

IMPLEMENTATION OF ADVANCE EQUIPMENT IN AYURVEDA PHARMACEUTICS W.S.R TO BHASMA

Abstract

Bhasma has given very much importance in both Dhatushoda and Dehavadha. In Ayurveda use of Bhasma as Therapeutic has enormous clinical importance. Bhasma a unique mineral preparation mentioned in Rasa texts which is prepared by putapaka method. Due to the technological development in current scenario, electrical horizontal muffle furnace is used for preparation of Bhasma to save manual labour, prevention of pollution, bulk production and ultimately for better results, the modern device are the need of the time. The development of standardized manufacturing method plays crucial role in addressing quality related challenges. Making Ayurveda more accessible and relevant in today's world Bhasma helps as a bridge to fill the form gap between ancient wisdom and modern expectation.

Keywords: Bhasma, Electrical horizontal muffle furnace, Ayurveda

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I. INTRODUCTION

During the 8th to 9th century A.D., which corresponds to the era of Nagarjuna, significant advancements took place in the field of Rasashastra, leading to the evolution and refinement of various pharmaceutical processing techniques, tools, and medicinal compounds within Ayurvedic Pharmaceutical technology. These innovations played a transformative role, enabling the conversion of different metals into forms suitable for internal use.

Mercurial preparations like Kupi Pakva and Pottali rasayana gained prominence for their remarkable effectiveness and were primarily employed as emergency remedies. In contrast, non-mercurial formulations such as Ayaskrti, Pisti, and Bhasma emerged as solutions for rejuvenation and disease treatment. Over time, Bhasma Kalpana gained increasing popularity due to its distinctive organo-metallic composition that facilitates assimilation. Bhasma, the final product derived from purified metals and minerals, undergoes a specific controlled heating process known as "puta" to transform it into nano particles.

In ancient texts, the precise amount of heat required for this process was determined by arranging cow dung cakes in specific patterns on the ground or within specially constructed pits designed for burning dried cow dung cakes. Various types of "putas," such as Mahaputa, Gajaputa, Varaha puta, Kukkuta puta, lavaka puta, and kapota puta, were detailed, each offering a precise level of heat to gradually refine the substances to finer states.

With modern technological advancements, contemporary practices involve the use of electrical horizontal muffle furnaces for the production of Bhasmas.

Rationale for Utilizing Electric Muffle Furnace:

1. In ancient times, practitioners (acharyas) personally crafted bhasma for their patients. However, modern demand for bhasma on a larger scale necessitates industrial production, raising concerns about safety, medicine effectiveness, and preservation of Indian heritage.
2. Classical putapaka, involving atmospheric conditions and cow dung cakes for ignition, results in varying maximum temperatures across successive putas. A muffle furnace, a modified instrument, addresses this by minimizing heat loss and ensuring consistent, homogeneous temperature control.
3. Standardization of bhasma requires meticulous documentation achieved through maintaining precise heating and temperature patterns.
4. Electric Muffle Furnace offers convenience due to factors like labor reduction, user-friendly operation, and controlled apparatus regulation.
5. Urban areas face challenges in sourcing cow dung cakes, making traditional preparation difficult. Electricity and available gadgets streamline the process, enabling quicker medicine production.

II. METHOD OF PUTA

In the traditional putapaka method, a systematic approach was employed to create the ideal conditions for the conversion of substances into their bhasma forms. This process involved several distinct steps.

To begin, a calculated quantity of cow dung cakes was gathered for the procedure. On average, about 2/3rd of the pit's volume was dedicated to accommodating these cow dung cakes. Each individual cow dung cake weighed around 140 grams and exhibited dimensions of approximately 13 cm in diameter. Notably, the cakes possessed a distinctive thickness, measuring 4 cm at the center and 2 cm at the periphery.

Within this arrangement of cow dung cakes, a specialized container known as the "Sharava Samputa" came into play. This container held pellets of purified drugs and was positioned at the central part of the arrangement.

The remaining 1/3rd of the pit's space was then filled with the remaining cow dung cakes. With the entire setup in place, the ignition of fire was initiated from the top.

