

## **Chemical characterization of incinerated gold (*Swarna Bhasma*)**

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### **ABSTRACT**

*Swarna Bhasma (incinerated gold) is used as a therapeutic medicine from long ago in the Ayurvedic medicinal practice. The numbers of procedures for its preparation were mentioned in the texts of Rasashastra. Bhasma is prepared from the different metals and minerals by its systemic incineration with specific herbals and other relevant media. Along with this, classical texts of Ayurveda Rasashastra (Indian Alchemy) mentioned its therapeutic efficacy depends on its particle size. Lesser the particle size increases its efficacy. However, it is typical mechanical process but its finished product contains different chemical elements. As it is used as a therapeutic agent, its chemical characterization is need of hour. Swarna Bhasma was analyzed by adopting modern scientific tools like XRD, EDS and ICP-OES to determine its major and minor contents. It was revealed that Swarna Bhasma (incinerated gold) contains 52.33 % Au in elemental form. Its particle size ranges in between 1-10  $\mu\text{m}$ .*

**Keywords:** *Swarna Bhasma*, incinerated gold, chemical characterization.

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### **INTRODUCTION**

Centuries ago, gold is used as a medicine in Ayurveda, an Indian system of Medicine. It was utilized in different form like raw gold, purified gold, incinerated gold (*Swarna Bhasma*), gold foils. It was observed that gold having numerous therapeutic values like rejuvenator, aphrodisiac, increases longevity of life etc [1].

Among all of its forms, the physicians of Ayurveda mostly admired incinerated structure. In the different texts of *Rasashastra* (Indian medicinal Alchemy), its different procedures were emphasized. *Bhasma* preparation is unique operative procedure carried out for different metals and minerals. Incinerated metals and minerals are in powder form that contains micron to nano size particles. In this procedure, metals and minerals are converted to therapeutic agent after repeated incineration and grinding with herbals and specified materials. It is completely mechanical process and its quality differs with its finished products particle size. The pharmaceutical procedure of preparation of *Swarna Bhasma* is based on the *Shodhana* (purification) and *Marana* (incineration) concept with relevant herbal media and equipments [2].

*Swarna Bhasma* is used directly as a medicine by physicians in number of disorders [3]. There are some controversies regarding the particle size, its heavy metal content, chemical characterization, and elemental gold content. Here an attempt was made to assess the chemical characterization of incinerated gold.

