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Standardization of Pottali Kalpana with Special Reference to Hemagarbha Pottali

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Abstract: *Rasashastra represents a specialized branch of Ayurveda that encompasses the pharmaceutical processing of metals, minerals, and herbal drugs into highly potent therapeutic formulations through specific purification and processing techniques. Among the various dosage forms described in classical Rasashastra, Pottali Kalpana is regarded as one of the most advanced pharmaceutical innovations because of its compact structure, minimal therapeutic dose, rapid onset of action, enhanced stability, prolonged shelf life, and ease of transportation and administration. Classical Rasashastra treatises describe several methods for the preparation of Pottali formulations, among which Hemagarbha Pottali, a mercurial preparation containing Shuddha Parada, Shuddha Gandhaka, Swarna, Tamra, and suitable Bhavana media, is considered a potent Rasayana formulation indicated in chronic debilitating disorders and emergency clinical conditions. Despite its extensive therapeutic applications, considerable variations exist in classical literature regarding ingredient proportions, pharmaceutical procedures, heating schedules, and processing techniques, making standardization essential for ensuring consistent quality, safety, efficacy, and reproducibility. The present review critically evaluates the concept, historical evolution, pharmaceutical principles, and classical references of Pottali Kalpana with special emphasis on Hemagarbha Pottali. It further discusses the standardization of raw materials, pharmaceutical processing, Kajjali Siddhi, Pottali Siddhi Lakshanas, and quality control measures by integrating classical Ayurvedic principles with contemporary analytical approaches, including physicochemical evaluation, Namburi Phased Spot Test (NPST), X-ray diffraction (XRD), scanning electron microscopy with energy dispersive X-ray analysis (SEM-EDX), Fourier transform infrared spectroscopy (FTIR), particle size analysis, and inductively coupled plasma-based elemental analysis. The integration of traditional pharmaceutical concepts with validated analytical methodologies provides a scientific framework for establishing standardized manufacturing protocols, ensuring batch-to-batch consistency, improving global acceptance, and enhancing the therapeutic reliability of Hemagarbha Pottali in contemporary Ayurvedic practice.*

Keywords: *Rasashastra*.

I. INTRODUCTION

Rasashastra is a specialized branch of Ayurveda that deals with the pharmaceutical processing of *Parada* (mercury), *Dhatu* (metals), *Uparasa* (minerals), *Ratna* (gemstones), and selected herbal substances to prepare potent therapeutic formulations. Through specialized pharmaceutical procedures such as *Shodhana* (purification), *Marana* (incineration), *Bhavana* (levigation), *Jarana* (roasting), and other *Samskaras*, raw materials are transformed into therapeutically effective dosage forms with enhanced stability, reduced toxicity, improved bioavailability, and prolonged shelf life. These pharmaceutical principles constitute the scientific foundation of Rasashastra and distinguish it from conventional Ayurvedic herbal pharmaceutics.[1–4]

Among the numerous dosage forms described in Rasashastra, including *Khalviya Rasayana*, *Parpati Kalpana*, *Kupipakwa Rasayana*, and *Pottali Kalpana*, the latter occupies a distinctive position because of its compact dosage form, high therapeutic potency, rapid clinical action, convenient administration, and ease of transportation. The term

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Pottali literally means a compact bundle or packet, wherein medicinal ingredients are processed into a hard, compact pharmaceutical unit through carefully regulated pharmaceutical procedures. This unique dosage form was developed to provide maximum therapeutic efficacy in a minimal dose while ensuring stability, portability, and prolonged preservation.[5–8]

The evolution of Pottali Kalpana demonstrates the remarkable pharmaceutical ingenuity of classical Rasashastra scholars. In ancient times, physicians frequently travelled while carrying medicines, making bulky powders and semisolid preparations inconvenient because of moisture absorption, contamination, and dosage inconsistency. To overcome these limitations, compact pharmaceutical preparations possessing greater stability and fixed dosage were developed. Classical Rasashastra texts describe different methods of Pottali preparation, including *Bhavana Pottali*, *Putapaka Pottali*, *Kaparda Purana Pottali*, and *Gandhaka Drava Pottali*, each employing specific pharmaceutical techniques to attain optimum therapeutic potency.[5,6,9,10]

