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Investigation of temperature pattern of traditional *Putra* in Ayurveda *Bhasma* preparation

P.M.Y.S.Pathiraja¹, S.K.M.K.Herapathdeniya², Sanja H.P.Gunawardane³

Abstract

Bhasma is a herbo-mineral preparation manufactured from metal/mineral after following complex ayurvedic pharmaceutical processes, *shodhana* (purification) and *marana* (incineration). The quantum of heat required for *marana* process in converting metal/mineral into *bhasma* form is known as *Putra* and this heat amount is substance specific and measured in terms of fuel used. Objectives of this research are to establish the temperature pattern of 3 traditional *putra* (*Varaha Putra*, *Gaja Putra* and *Maha Putra*) and verifying the *Varaha Putra* temperature pattern by comparing properties of Chalcopyrite ash (*Swarna Makshika Bhasma*) prepared using traditional *putra* and using electric muffle furnace.

Temperature pattern for *Maha Putra*, *Gaja Putra* and *Varaha Putra* were determined using dried cow dung cakes with an average calorific value of 15.44MJ/kg as the fuel and the maximum temperatures achieved for *Maha Putra*, *Gaja Putra* and *Varaha Putra* were 1380°C, 1060°C and 850°C respectively. Further, the temperature pattern of traditional *Varaha Putra* was matched with a muffle furnace and selected ash was prepared using both traditional method and electric muffle furnace and compared properties of the resultant ash (*bhasma*) from two methods. The ash produced using both methods have shown similar properties.

Keywords : *Putra*, *bhasma*, purification (*shodhana*), incineration (*marana*), electric muffle furnace

Introduction

In Ayurveda system of medicine, minerals, metals, poisonous materials and gems are used to prepare drugs combining with various herbs for curing diseases. Converting metals and minerals into acceptable form for internal administration is done by various pharmaceutical processing methods.

Metals and minerals processed with various herbal materials are converted into special form known as *bhasma* (ash) and these herbo-mineral preparations come under a special branch of Ayurveda called *Rasa Shastra*.

Preparation of most *Rasa* drugs is an elaborate process involving *shodhana* (purification) and *marana* (incineration / calcination). Purification is an important initial pharmaceutical process in converting metals and minerals into ash (*bhasma*). Due to *shodhana* process external and internal impurities of metals and minerals are removed [1].

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The next stage, incineration (*marana*) is the process in which purified metals or minerals are made in to pellet form with various materials and herbal extracts and then it is subjected to fire treatment in closed earthen crucibles in a pit by burning dried cow dung cakes to obtain *bhasma* (ashes) [2]. The quantum of heat required to produce specific *bhasma* is known as *Putra*. In Ayurvedic texts, amount of heat needed to produce specific ash is described in terms of cow dung cakes to be burnt and temperature profiles are not defined for traditional *Putra*.

Materials & Methods

Analysis of Cow dung cakes

Cow dung cakes were prepared using different compositions of cow dung, paddy husk and saw dust as shown in Table 1 to identify suitable composition. Diameter and height of the mould used to prepare cow dung cakes were 6" and 1" respectively [3]. Calorific value of each sample was measured using Bomb calorimeter.

Table 1 : Compositions for preparation of cow dung cakes

Sample No.	Composition (%)		
	Cow dung	Paddy husk	Saw dust
1	60	40	-
2	82	18	-
3	76	24	-
4	63	20	17

Temperature pattern establishment

In order to measure *Putra*, the pits were built for *Varaha Putra*, *Gaja Putra* and *Maha Putra* using bricks and clay. Dimensions of the 3 *Putra* and number of cow dung cakes burnt were shown in Table 2. For *Varaha Putra* and *Gaja Putra*, number of cow dung cakes to be burnt were mentioned as 150 and 1000 [5] respectively in literature. But maximum cow dung cakes that could be arranged in above 2 pits were 120 and 600 respectively though cow dung cakes were prepared according to the dimensions given in Ayurvedic texts. For *Maha putra*, 1500 cow dung cakes could be arranged in the pit as mentioned in the Ayurvedic texts.

Arrangement of cow dung cakes for Varaha Puta:

80 cow dung cakes were filled to the *Varaha Puta* pit, placed the sealed earthen crucibles containing mineral and then it was covered with remaining 40 cow dung cakes.