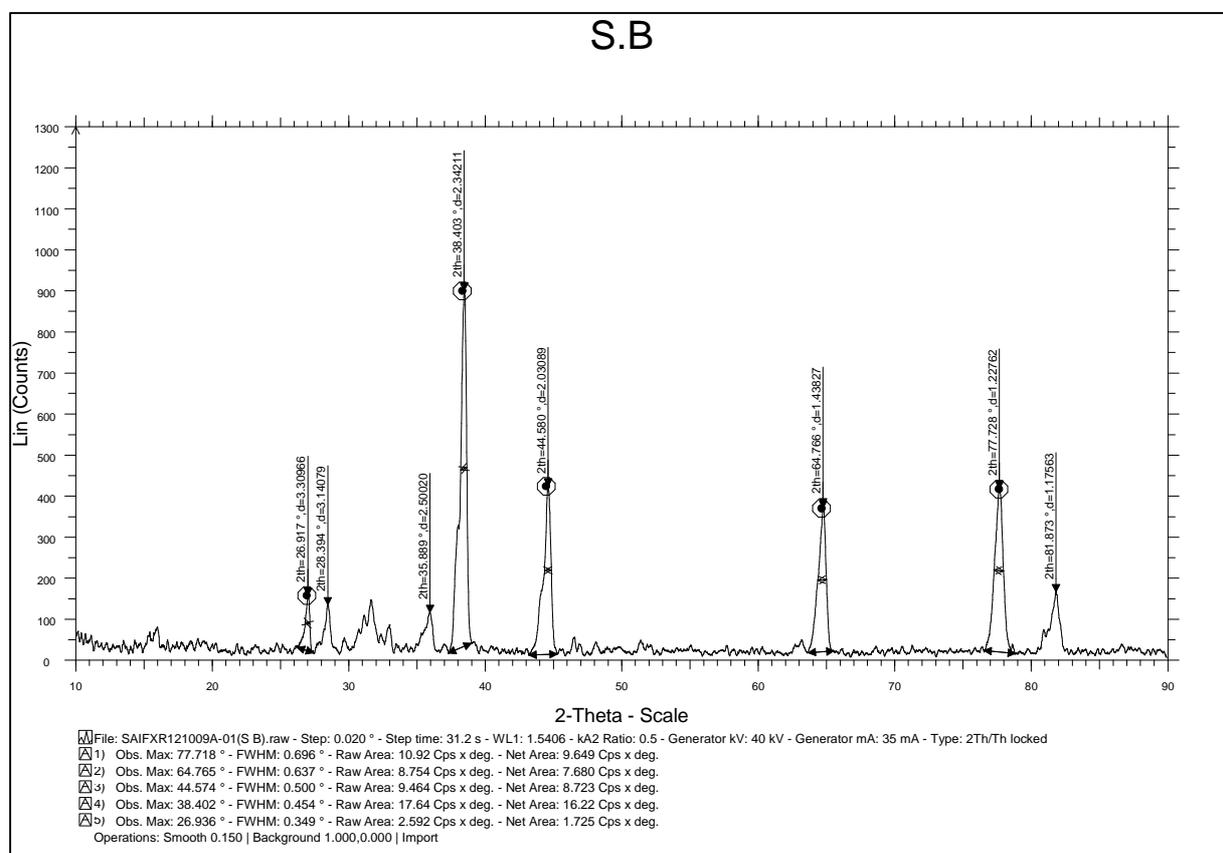
## MATERIALS AND METHODS

*Swarna Bhasma* was prepared in the department of *Rasashastra* and *Bhaishjya Kalpana*, IPGT & RA, Gujarat Ayurved University, Jamnagar. For the purification purpose, procedure of *Sharangdhara* [4,5] was applied and for incineration procedure of *Rasatarangini* [6,7] were followed. Thirty subsequent *Putas* (heating procedure) were applied. The prepared *Swarna Bhasma* was designated as SB. The elemental composition of *Swarna Bhasma* was determined by X- Ray diffraction (XRD), Energy dispersive spectroscopy (EDS) and Inductively Coupled Plasma Atomic Absorption Spectrometry (ICPOES) [8]. It was analyzed in the SAIF, STIC, Cochin University.

## RESULTS

### Characterization by XRD:

The XRD pattern of SB sample reflects gold metal as the major phase. In the pattern, there are few peaks below 2 theta value of 37 degree, out of these one peaks fits with rutile phase of gold metal whereas other peaks or impurity peaks which can be identified after further critical analysis. (Graph 1)



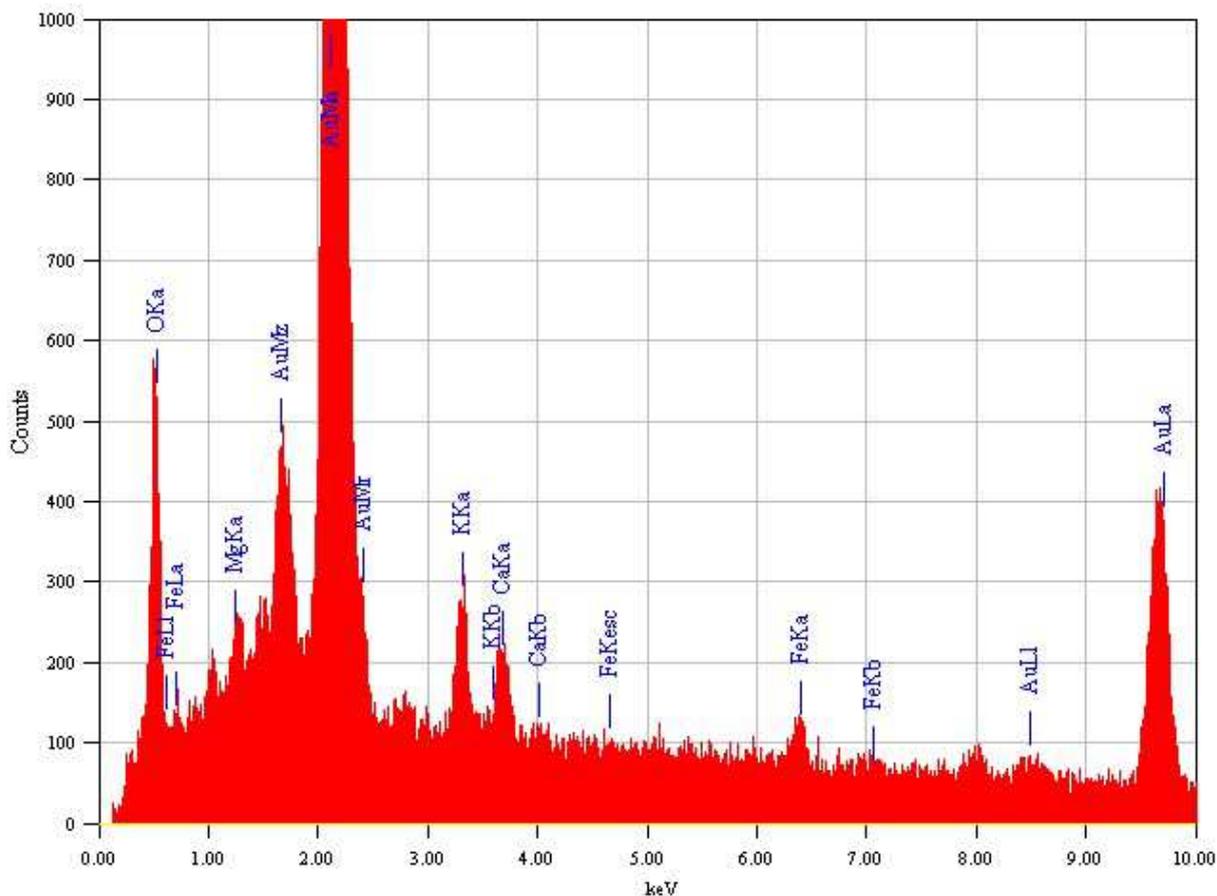
Graph 1: shows peaks of gold in Swarna Bhasma by X-Ray Diffraction Analysis (2-theta-scale)

