Recent research highlights the growing recognition of the health benefits of SP for children with CP. There is a wealth of insightful knowledge regarding SP, encompassing its properties and mechanisms of action. In a nutshell, SP is a promising Ayurvedic electuary that exhibits a range of pharmacological activities and demonstrates multiple mechanisms of action,

influencing cellular, biochemical and physiological regulation. The study indicates that SP can be a cost-effective, harmless, and effective formulation for the management of CP. Nevertheless, further comprehensive and definitive clinical studies are required to evaluate the potential of SP in preventing complications and managing CP in children.

The antioxidant effects of SP in children with CP present promising avenues for therapeutic intervention. Through its antioxidant properties, SP demonstrates the potential in mitigating oxidative stress, which is a significant contributor to the pathogenesis of CP. While further research is warranted to elucidate the mechanisms underlying its efficacy and to establish standardised protocols for administration, the findings suggest that SP can be a valuable adjunctive therapy in the management of CP. Additionally, its natural composition and historical use in *Ayurveda* make it an appealing option for those seeking complementary and alternative treatments. Nonetheless, interdisciplinary collaboration and rigorous clinical trials are essential to validate its efficacy and safety for widespread clinical application.

The findings of this study present a hopeful perspective on the benefits of *Ayurveda* in improving the quality of life for children affected by CP. It is anticipated that these findings will encourage further research in this field, paving the way for enhanced interventions for children who endure significant challenges due to circumstances beyond their control. Additional clinical trials are necessary to assess and validate the efficacy of specific Ayurvedic treatments on a larger population. Furthermore, investigating the effects of initiating treatment at an early stage, immediately following cerebral injury and diagnosis, may yield more favourable outcomes. The extensive knowledge within *Ayurveda* holds promise for providing diverse and effective treatment modalities for managing CP. The benefits of SP in children, as mentioned in Ayurvedic texts, are to be assessed and re-established with the help of experimental and clinical studies.

6. Future Prospectives

The prospects for SP and related Ayurvedic formulations are promising for children with CP, especially in light of scientific studies demonstrating their antioxidant, immunomodulatory, anti-infective, nootropic, appetite-stimulating, and metabolism-modulator properties and other potential health benefits. Further research and clinical studies could explore their mechanisms of action, optimise dosages, and investigate their efficacy in various types of CP. Additionally, augmenting SP with other herbs could open new avenues for their application for specified target problems in CP. Collaboration between traditional medicine and modern science holds the potential for developing safer and more effective therapies for promoting health and managing associated problems in children with CP.

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8. Author contribution

KP: Conceptualisation, resources, supervision, original draft, review. GS: Conceptualisation, formal analysis, writing - review and editing. NP: Methodology, writing - review and editing. All authors have read and agreed to the published version of the manuscript.

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