Table 2: Details of Puta systems

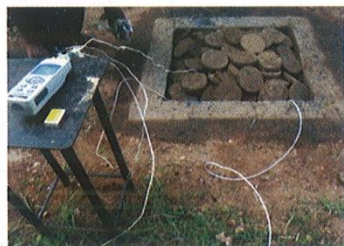
Puta	Dimensions	No. Cow dung Cakes	W't of Cow dung cakes (kg)
<i>Varaha Puta</i>	16.5"x16.5" x16.5"[4,6]	120	12.7
<i>Gaja Puta</i>	22.5"x22.5" x22.5"[5]	600	81.8
<i>Maha Puta</i>	36"x36" x36"[4]	1500	186.7

Arrangement of cow dung cakes for Gaja Puta:

400 cow dung cakes were filled to the *Gaja Puta* pit, placed the sealed earthen crucibles containing material and then it was covered with remaining 200 cow dung cakes as shown in figure 1.

Arranging of cow dung cakes for Maha Puta:

1000 cow dung cakes were filled to the *Maha Puta* pit, placed the sealed earthen crucibles containing material and then it was covered with remaining 500 cow dung cakes. Figure 2 shows the burning of cow dung cakes in *Maha puta*.

**Figure 1: Arranging of cow dung cakes in Gaja Puta**

Thermocouple wires were inserted to the crucibles containing material for all the three *Putas* to record temperatures inside the crucibles using Temperature Data Logger (Model: TM-947SD, Type: 4 Channel Thermometer).

Then cow dung cakes were ignited on all four sides and in the middle of the pit and when burning was over, the contents in the crucible were allowed to self cool completely.

**Figure 2: Burning cow dung cakes in Maha Puta**

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Temperature pattern verification for Varaha Puta**1. Purification of Chalcopyrite**

Chalcopyrite mineral was ground using mortar and pestle and then 325g of ground Chalcopyrite was roasted in an open pan with 400ml of lime juice for 48 min [4].

2. Purification of Sulphur

Approximately 2 L volume clay pot was filled with 1 L of cow's milk and mouth of the clay pot was tied with a piece of cloth and applied cow's ghee on the cloth. Then placed 245g of powdered Sulphur on the cloth and it was covered and sealed with another similar size clay pot using clay-smear cloth. After that pot containing milk was buried and heated the outside of upper clay pot using 2.5kg of cow dung cakes (app. 20 cow dung cakes). Sulphur then melts and drops gradually into milk. Finally Sulphur in the milk was washed with warm water and process was repeated three times using resultant Sulphur. [4]

3. Preparation of Chakrika (pellets)

Equal amounts of purified Chalcopyrite and purified Sulphur (200g of each) were put into the mortar and lime juice was added till covering the mixture. Then mixture was ground till drying the lime juice, pellets were made (approximately 2cm diameter and 3mm thick) and they were sun dried.

4. Incineration of pellets in Varaha Puta

15 number of Sun dried pellets (wt 61.3690g) were placed in the earthen crucible and sealed with another crucible as explained earlier. Then it was incinerated in *Varaha Puta* (*Puta* 1) using 120 cow dung cakes and allowed to self cool. The resultant ash (*bhasma*) from *Puta* 1 was again ground with lime juice; pellets were prepared and incinerated in *Varaha Puta*. This process was repeated 5 times up to *Puta* 5.

5. Incineration pellets in electric muffle furnace

15 number of Sun dried pellets (wt 64.0114g) were placed in the earthen crucible and sealed with another crucible. Then it was incinerated in muffle furnace following the temperature pattern established for *Varaha Puta* (cycle 1). The resultant ash (*bhasma*) from *Puta* 1 was again ground with lime juice; pellets were prepared and incinerated in muffle furnace. This process was repeated 5 times up to cycle 5.

Properties of resultant ash (bhasma)

Properties such as weight loss in each stage, colour of ash, *rekapurnata* (furrow filling), *varitara* (floatability), *nirutta* (metal irreversibility), loss on drying and chemical composition were examined.

Rekapurnata (Furrow filling): The *bhasma* was rubbed between the thumb and index finger. The particles of *bhasma* attain such a state that the *bhasma* could enter the furrows of finger [4].

Varitara (Floatability): A pinch of the bhasma was sprinkled on water taken in a beaker and the floating tendency of the bhasma was observed [4].

Nirutta (Metal Irreversibility Test): A known amount of silver was heated in a muffle furnace for 15 minutes with the *bhasma* at various temperatures in a crucible. The crucible was cooled to room temperature and the weight was recorded. The change in the mass of silver is an indication of improper calcination during the preparation of bhasma [9].

Loss on drying: 1g of *bhasma* was taken in a crucible and dried in an oven at 105°C for about 5 hours. The sample was allowed to cool in the desiccators and the dry mass was determined. The difference in mass was used to determine the loss on drying and expressed in percentage [9].

Chemical composition:

Chemical composition was analyzed using Atomic Absorption Spectrophotometer (Model: GBC933AA, Type: Atomic Absorption Spectrophotometer).

Results

Analysis of Cow dung cakes

Properties of cow dung cakes are shown in Table 3.

