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Synthesis and Characterization of Naga (Lead) Bhasma

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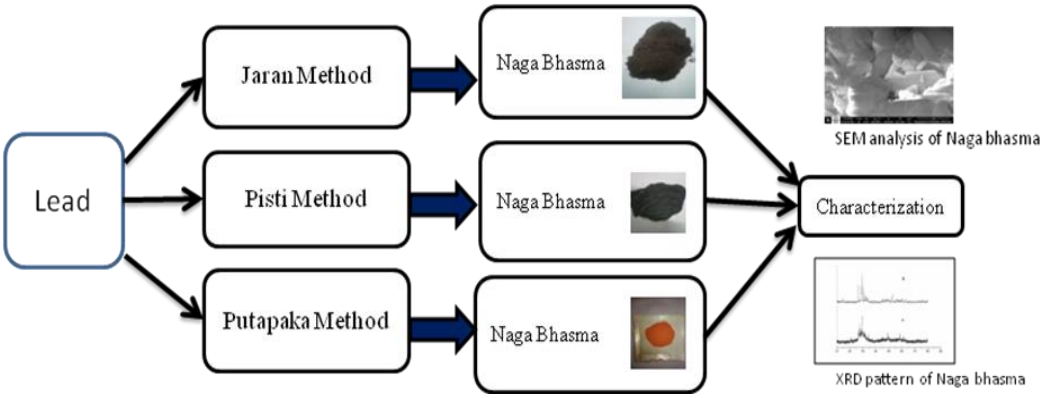
ABSTRACT

The present study deals with the synthesis and characterization of Naga (lead) Bhasma. It was prepared by three methods viz. Jarana method, pisti (amalgam) method and putapaka (herbal media) method. The analysis of prepared bhasma was done by classical ayurvedic tests as well as modern analytical techniques such as EDAX, SEM, XRD and FTIR. The study reveals that Naga bhasma is a mixture of compounds of lead: PbS, PbS_2, PbO, Pb_2O_3 and Pb_3O_4. Elemental analysis confirms presence of Al, Ca, Fe, Si along with carbon which suggests that bhasma is a herbo-mineral compound.

Graphical Abstract



Keywords: Naga bhasma, Elemental analysis, Characterization, Lead.

INTRODUCTION

Metallic bhasma are highly valued and have their own importance in ayurvedic formulations. A preparation of bhasma is very tedious and time consuming procedure. Previously the bhasma were prepared by the ayurvedic physicians themselves as per their requirements. Now a days they are manufactured in large scale in pharmaceutical houses. This new approach has created several problems, because the use of new appliances has not been standardized regarding the quality of these bhasma

preparations. The different pharmaceutical procedures used for the preparation results in the same bhasma with different characters. This leads to the variation in the metal content of the marketed samples containing these bhasmas. There are several reports mentioning presence of toxic mercury, arsenic in the final bhasma product. Thus, it is necessary to standardize the procedure of synthesis by controlling its quality at various stages of preparation. Hence, the present work was undertaken to establish a standard quality control procedure during synthesis of bhasma at various stages of preparation.

In our previous papers we have reported synthesis and characterization of silver [1], mandur [2] and tamra bhasma [3].For the present study Naga (lead) bhasma was selected as it is more commonly and widely used. It is used to treat various diseases like diabetes mellitus, Tropical sprue, diarrhea, spleen and skin diseases [4]. Naga bhasma has shown testis regenerative potential on partially degenerated testes [5].Clinical studies have proved the antidiabetic activity of Naga bhasma [6]. The present work deals with the synthesis and characterization of Naga bhasma using three different methods viz. jarana, pisti and putapaka.

The synthesis of bhasma mainly consists of shodhana (purification), Jarana (open heat frying) and Marana (incineration). The shodhana method deals with samanya shodhana (general purification) and vishesh shodhana (Special purification). When shodhana is done for a group or a class as a whole it is called samanya shodhana. When shodhana is carried out for specific metal by specific method is called vishesh shodhana. However, for some of the metals such as lead samanya shodhana method can be omitted. In order to see the effect of samanya shodhana on finally prepared bhasma, we have synthesized Naga bhasma with and without samanya shodhana by different methods.

MATERIALS AND METHODS

Lead was procured from PPC laboratory, sesame oil from D.G.Pardeshi and sons laboratory, Pune, purified mercury from Goradia Gandhi Aushadhalaya, Mumbai, purified sulfur and Manashila (As_2S_2), from Tripathi ayurvedic Aushadhalaya, Pune. Vitex nigundo (Nirgundi), turmeric powder, tamarind powder, Ficus religosa powder and horse gram seeds were purchased from local ayurvedic medical shop. Sour gruel, decoction of horse gram and buttermilk were prepared as per references of Ayurvedic texts [7-9].