Among the various Pottali formulations, Hemagarbha Pottali is considered one of the most important Swarna-containing mercurial preparations. It generally comprises *Shuddha Parada*, *Shuddha Gandhaka*, *Swarna*, *Tamra Bhasma*, and suitable *Bhavana Dravyas* such as *Kumari Swarasa*. Classical texts including *Rasendra Sara Sangraha*, *Rasaprakasha Sudhakara*, *Rasaratna Samuccaya*, *Rasayoga Sagara*, *Bhaishajya Ratnavali*, and *Yogaratnakara* describe different formulations and methods of preparation, indicating its extensive therapeutic application in disorders such as *Rajayakshma*, *Kasa*, *Shwasa*, *Pandu*, *Grahani*, *Jwara*, and chronic *Vata-Kapha* diseases.[5–11]

Despite its long-standing therapeutic importance, considerable variations exist among classical texts regarding ingredient proportions, pharmaceutical processing, heating schedules, duration of *Gandhaka Drava Paka*, and quality assessment methods. Such variations may influence the physicochemical characteristics, safety, therapeutic efficacy, and reproducibility of the finished product. Consequently, pharmaceutical standardization has become essential for establishing reproducible manufacturing protocols while preserving the classical principles of Rasashastra.[12,13]

Recent advances in pharmaceutico-analytical research have substantially strengthened the scientific evaluation of Ayurvedic metallic formulations. Modern analytical techniques such as X-ray diffraction (XRD), scanning electron microscopy coupled with energy-dispersive X-ray spectroscopy (SEM-EDX), Fourier transform infrared spectroscopy (FTIR), inductively coupled plasma-atomic emission spectroscopy (ICP-AES), particle size analysis, and Namburi Phased Spot Test (NPST) provide valuable information regarding elemental composition, crystalline structure, surface morphology, particle size, and chemical characteristics of Pottali formulations. Integration of these analytical techniques with classical quality assessment parameters such as *Kajjali Siddhi* and *Pottali Siddhi Lakshanas* offers a comprehensive framework for ensuring quality, safety, batch-to-batch consistency, and therapeutic reliability of Hemagarbha Pottali.[12–16] Therefore, the present review critically evaluates the classical concept, pharmaceutical processing, and standardization of Pottali Kalpana with special reference to Hemagarbha Pottali by integrating traditional Ayurvedic principles with contemporary analytical approaches.

II. HEMAGARBHA POTTALI IN CLASSICAL LITERATURE

Hemagarbha Pottali is one of the most distinguished mercurial formulations described in classical Rasashastra literature. It is categorized under *Pottali Kalpana*, a specialized pharmaceutical dosage form developed to achieve maximum therapeutic efficacy in a minimal dose. The incorporation of *Swarna* (gold) along with *Shuddha Parada* and *Shuddha Gandhaka* distinguishes Hemagarbha Pottali from other Pottali formulations and imparts potent *Rasayana*, *Balya*, and *Yogavahi* properties. Classical Ayurvedic scholars recognized the formulation as a highly effective medicine for chronic, difficult-to-treat disorders and conditions requiring rapid therapeutic action.[31–34]

The evolution of Hemagarbha Pottali can be traced through various classical Rasashastra treatises, where differences in composition and pharmaceutical processing reflect the gradual advancement of Ayurvedic pharmaceutics. Among these texts, *Rasendra Sara Sangraha* provides one of the earliest detailed descriptions of Pottali preparations and emphasizes the importance of meticulous pharmaceutical processing to obtain a compact, therapeutically potent formulation.[32] Subsequently, *Rasaprakasha Sudhakara* elaborated the preparation method by describing the sequential processing of

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Kajjali, incorporation of metallic ingredients, repeated *Bhavana*, and heating in molten sulphur (*Gandhaka Drava Paka*), highlighting the significance of each pharmaceutical step in enhancing the medicinal properties of the formulation.[33]

Rasaratna Samuccaya further strengthened the pharmaceutical concept of Pottali Kalpana by describing the principles governing the preparation of compact mercurial formulations. The text emphasizes that proper purification (*Shodhana*) of *Parada*, *Gandhaka*, *Swarna*, and other ingredients is indispensable before pharmaceutical processing. It also stresses that the success of the formulation depends upon the attainment of *Kajjali Siddhi* and appropriate completion of the heating process, ensuring a stable and therapeutically effective product.[31] These descriptions demonstrate the advanced understanding of pharmaceutical standardization that existed in classical Ayurveda.