This cyclic process was repeated iteratively, with the specific goal of achieving "bhasma siddhi lakshana," which marked the successful transformation of the substances into the desired bhasma form. This traditional method of preparation aimed to ensure the controlled and gradual conversion of the substances, culminating in the creation of bhasma with its unique properties and characteristics

III.ELECTRICAL HIGH TEMPERATURE VERTICAL MUFFLE FURNACE

Introduction: A muffle furnace is a specialized equipment commonly found in research facilities, characterized by its box-type structure with a front-loading mechanism. This furnace is extensively employed for various scientific purposes, including the assessment of non-combustible and non-volatile components within a sample, specifically the residue known as "ash." It serves as a versatile tool for processes such as incineration, drying, degradation studies, re-heating, and other thermal treatments.

The furnace achieves the desired temperature levels through different heating mechanisms, namely conduction, convection, or the emission of blackbody radiation. This temperature elevation is accomplished by utilizing electrical resistance heating elements strategically placed within the furnace's interior.

In essence, a muffle furnace plays a crucial role in scientific experimentation, enabling researchers to subject samples to controlled and precise heating conditions for the purpose of analysis, investigation, and the extraction of valuable insights.

IV.HORIZONTAL MUFFLE FURNACE

The Muffle Furnace is skillfully crafted in the form of a rectangular chamber, utilizing lightweight materials for its construction. This chamber is equipped with heating elements and a temperature control system, ensuring precise regulation of the internal temperature. These furnaces are meticulously designed to adhere to established industry standards, guaranteeing their performance, safety, and reliability in various applications.

Parts:

- Exterior chamber – Mild Steel Body,

- Interior chamber - Insulation Bricks, 4 sets of Kanthal A-1 heating coils covered with Good refractory muffle, Ceramic fibre blanket, and Ceramic rope.
- Control Panel – Main Switch, Main indicator lamp, Programmable digital electronic temperature and time controller, simultaneously indicating the actual and set temperature by K thermocouple. Heater on indicator, heater switch.
- Other – Crucible tongs, Thermal gloves

1. Mild Steel Body : Steel, a versatile alloy, primarily comprises iron and contains a carbon content ranging from 0.2% to 2.1% by weight, varying according to its specific grade. The presence of carbon and other elements serves as a vital hardening agent, effectively impeding the movement of dislocations within the crystal lattice of iron atoms. This mechanism enhances critical attributes like hardness, ductility, and tensile strength within the resultant steel.

By modulating the carbon content, steel can be intentionally reinforced, rendering it harder and more robust compared to pure iron. This inherent ability to fine-tune the carbon composition empowers the creation of steel with a diverse spectrum of properties, enabling it to be tailored for an array of applications and industries.

2. Insulation (Refractory) Bricks : The inner chamber of the furnace is meticulously constructed using premium-quality lightweight refractory bricks, which boast a significant alumina content and are entirely devoid of asbestos or iron oxide. These bricks are meticulously crafted through a meticulous process that involves blending carefully chosen **clays with expanded perlite**. This distinctive blend is subjected to precise processing within the plant's facilities, executed in strict accordance with internal specifications. The outcome is a highly durable and thermally efficient inner chamber that meets stringent standards of quality and safety.

Features:

- Temperature range - 200⁰C – 1750
- High mechanical strength
- Structural and dimensional stability
- Minimal creep in compression
- Very light weight and Excellent Insulating properties

3. Ceramic fibre blanket - Flexible, Hi-Alpha Alumina fiber insulation materials are predominantly composed of key components such as Al₂O₃ (aluminum oxide), SiO₂ (silicon dioxide), organic compounds, and trace elements. These insulation materials find their primary application within the linings of heated furnaces. Remarkably, these polycrystalline fiber blankets exhibit exceptional properties, including an elevated temperature tolerance, minimal shrinkage, and heightened resistance to various chemicals. This unique combination of attributes makes them well-suited for environments requiring insulation under high-temperature conditions, ensuring both durability and effective thermal management.

Features:

- Temperature range - 200⁰C - 1600⁰C

- High tensile strength
- Low thermal conductivity
- Low shrinkage
- Excellent hot strength.
- Low heat storage.

4. Kanthal A-1 Coils: Kanthal stands as an alloy predominantly comprised of iron, chromium (constituting 20–30 % of its composition), and aluminum (ranging from 4–7.5 %). This alloy has garnered renown for its remarkable capacity to endure elevated temperatures and exhibit intermediate electrical resistance. Notably, Kanthal wire has the propensity to develop a safeguarding layer of aluminum oxide, also known as alumina. This layer plays a pivotal role in establishing effective electrical connections.