Table 3: Properties of cow dung cakes

Sample No.	Avg. Calorific Value (MJ/kg)	Moisture Content (%) (dry basis)
1	15.18	15.84
2	15.30	14.97
3	15.44	15.56
4	14.65	14.28

Temperature pattern Establishment

Temperature profiles established for *Varaha Puta*, *Gaja Puta* and *Maha Puta* are shown in Figure 3, Figure 4 and Figure 5 respectively.

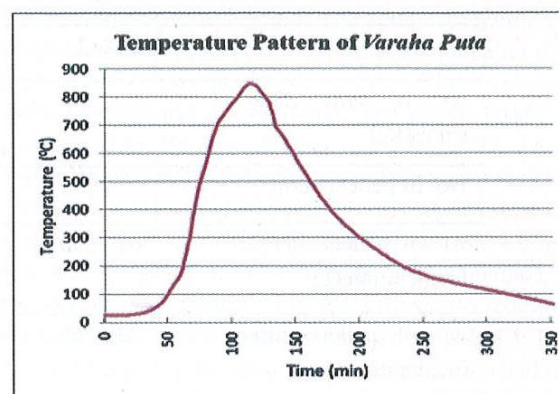


Figure 3: Temperature pattern for *Varaha Puta*

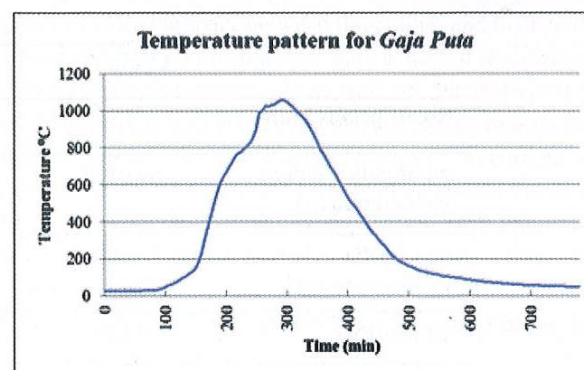


Figure 4: Temperature pattern for *Gaja Puta*

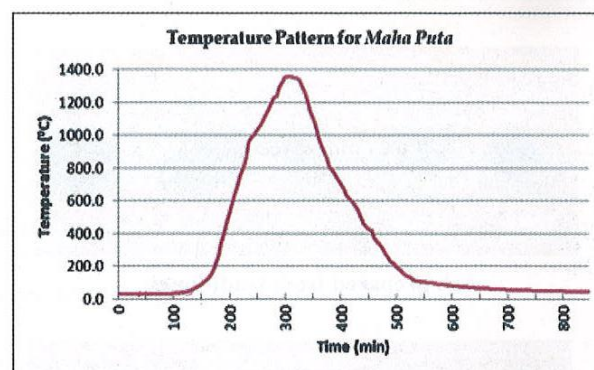


Figure 5: Temperature pattern for *Maha Puta*

Details of incineration of pellets in traditional *Varaha Puta* and in muffle furnace are shown in Tables 4 & 5 respectively.

Table 4: Incineration of pellets in traditional *Varaha Puta*

	<i>Putta</i> 1	<i>Putta</i> 2	<i>Putta</i> 3	<i>Putta</i> 4	<i>Putta</i> 5
wt of cow dung cakes(kg)	12.7	12.5	12.1	12.9	11.9
No. of pellets burnt	15	5	3	3	1
wt of pellets before incineration (g)	61.3690	22.4531	14.8244	10.5585	7.1096
wt of pellets after incineration (g)	22.6666	16.4380	12.7806	9.5264	6.4796
wt loss (%)	63.07	26.79	13.79	9.78	8.86

Table 5: Incineration of pellets in electric muffle furnace

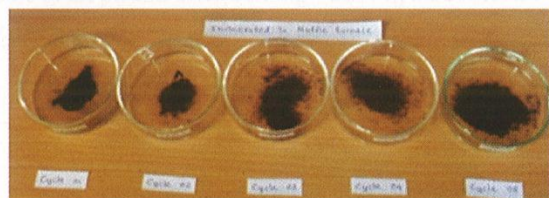
	Cycle 1	Cycle 2	Cycle 3	Cycle 4	Cycle 5
No. of pellets burnt	15	4	3	2	1
wt of pelle before incineration (g)	64.0114	19.5476	12.6293	9.5075	5.6589
wt of pelle after incineration (g)	22.6031	14.5636	11.0014	8.5561	5.1773
wt loss (%)	64.69	25.50	12.89	10.01	8.51

Verification of traditional *Varaha Puta* temperature pattern using Muffle Furnace

Colour change of resultant ashes from both methods during the each stage is shown in Figure 6.