Other authoritative texts such as *Rasayoga Sagara*, *Bhaishajya Ratnavali*, *Yogaratnakara*, *Ayurveda Prakasha*, and *Rasakamadhenu* also mention Hemagarbha Pottali or related mercurial Pottali preparations with minor variations in ingredient proportions, *Bhavana Dravyas*, duration of trituration, and heating schedules.[34–38] Although these variations exist, the fundamental pharmaceutical principles remain consistent, namely the use of purified ingredients, preparation of homogeneous *Kajjali*, repeated levigation, compact Pottali formation, and controlled thermal processing. These similarities indicate that classical physicians considered pharmaceutical processing rather than minor compositional variations as the principal determinant of therapeutic efficacy.

The therapeutic importance of Hemagarbha Pottali is repeatedly emphasized throughout the Rasashastra literature. Classical authors recommend the formulation in diseases such as *Rajayakshma*, *Kasa*, *Shwasa*, *Grahani*, *Pandu*, *Jwara*, *Prameha*, chronic *Vata-Kapha* disorders, and conditions associated with severe debility. Owing to the presence of *Swarna* and the *Yogavahi* nature of *Parada*, the formulation is traditionally regarded as a potent *Rasayana* capable of promoting strength, vitality, immunity, and tissue nourishment while facilitating rapid therapeutic response even in minute doses.[32–36]

From a contemporary perspective, the classical descriptions of Hemagarbha Pottali demonstrate remarkable pharmaceutical foresight. The repeated emphasis on purification, controlled processing, compact dosage form, and assessment of pharmaceutical characteristics corresponds closely with modern concepts of quality assurance and process standardization. Recent pharmaceutico-analytical investigations have further validated these classical principles by demonstrating that standardized processing significantly influences the physicochemical characteristics, elemental distribution, particle size, and structural stability of Pottali formulations.[39,40] Thus, the collective evidence from classical literature provides a strong conceptual and pharmaceutical foundation for the scientific standardization of Hemagarbha Pottali in contemporary Ayurvedic pharmaceutics.

III. PHARMACEUTICAL PROCESSING OF HEMAGARBHA POTTALI (STANDARD OPERATING PROCEDURE)

The pharmaceutical preparation of Hemagarbha Pottali is a meticulously designed process in Rasashastra that involves successive stages of purification, trituration, levigation, compact Pottali formation, and controlled heat treatment. The objective of this process is to obtain a stable, potent, and therapeutically effective mercurial formulation while ensuring the safety and bioavailability of its constituent minerals and metals. Classical texts emphasize that each pharmaceutical step contributes significantly to the quality, efficacy, and stability of the final product.[41–44]

The principal raw materials required for the preparation of Hemagarbha Pottali include *Shuddha Parada* (purified mercury), *Shuddha Gandhaka* (purified sulphur), *Shuddha Swarna* (purified gold), *Shuddha Tamra* (purified copper), and *Kumari Swarasa* (*Aloe vera* juice) used as the levigating medium (*Bhavana Dravya*). The quality and purity of these ingredients are considered essential prerequisites for successful pharmaceutical processing.[41–44]

The first stage involves *Shodhana* (purification) of all mineral and metallic ingredients according to the classical procedures described in Rasashastra texts. Purification removes physical and chemical impurities, minimizes undesirable properties, and enhances the therapeutic suitability of the raw materials. After purification, *Parada* and *Gandhaka* are triturated thoroughly to prepare a fine, smooth, lustreless black powder known as *Kajjali*. The attainment