In its standard form, Kanthal possesses a melting point of 1,200 °C, a testament to its exceptional thermal stability. However, specialized variations of Kanthal boast even higher melting points, reaching an impressive 1,425 °C. This unique amalgamation of constituents renders Kanthal an indispensable material for applications demanding resilience under extreme heat and electrical conditions.

- 5. Power Switch:** Turns main power on and off to furnace.
- 6. Digital Display:** Displays the operating and programmed temperatures, Times and status condition.
- 7. Power Light:** Illuminate when power is on.
- 8. Set temperature:** The muffle temperature is regulated by adjusting the power controller to the required power level, necessary to achieve the desired temperature.
- 9. Heater switch:** Turns the Kanthal A-1coils on and off to furnace. Serves as an ON/ OFF switch and a proportional electrical power controller. It controls the power applied to the coils and muffle temperature. When the desire temperature level raises it automatically switched off. When it comes down it automatically switched on.
- 10. Heater Light:** Illuminate when Heater is on.
- 11. Thermocouple:** Pyrometer consists of K-type inconel thermocouple or sensor K-type with inconel S/S sheath; compensating cable or extension wire.
- 12. Temperature:** Displays the currently programmed temperature and gives the operator to access and programme the desired value. The temperature LED'S alternately flash each time when SET TEMP adjusted. When the corresponding LED is flashing the indicated TEMP can be reviewed and programmed.

V. SPECIFICATIONS

1. Electrical:

Power requirements in watts at nominal line voltage	9 KWatts
Nominal current line voltage	440 V/ Three phase
Maximum Temperature	1100 ⁰ C
Mode of Heating	Thru' Kanthal A1 Heating Element
Mode of Control Insulation	Thru' Digital Temp. Controller
Insulation	High Temp. HFK Bricks & Ceramic Fiber Blanket
Door	Pull Open Type with Ceramic Rope

2. Operational – Temperature Control:

Temperature Variation (Time)	+/- ⁰C	0-5 ⁰C
Temperature Deviation (spatial)	+/- ⁰ C	0-5 ⁰ C
Readability / Set ability	⁰ C	1 ⁰ C
Temperature Range	⁰ C	26 ⁰ C - 1100 ⁰ C
Sensor Thermocouple		
Controller		Solid state digital controller
Display		LED
Adjustable alarm		Optional

Operating the furnace:

Manual controller: Adjust the power controller dial to the desired level. Once the furnace has been given sufficient time to heat up, closely monitor the temperature indicator. When the temperature reaches the desired peak level, deactivate the controller and allow the furnace to undergo a self-cooling process.

VI. DISCUSSION

1. Mode of Heat Ignition & Distribution in puta method: In the Puta method, heat ignition and distribution operate as follows:

- **Heat Flow and Distribution by Conduction Method:** The heat transfer process within the Puta and Sharava Samputa occurs predominantly through conduction, where heat moves from a hotter surface to a cooler one. In this context, heat is uniformly applied to the Sharava Samputa from all sides. As a result of this application, a distinct temperature gradient emerges between the outer and inner regions of the Sharava Samputa. The sequence of heat distribution unfolds as follows:

heat travels from the cow dung cakes to the cakes themselves, then from the cakes to the Sharava Samputa, and finally from the Sharava Samputa to the enclosed drug pellets. This methodical arrangement ensures the establishment of a sustained and uniform temperature enveloping the Sharava. However, due to external factors like atmospheric conditions and the ignition of cow dung cakes, achieving the maximum temperature can vary across different successive Putas.

- **Combustion and Temperature Variation:** During the process of combustion, it's important to note that not all cow dung cakes ignite simultaneously. Instead, a sequential pattern emerges: one set of cakes attains its peak temperature and subsequently begins to cool, while another set of cakes subsequently reaches the same maximum temperature. This second set then takes over the role of maintaining the temperature, allowing for a plateau of maximum temperature to be sustained over time. This cyclic pattern ensures a consistent high temperature within the Sharava Samputa. However, it's worth mentioning that there can be observed variations in temperature deviation during successive Gaja Putas. These variations likely result from a combination of factors, including the intricate interplay of heat distribution, combustion dynamics, and the influence of atmospheric conditions.
- 2. Mode of Heat Ignition & Distribution in Horizontal Muffle Furnace:** The placement of the Sharava within the heating element chamber was a precisely orchestrated process. It was positioned at the center, maintaining a distance of 3 inches from the sides of the chamber. Additionally, the Sharava was situated at a distance of 2 1/2 inches from the thermocouple, a crucial component for temperature monitoring.