The synthesis of Naga bhasma was carried out by three methods viz. jarana, pisti and putapaka. The first step in all these methods was samanya shodhana. In this method lead was heated in an iron pan. The molten lead was then poured in sesame oil (tila taila), butter milk (takra), cow urine (gomutra), sour gruel (kanji) and decoction of horse gram (kulatha kwath) successively. This process was repeated 3 times each. [10]

The lead obtained from samanya shodhana was subjected to vishesh shodhana. For this purpose lime water (churnodaka) [11], decoction of Triphala [12] and juice of Vitex nigundo (Nirgundi swarasa) [13] were used in case of jarana method, pisti method and putapaka method respectively. The lead was heated and molten lead was poured in lime water and decoction of Triphala for seven times and three times in Vitex nigundo respectively.

The purified lead thus obtained was subjected to jarana and marana process in case of jarana and putapaka methods. While in case of pisti method purified lead is subjected to only incineration method. The details are described below.

Jarana method: After vishesh shodhana obtained lead was melted under high temperature and powder of Tamarindus indica (chincha) and Ficus religosa (ashwatha) was added to it. This mixture was heated in an iron pan till it becomes red hot. This powder was collected in center and covered with earthen saucer and

strong heat was applied. This powder was heated for 24 h [14]. Powder thus obtained was sieved through 100 micron mesh. The powder which was not passed through mesh was again subjected for same procedure for 3 times.

This powder was further incinerated. For this purpose equal quantity of powder of manashila (realgar - As_2S_2) and juice of citrus acida were added and mixture was heated in furnace at 600^0C for 3 h (Kukkut puta). The procedure was repeated 3 times [15].

The Photographs of series of steps are shown in fig. 1





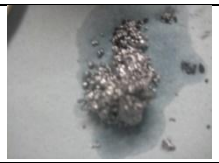
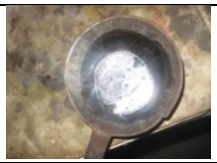

Shodhana	After shodhana	Jarana	Pelletes	Incineration	Final bhasma

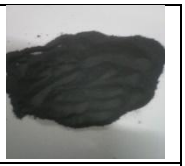
Fig 1: Jarana method

Pisti method: Lead obtained after vishesh shodhana was heated in an iron pan, after melting it was poured in crucible containing purified mercury. Amalgam of mercury and lead was formed i.e. Naga Pisti. It was triturated with lemon juice and purified sulfur till it was converted into black colored kajjali [16]. This black colored kajjali was sieved through 100 micron mesh. The powder which was not passed through mesh was again subjected for same procedure for 3 times.

This is further incinerated with purified **s**ulfur and juice of citrus acida at 600^0C for 3 h (Kukkut puta). The procedure was repeated 3 times [17].

The Photographs of series of steps are shown in fig. 2

Shodhana	After shodhana	Molten lead	Amalgamation -Pisti	Incineration	Final bhasma

Fig 2: Pisti method

Putapaka method: Lead obtained after vishesh shodhana was melted in an iron pan and was stirred continuously with stem of Adhatoda vesica, resulting in red colored powder. This powder was collected in center and covered with earthen saucer and strong heat was applied. This powder was heated for 24 h [18] and then sieved through 100 micron mesh. The powder which was not passed through mesh was again subjected for same procedure for 3 times.

This was further incinerated using decoction of Adhatoda vesica. Decoction of Adhatoda vesica was prepared by taking Adhatoda vesica powder 1 part and 8 parts of water and heated till it reduced to ¼th of original volume. This mixture was heated in furnace at 600^0C for 3 hours (Kukkut puta). The procedure was repeated 3 times [19].

The Photographs of series of steps are shown in fig. 3

					
After shodhana	Jarana wth adatoda vesica stem	After jarana	Pelletes	Incineration	Final bhasma

Fig 3: Putapaka method

Final product of Naga bhasma was analyzed by traditional ayurvedic methods and modern analytical methods viz. XRD, FTIR, FESEM and EDAX.

RESULTS AND DISCUSSION

Synthesized Naga bhasma was analyzed by methods described in classical ayurvedic texts [20].

Varitara- (ability of bhasma to float on water) A small amount of prepared Naga bhasma was sprinkled over the still water in a beaker. It was found that bhasma particles floated over the surface water.

Unnama – (a grain floats on a film of sprinkled bhasma on water) - when a grain was put over the film formed by Naga bhasma over the water, it floated on water like a swan.