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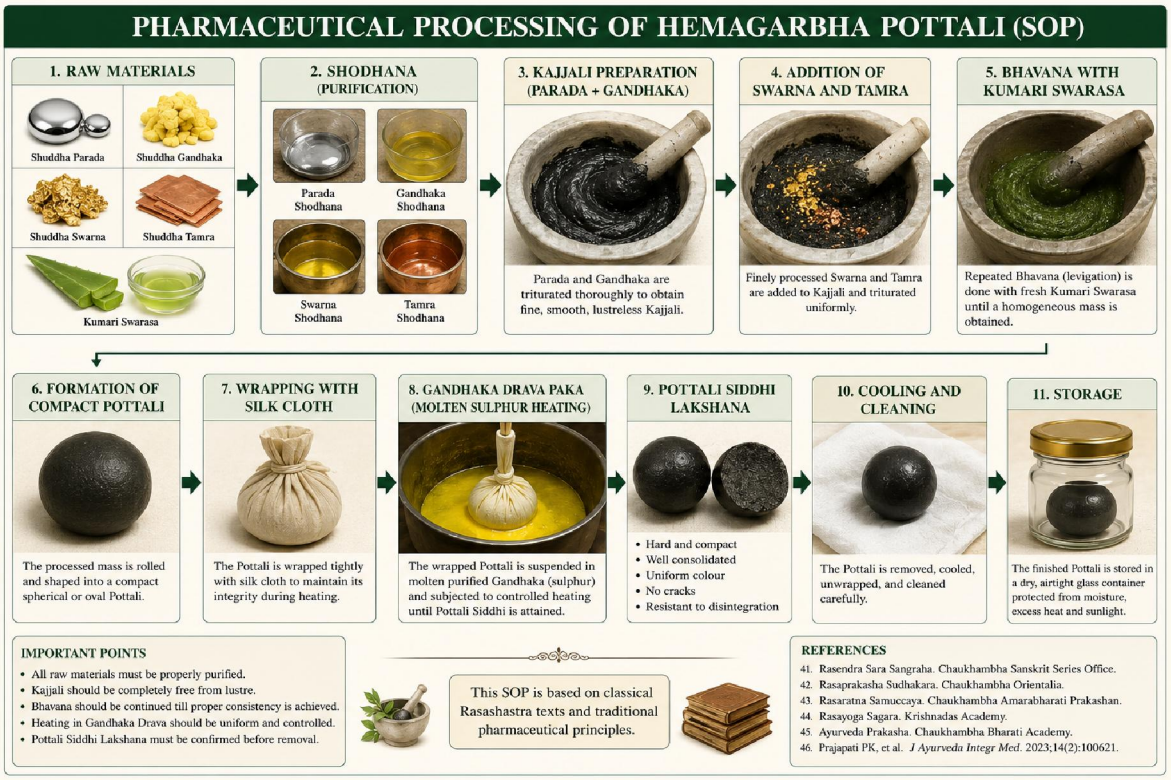
of proper *Kajjali Siddhi Lakshana*, including complete absence of metallic lustre (*Nischandratva*), smooth texture (*Slakshnatva*), fineness (*Rekhapurnatva*), and homogeneity, indicates successful preparation.[42–45]

Finely processed *Swarna* and *Tamra* are subsequently incorporated into the prepared Kajjali and triturated uniformly. The mixture is then subjected to repeated *Bhavana* with fresh *Kumari Swarasa*, which facilitates uniform mixing, improves cohesiveness, and enhances the pharmaceutical characteristics of the formulation. Continuous trituration is carried out until a soft, homogeneous mass suitable for shaping is obtained.[42–44]

The processed mass is moulded into a compact spherical or oval-shaped Pottali and wrapped securely using silk cloth to maintain its structural integrity during heating. The wrapped Pottali is suspended in molten purified sulphur and subjected to controlled heating, a procedure known as *Gandhaka Drava Paka*. During this stage, uniform temperature is maintained throughout the process to facilitate proper maturation of the formulation without causing thermal degradation. This specialized heating technique plays a crucial role in achieving desirable physicochemical transformation and ensuring therapeutic potency.[42–46]

Completion of the pharmaceutical process is confirmed by the appearance of classical *Pottali Siddhi Lakshana*, which include a hard, compact, well-consolidated structure, uniform consistency, characteristic colour, absence of cracks, and resistance to disintegration. After cooling to room temperature, the silk covering is removed, and the finished Pottali is cleaned carefully before storage. The final product should be preserved in a dry, airtight glass container protected from moisture, excessive heat, and direct sunlight to maintain its physicochemical stability and therapeutic efficacy throughout its shelf life.[41–46]