The arrangement involved the strategic placement of 4 sets of Kanthal A-1 coils, meticulously grooved within insulation bricks, surrounding the Sharava. This configuration served as a means to provide controlled and uniform heating to the Sharava.

To regulate the temperature effectively, the set temperature was adjusted to a desired value. This desired value was derived as the mean temperature from a number of Putas, a term referring to the classical Bhasma preparation process.

Achieving and maintaining the desired temperature within the heating element chamber was of paramount importance. This endeavor ensured a consistent and constant temperature throughout the duration of each successive Puta. The temperature variation during this process was closely monitored, with adjustments made to maintain a range of 0 to 100 degrees Celsius over a period of 15 minutes. This meticulous control and monitoring of temperature enabled the sustenance of an optimal environment for the study and uniformity of the Bhasma preparation process, contributing to the precision and reliability of the results.

- 3. Temperature Pattern:** The temperature pattern was meticulously observed and documented during the Bhasma preparation process. Initially, the Classical puta method was employed, involving a series of puta procedures. At intervals of 5 minutes over a span of 6 hours, the temperature was recorded. Several key aspects were captured during this process:

- **Temperature Rise and Fall Times:** The duration taken for the temperature to ascend from its base level to the peak level, as well as the time taken for it to descend from the peak level back to the base.
- **Peak Range Temperature:** The range of temperatures encompassed during the peak phase was meticulously noted.
- **Peak Stay Time:** The amount of time the temperature remained at its peak value was carefully recorded for each successive Puta.

The collected temperature data were then analyzed statistically to determine the Mean Temperature, indicating the specific hour at which the temperature reached its peak value in degrees Celsius. Additionally, the Average Peak Range Time, expressed in terms of hours and minutes, was calculated. Expert opinions were sought to ascertain the Mean Peak Temperature and Average Peak Range Time. These values were subsequently applied to the Electric Horizontal Muffle Furnace (EHMF) for the Bhasma preparation.

In the EHMF, the temperature settings were manually adjusted to replicate the observed temperature pattern and duration from the Classical puta method. This deliberate adjustment ensured the emulation of a uniform and controlled heat rise, with a temperature deviation of 3-5 degrees Celsius per minute. This process was conducted with the EHMF operating at a continuous nominal current line voltage of 9 kW / 440 V / Three phase. The meticulous attention to temperature dynamics and control within the EHMF facilitated the accurate preparation of Bhasma in accordance with the Classical puta method.

4. **Duration of Temperature:** To illustrate the concept, let's consider the example of Vimala Bhasma preparation through both the classical puta method and Electric Horizontal Muffle Furnace (EHMF) in TGAMC, Bellary, Karnataka in 2011.

In the classical puta process, the duration required for the completion of Vimala Bhasma was 6 hours, followed by a subsequent 24-hour period of complete self-cooling. During this traditional method, the temperature reached a range of 800-912 degrees Celsius within 20 Gajaputas. However, the time during which the peak temperature was sustained remained relatively brief. This is attributed to the open atmosphere nature of this Puta, which necessitates maintaining the peak temperature for a shorter duration.

In the EHMF study, a statistical mean peak temperature of 793 degrees Celsius was applied for a duration of 1 hour. The time taken to reach this peak temperature averaged around 2 hours and 15 minutes. Subsequently, the temperature controller was turned off, allowing for self-cooling over a 45-hour period.

5. **Several factors influence the temperature range and duration within Gajaputas:**

- **Variation in Attaining Peak Temperature:** Across 20 puta procedures, the time taken to reach peak temperature varied from 20 to 30 minutes. On average, it took about 1 hour and 25 minutes to attain the peak temperature in Gajaputa. This variance may arise due to the gradual spread of heat between cow dung cakes, each

contributing differently to the heat transfer. This principle extends to Swangasheeta time, which also varies under the same rule.