Rekhapurnatava – (particle should occupy the furrows of the finger) - A pinch of Naga bhasma was taken in between the thumb and the index finger and rubbed. It was observed that the bhasma entered into the lines of the finger. It was not easily washed out from the cleavage of the lines.

Susukshma - (reduced particle size): This test is applied to study the lightness and fineness of Naga bhasma. This also ensures microfineness of bhasma.

Niswadatvam or Gata Rasatvam: (tasteless) every metal has its specific metallic taste. The prepared Naga bhasma was found tasteless when a small amount was kept on the tongue.

Nishchandratvam: (lusterless). The luster is a character of metal. The Naga bhasma was taken in a petri dish, no luster was observed in sunlight.

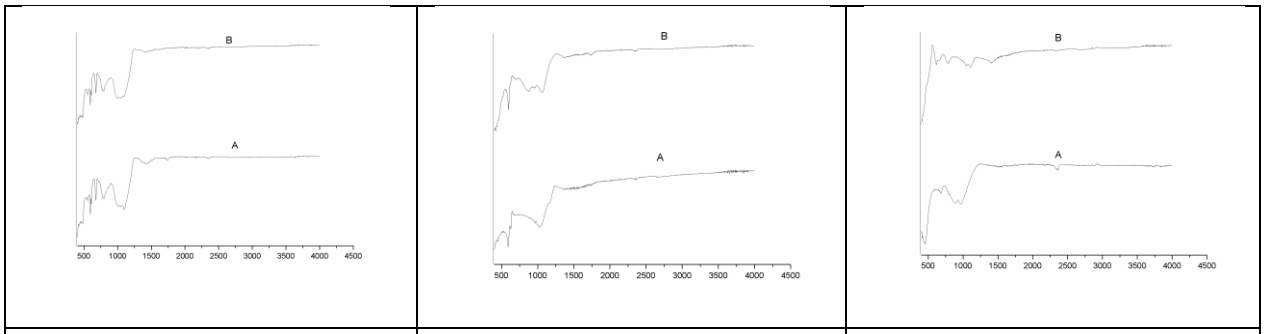
Apurnabhavatva: Naga bhasma when mixed with mitrapanchaka [Cow's Ghee, Gunja (Abrus), Tankan (Borax), Honey, Guggul (Commiphora mukul)] and heated at high temperature, bhasma did not regain its original state.

Niruttha: The Naga bhasma treated with silver at high temperature in furnace, Weight of the silver remained almost the same.

All the above tests were found to be positive for the prepared bhasmas indicating formation of proper bhasma.

Characterization of Naga bhasma by FTIR

The FTIR spectrum of Naga bhasma was studied in the region of 4000 to 400cm^{-1} and is shown in fig.4.



Jarana method	Pisti method	Putapaka method

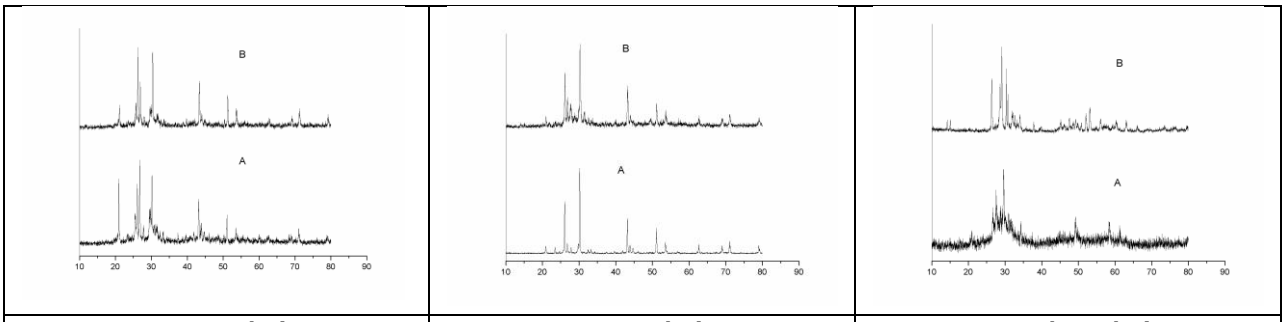
Fig 4: FTIR analysis of Naga bhasma prepared by various methods
(A: With samanya shodhana, B: Without samanya shodhana)

An examination of fig 4 reveals that, all bhasmas show peak in the region of 2700 cm $^{-1}$ - 3700 cm $^{-1}$. This represents hydroxyl group. Presence of hydroxyl group may be because of hydrophilic nature of bhasmas and moisture. All bhasmas also show peaks in the region of 1406 cm $^{-1}$- 2363 cm $^{-1}$, peak at 2363 cm $^{-1}$ in all samples indicates carbonate group.