IV. STANDARDIZATION OF HEMAGARBHA POTTALI

Standardization of Hemagarbha Pottali is essential to ensure its safety, efficacy, reproducibility, and quality. Since the formulation comprises processed metals and minerals, every stage of manufacturing, from selection of raw materials to

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finished product evaluation, requires systematic quality control. Classical Rasashastra provides detailed pharmaceutical guidelines for preparing Pottali formulations, while modern analytical techniques enable objective evaluation of their physicochemical characteristics. Integration of classical principles with contemporary analytical methods establishes scientific validation and promotes global acceptance of Ayurvedic herbo-mineral formulations.[47–50]

4.1 Raw Material Standardization

Standardization begins with the authentication and quality assessment of all raw materials used in Hemagarbha Pottali preparation, namely *Parada* (Mercury), *Gandhaka* (Sulphur), *Swarna* (Gold), *Tamra* (Copper), and *Kumari Swarasa* (*Aloe vera* juice). Botanical authentication of Kumari and elemental authentication of metallic ingredients should be performed before pharmaceutical processing.[47–49]

Purity of raw materials is ensured through classical *Shodhana* procedures described in Rasashastra. Purification removes physical and chemical impurities, detoxifies the ingredients, and improves their pharmaceutical suitability. Classical quality assessment includes examination of colour, texture, lustre, homogeneity, and characteristic physical properties before and after purification. Standard pharmaceutical-grade reagents and contamination-free raw materials should be used throughout the manufacturing process to ensure consistency and safety.[47–50]

4.2 In-process Standardization

In-process quality control is one of the most critical aspects of Hemagarbha Pottali preparation because pharmaceutical transformations occur throughout successive processing stages. The first quality checkpoint is the preparation of *Kajjali*, which should exhibit classical *Kajjali Siddhi Lakshana* such as *Nischandratva* (absence of metallic lustre), *Rekhapurnatva* (entry into the furrows of fingers), *Slakshnatva* (smoothness), *Sukshmatva* (fineness), and complete homogeneity. These characteristics indicate adequate trituration and intimate mixing of *Parada* and *Gandhaka*.[48–50]

Uniform incorporation of *Swarna* and *Tamra*, followed by repeated *Bhavana* with *Kumari Swarasa*, should produce a cohesive and homogeneous pharmaceutical mass suitable for Pottali formation. During *Gandhaka Drava Paka*, careful control of heating temperature, heating duration, and maintenance of a stable molten sulphur bath are essential to avoid under-processing or overheating. Excessive heating may alter the physicochemical characteristics of the formulation, whereas insufficient heating may result in incomplete pharmaceutical transformation. Completion of the heating process is confirmed by the appearance of *Pottali Siddhi Lakshana*, including a hard, compact structure, uniform colour, absence of cracks, and satisfactory consolidation of the dosage form.[47–50]

4.3 Finished Product Evaluation

Evaluation of the finished Hemagarbha Pottali involves both classical and modern quality assessment methods. Organoleptic evaluation includes observation of colour, odour, surface texture, hardness, compactness, and overall appearance. A properly prepared Pottali should be uniformly compact, smooth, crack-free, and resistant to mechanical disintegration.[48,49]

Classical pharmaceutical tests include assessment of structural integrity, compactness, and confirmation of complete maturation of the formulation. Modern physicochemical evaluation includes determination of moisture content, loss on drying, ash value, acid-insoluble ash, water-soluble extractive, alcohol-soluble extractive, pH, bulk density, true density, hardness, and elemental composition where applicable. These parameters establish product identity, purity, stability, and batch reproducibility.[49–52]

4.4 Advanced Analytical Characterization

Recent advances in analytical instrumentation have significantly strengthened the scientific validation of Ayurvedic metallic formulations. X-ray Diffraction (XRD) is employed to determine crystalline phases and identify mineral transformations occurring during pharmaceutical processing. Scanning Electron Microscopy (SEM) provides information regarding particle morphology, surface characteristics, and microstructural organization of the finished

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formulation. SEM coupled with Energy Dispersive X-ray spectroscopy (SEM–EDX) facilitates elemental mapping and confirms the uniform distribution of mercury, sulphur, gold, copper, and other constituent elements.[51–54]