- **Influence of Cow Dung Cakes Arrangement:** Some Gajaputas exhibited higher average peak strike temperatures due to the compact arrangement of cow dung cakes in the pit. This arrangement generates a greater quantum of heat. The difference in the time taken for temperature to rise from peak to base level and from base to peak is determined by the onset time and the heat quantum of each cow dung cake.
- **Geographical Position and Atmospheric Temperature:** Variation in the total average atmospheric temperature is attributed to the geographical location of the trial. The atmospheric temperature on the day of performing Gajaputa is influenced by the specific environmental conditions of the location. As a result, the temperature range is maintained for a shorter duration, typically around 50-55 minutes.

These factors collectively contribute to the dynamic and nuanced temperature patterns observed during Gajaputa procedures, highlighting the intricacies of the process and its sensitivity to various influences.

6. Duration of Self-Cooling in Classical Puta and Horizontal Muffle Furnace:

- The period of self-cooling after the completion of the Puta process varies between the Classical Puta method and the Electric Horizontal Muffle Furnace (EHMF) method.
- In the Classical Puta method:
 - The total time duration needed for the burning of a Gajaputa amounted to 6 hours.
 - Following this heating phase, the complete self-cooling process spanned a total of 24 hours.
 - This extended cooling time was due to the fact that the Gajaputa process is typically carried out in an open atmosphere. The surrounding environment aids in the cooling process, allowing for a relatively shorter cooling duration.
- However, in the Horizontal Muffle Furnace (EHMF)
 - The self-cooling period was notably longer, requiring 45 hours to complete.
 - This extended cooling period is attributed to the design of the EHMF. The heating element chamber is constructed using heat-resistant refractory bricks, which effectively retain and release heat over a more extended period of time. As a result, the furnace maintains a higher temperature for a longer duration, thus necessitating a longer self-cooling period.
- This distinction in self-cooling duration between the Classical Puta method and the EHMF approach underscores the impact of the specific heating and chamber materials on the overall cooling process. It also highlights how different procedural conditions can lead to varying cooling times, influencing the entire Bhasma preparation process.

7. Yield of Classical Gaja puta & Horizontal Muffle Furnace: The yield of Shodhita Vimala 87.5%, yield of Vimala Bhasma (Classical) & 63.6% and Vimala Bhasma 70%.

8. Analytical Study:

- **EDX SEM-** Results showed
- **Vimala bhasma (classical)** - C 1.755%,O 21.605%,Si 3.76%,P 0.03%,S 0.275%,K 0.43%, Fe 64.11%,Co 0.52%,Cu 0.49%, Ag 0.3%.
- **Vimala bhasma (EHMF)** - C 1.365%,O 30.045%,Si 1.285%,S 0.505%,K 0.77%,Fe 64.07%,Ni 0.385%,Cu 0.385%,As 0.36%,Ag 0.525%, P 0.01%
- **Particle Size:** Mean particle size of Vimala Bhasma(classical) is 2.13 μm , Vimala Bhasma (EHMF) 1.78 μm .
- **XRD Results** - Both Vimala Bhasma prepared by Classical puta method & EHMF can be considered as Ferrous Sulphide & Ferric Oxide .The crystal structure was found to be Hexagonal & Cubic. In the present entitled study, Vimala Bhasma (EHMF) is Pharmaceutically very convenient to prepare and Shows good Analytical results compare to V.B.(Classical).

VII. CONCLUSION

In conclusion, the pharmaceutical methods documented by our ancient acharyas in the past were not always exhaustive or comprehensive. As a result, the need for revalidation of Bhasma preparation methods using modern parameters became imperative to achieve standardization. In this pursuit, the traditional puta system for heating was replaced by the more advanced electric muffle furnace.

The adoption of the Electric Muffle Furnace brought about several advantages, including the elimination of labor-intensive processes, simplified operation, and the availability of a well-regulated apparatus. These factors collectively contribute to a more streamlined and efficient approach.

The development of standardized manufacturing methods plays a crucial role in addressing quality-related challenges. By implementing these methods, we can ensure a higher level of control over the quality of Ayurvedic products. This, in turn, enhances the credibility and acceptance of Ayurveda on a global scale.

In essence, the transition from traditional practices to contemporary techniques reflects a progressive approach towards refining and modernizing Ayurvedic pharmaceutical processes. The integration of advanced technologies helps bridge the gap between ancient wisdom and modern expectations, making Ayurveda more accessible and relevant in today's world.