Ash prepared from traditional



Ash prepared from electric muffle

Figure 6: Colour of resultant ash

Floatability of final ashes on surface of water is shown in Figure 7.

**Figure 7 : Floatability Test**

Results obtained for physical tests are summarized in Table 6.

Table 6: Physical Properties

	<i>Putra</i>	Muffle
Colour	Reddish Brown	Reddish Brown
<i>Rekapurnata</i>	Fills the space between finger lines	Fills the space between finger lines
<i>Varitara</i>	Floats on surface of water	Floats on surface of water
<i>Nirutta</i>	Silver wt remain unchanged	Silver wt remain unchanged
Loss on drying (%)	0.09	0.14

Chemical composition of raw mineral and resultant ashes is shown in Table 7.

Table 7: Chemical composition of raw mineral & resultant ash

Chemical constituent	Composition (%)			
	Raw mineral	Pellets	Final <i>bhasma</i>	
			<i>Putra</i>	Muffle
Fe	44.10	22.05	48.6	48.2
Cu	<0.01	<0.01	<0.01	<0.01
SiO ₂	2.28	1.14	8.1	2.75

Discussion

Maximum Calorific Value was obtained for cow dung cakes prepared using 76% cow dung and 24% paddy husk mixture (dry basis) and also that was the most stable mixture among the prepared samples.

Temperature pattern for *Varaha Putra* is shown in Figure 4 and the temperature started to increase after 35 min of ignition. Peak temperature was observed as 850°C at 115min after ignition and that temperature was remained for 5min. Temperatures above 750°C and above 600°C were maintained for 35 min and 70±5 min respectively. *Varaha Putra* was taken about 5hrs for self cooling (to 40°C).

Temperature pattern of *Gaja Putra* is shown in Figure 5 and after 90±5min of ignition, temperature started to increase. Peak temperature was observed as 1060°C at 295min after ignition. Temperatures above 1000°C, 800°C and 600°C were observed for 55 min, 125 min and 195min respectively. *Gaja Putra* system was taken about 11 hrs for self-cooling (to 40°C).

Temperature pattern for *Maha Putra* is shown in Figure 6 and temperature started to increase after 100min of ignition. Peak temperature was observed as 1360°C at 305min after ignition and it was started to decrease within another 7-8min. Temperatures above 1300°C and above 1100°C were maintained for 40min and 90min respectively. Temperatures above 1000°C, 800°C and 600°C were maintained for 115min, 160min and 210min respectively. It was taken 13hrs for self-cooling (to 40°C). When preparing various ashes in muffle furnace, temperature data which were obtained from traditional *putra* method can be utilized to control the temperature in muffle furnace. As shown in Table 4 & Table 5, weight loss during the each cycle in *Varaha Putra* and muffle furnace incinerated ashes are approximate to each other.

Colour of the final ashes (*bhasma*) obtained from both methods were reddish brown and it is similar to the colour of Chalcopyrite ash mentioned in Ayurvedic text [7]. Both ashes (*bhasma*) filled the space between finger lines and float on the surface of water confirming that they achieved the required fineness of the final *bhasma*. In *nirutta* tests, wt of silver were not increased for both ashes and it proved that there is no free metallic portion in the *bhasma* samples. According to literature [7], loss on drying of final *bhasma* should not more than 0.5% w/w and *bhasma* prepared from both traditional *Putra* and from electric muffle furnace shown 0.09% and 0.14% of loss on drying respectively. Therefore, results obtained were within the required level of loss on drying.

Chalcopyrite mineral that was taken for preparation of ash contains 44.10% Fe, <0.01% Cu and 2.28% SiO₂. According to the literature, Chalcopyrite should contain approximately 34.5% Cu [8]. But 2 market samples from different suppliers were analyzed and both contain <0.01% Cu content. Therefore, preparation of ash was continued with the above sample.

The composition of Fe, Cu, SiO₂ in pellets becomes half of the initial raw mineral composition since Chalcopyrite was mixed with equal amount of Sulphur in the preparation of pellets. After incineration, Fe, SiO₂ content in ash prepared in *Varaha Putra* were 48.6% & 8.1% respectively while they were 48.2% & 2.75% respectively in the ash prepared in the muffle furnace.

Conclusion

Temperature patterns for *Maha Putra*, *Gaja Putra* and *Varaha Putra* were established and the maximum temperatures achieved for *Maha Putra*, *Gaja Putra* and *Varaha Putra* were 1380°C, 1060°C and 850°C respectively. Ash prepared using traditional *Varaha Putra* and in an electric muffle furnace following the same temperature profile showed similar results according to classical tests of Ayurveda and the chemical composition.

Therefore, temperature pattern established for traditional *Varaha Puta* by burning cow dung cakes was verified using the electric muffle furnace.

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