All the bhasmas except, those prepared by using putapaka method, show sharp peaks in the region 1000 cm $^{-1}$ - 1400 cm $^{-1}$, this represents S=O group. In these bhasmas (jarana method and pisti method) purified sulfur or sulfur containing molecules like manshila (As_2S_2) were used.

Bhasma prepared in Putapaka method shows peaks at 1408.9, 529.0, 682.5 and 669.1, 668.2 indicating formation of Pb_3O_4 and PbO. Similar findings were reported by Sangle et al [21]. Strong peaks at the region of 470 cm $^{-1}$ - 600 cm $^{-1}$ indicates presence of Si =O group. This is attributed to earthen pot used in calcination steps [22, 23].

Characterization of Naga bhasma by XRD: XRD is a nondestructive technique that reveals detailed information of chemical composition and crystalline structure. XRD of different bhasma are shown in fig.5.



Jarana method	Pisti method	Putapaka method

Fig 5: XRD pattern of Naga bhasma prepared by various methods
(A: With samanya shodhana, B: Without samanya shodhana)

XRD pattern of all bhasmas shows presence of sharp diffraction peaks, suggesting highly crystalline nature of bhasma. All samples of bhasmas are complex mixture of PbS, α-PbS_2, β- PbS_2, PbO, Pb_3O_4 and Pb_2O_3. XRD pattern of bhasmas prepared by jarana method and pisti method shows predominantly PbS, α-PbS_2, β- PbS_2. In these methods, sulfur compounds were used. In putapaka method XRD pattern predominantly suggests of formation of PbO, Pb_2O_3, Pb_3O_4 along with minor amount of PbS, PbS_2.

Characterization of Naga bhasma by SEM: SEM micrographs of Naga bhasma are shown in fig. 6

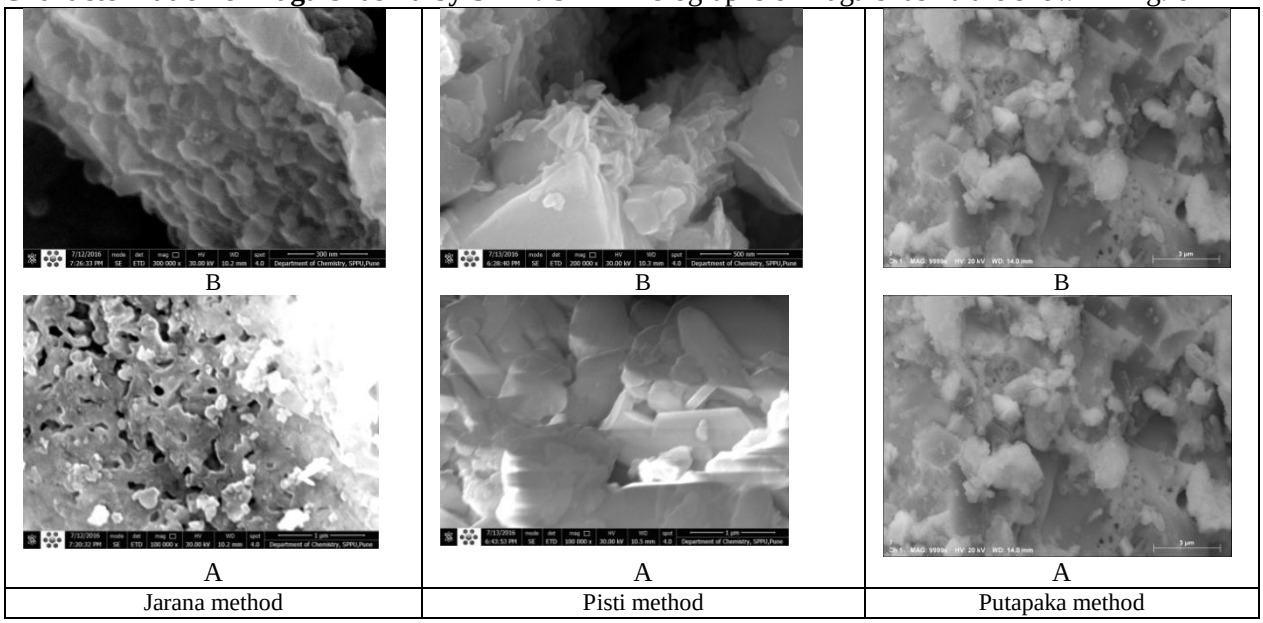


Fig 6: SEM Micrographs of Naga bhasma prepared by various methods
(A: With samanya shodhana B: Without samanya shodhana)