Fourier Transform Infrared Spectroscopy (FTIR) identifies functional groups and possible interactions between organic constituents from *Bhavana Dravya* and inorganic mineral components. Inductively Coupled Plasma–Atomic Emission Spectroscopy (ICP-AES) accurately quantifies elemental composition and detects trace impurities or heavy metal contaminants. Particle Size Analysis determines the distribution of micro- and nanoparticles generated during repeated trituration and heating, which may influence dissolution, bioavailability, and therapeutic performance. Nanoparticle Size Tracking (NPST), wherever available, provides additional information regarding nanoparticle distribution and stability in suspension. X-ray Fluorescence (XRF) serves as a rapid, non-destructive analytical technique for elemental characterization and quality verification of finished Pottali preparations. Collectively, these analytical techniques provide comprehensive evidence regarding the identity, purity, structural integrity, elemental composition, and pharmaceutical consistency of Hemagarbha Pottali.[51–56]

4.5 Quality Assurance

Quality assurance encompasses the entire manufacturing process and ensures that every batch of Hemagarbha Pottali consistently meets predefined quality specifications. Preparation should be carried out according to validated Standard Operating Procedures (SOPs) describing each manufacturing step, processing parameter, quality checkpoint, and acceptance criterion. Compliance with Good Manufacturing Practices (GMP) minimizes process variability, prevents contamination, and ensures traceability throughout production.[47,50]

Comprehensive documentation should include procurement records of raw materials, purification procedures, manufacturing logs, in-process observations, analytical reports, equipment calibration records, packaging details, and batch release documentation. Batch-to-batch consistency should be verified through routine physicochemical and analytical evaluation. Stability studies conducted under appropriate environmental conditions are essential to determine shelf life and preserve pharmaceutical quality. Finally, the finished Hemagarbha Pottali should be packed in clean, moisture-resistant, airtight containers and stored in a cool, dry place away from direct sunlight and excessive humidity to maintain its physicochemical stability and therapeutic efficacy during storage.[51–56]

V. DISCUSSION

Hemagarbha Pottali represents one of the most sophisticated dosage forms developed in Rasashastra, reflecting the advanced pharmaceutical knowledge of classical Ayurvedic scholars. Unlike conventional mercurial preparations, the Pottali dosage form employs a systematic sequence of purification (*Shodhana*), *Kajjali* preparation, repeated *Bhavana*, compact Pottali formation, and *Gandhaka Drava Paka*, all of which are intended to enhance the safety, stability, and therapeutic efficacy of the formulation. Classical texts consistently emphasize meticulous pharmaceutical processing, indicating that therapeutic success depends not only on the ingredients but also on adherence to standardized manufacturing procedures.[41–50]

Modern analytical techniques have provided scientific support for these traditional pharmaceutical principles. Instrumental methods such as XRD, SEM, SEM–EDX, FTIR, ICP-AES, particle size analysis, and XRF facilitate comprehensive evaluation of the physicochemical characteristics, elemental composition, structural integrity, and batch consistency of Hemagarbha Pottali. Integration of these techniques with classical quality assessment bridges traditional Ayurvedic pharmaceutics and contemporary quality assurance systems. Furthermore, implementation of validated Standard Operating Procedures (SOPs), Good Manufacturing Practices (GMP), proper documentation, and stability studies ensures reproducible manufacturing and enhances regulatory acceptance. Therefore, the combined application of classical Rasashastra principles and modern analytical methodologies provides a robust framework for the standardization, quality assurance, and wider scientific acceptance of Hemagarbha Pottali as a safe and effective Ayurvedic herbo-mineral formulation.[47–56]

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VI. CONCLUSION

Hemagarbha Pottali is a unique and highly specialized mercurial formulation of Rasashastra that exemplifies the sophistication of classical Ayurvedic pharmaceutics. Its preparation involves carefully standardized pharmaceutical procedures, including *Shodhana*, *Kajjali* preparation, *Bhavana*, Pottali formation, and *Gandhaka Drava Paka*, which collectively determine its quality and therapeutic efficacy. Standardization through the integration of classical quality assessment with modern analytical techniques ensures product identity, purity, safety, and batch-to-batch consistency. Adoption of validated SOPs, GMP guidelines, and advanced characterization methods provides a scientific basis for quality assurance and supports the wider acceptance and global application of Hemagarbha Pottali in contemporary Ayurvedic practice.

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