SEM is the technique which reveals the information of external morphology (texture), chemical composition, crystalline structure and orientation of material sample. SEM micrograph reveals the average particle size of bhasma varies from micro to nano meter. Most of the particles are in the range of 50 to 500nm. Few micron size (1 to 2 micron) are also observed. It is seen that nano size particles are clustered on bigger size particles. All particles are irregularly shaped. Particles from jarana method shows polygonal shapes while pisti method shows rod shaped particles. It is also observed that surface area was smooth in bhasma synthesized using samanya shodhana process. Putapaka method shows less crystalline pattern. This is the effect of bhasmikarana due to which relatively microscopic state of powder is transformed into nanometric bhasma state. This is an important finding which is likely to result in an enhancement of medicinal properties of the bhasma. Similar findings were reported by Deshmukh et al. [24]

Characterization of lead bhasma by Energy Dispersive X-Ray Spectroscopy (EDX): EDX spectra of different bhasma are shown in fig.7

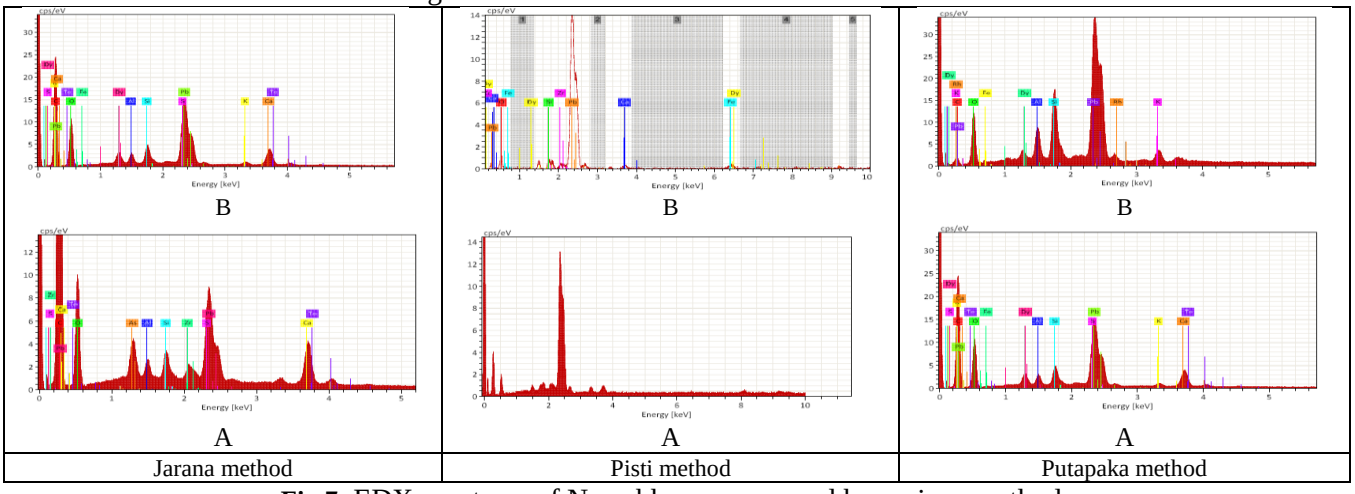


Fig 7: EDX spectrum of Naga bhasma prepared by various methods
(A: With samanya shodhana B: Without samanya shodhana)

An examination of spectra reveals that amount of lead in final product of bhasma is found to be less when samanya shodhana process is used. The presence of elements like Ca, Al, Mg, Si and Fe indicate their incorporation during samanya and Visheshshodhana processes. Presence of elements Ca, Mg and Fe helps in digestion of bhasma. Presence of carbon along with other metals suggests formation of organometallic compound.

APPLICATIONS

The study carried in the present paper can be applied for authentification of commercial bhasma.

CONCLUSIONS

1. XRD pattern shows highly crystalline nature of bhasma with presence of PbS, PbS_2, PbO, Pb_2O_3 and Pb_3O_4.
2. EDX study reveals bhasmas prepared without samanya shodhana process incorporates more elements than bhasmas prepared with samanya shodhana process. Elements like Fe, Ca, and Al along with carbon are also incorporated in it. These elements are required for digestion of bhasma.
3. FTIR study reveals presence of various bonds of different functional group which indicates organo-metallic nature of bhasma.
4. SEM study reveals crystalline nature of bhasma, particle size ranges between 50 nm to 1 µm which clearly indicates formation of nano particles in prepared bhasma.

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