### Characterization by Energy Dispersive Spectroscopy (EDS):

The major Au metal phase is evident also from the EDS table data provided (Fig 1 d). The element corresponding to peaks are marked in graph and sample is composed of O, Mg, K, Ca, Fe and Au. By calculating the net area of peaks, the atom percentage of the elements is tabulated (Table 1) (Graph 2).

Table 1: Atom percentage of elements present in *Swarna Bhasma* evaluated by EDS

Sr. No.	Element	(keV)	Mass%	Atom%	K
1.	O	0.525	2.62	22.35	0.3096
2.	Mg	1.253	0.33	1.87	0.2245
3.	K	3.312	1.43	4.99	0.3526
4.	Ca	3.69	0.99	3.36	0.371
5.	Fe	6.398	1.11	2.71	0.7289
6.	Au	2.12	93.52	64.73	1
	Total		100	100	

Graph 2 Energy dispersive Spectroscopy of *Swarna Bhasma* Sample**Characterization by ICPOES:**

*Swarna Bhasma* was analyzed by ICPOES for the presence of microelements. It was estimated along with lead, arsenic and copper. Instrument used was calibrated with reference standard 1 ppm. Reference standard identification was CPA Ltd. Bulgaria. Model Optima 3300 RL was used.

Apart from presence of 52.33 % elemental Gold; Arsenic and Mercury were detected in part per million levels in *Swarna Bhasma* samples. Lead and cadmium were below detection limits in *Swarna Bhasma* (Table 2).

Table 2: Element percentage in *Swarna Bhasma* evaluated by ICP-OES

Sr .No.	Element	Unit	<i>Swarna Bhasma</i>	Detection Limit(ppm)
1.	Au	%	52.33	0.01
2.	As	%	0.316	0.05
3.	Hg	%	0.054	0.05
4.	Cd	%	BDL	0.01
5.	Pb	%	BDL	0.05

**Particle Size:**

Spot magnification photographs revealed the particle size of *Swarna Bhasma* was found ranging between 1-10  $\mu\text{m}$ . The images show crystallites are agglomerated in a single particle giving rise to microcrystalline structure with loss of grain boundaries (Fig 1,2,3)

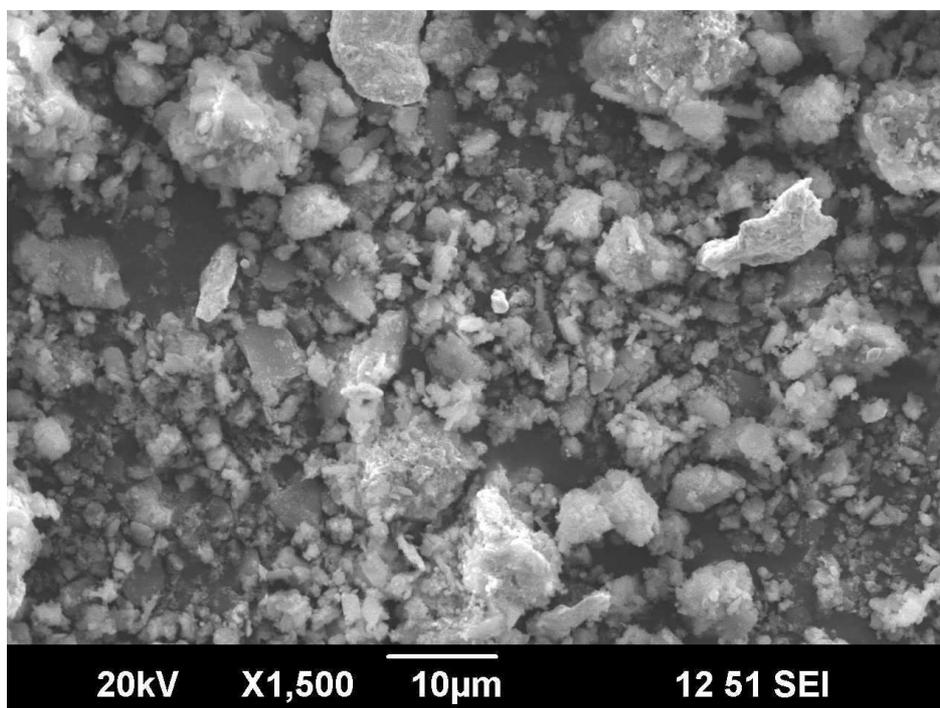


Fig 1 spot magnification photographs of *Swarna Bhasma* (At 1500 resolution) shows particle of microcrystalline structure within range in 10  $\mu\text{m}$

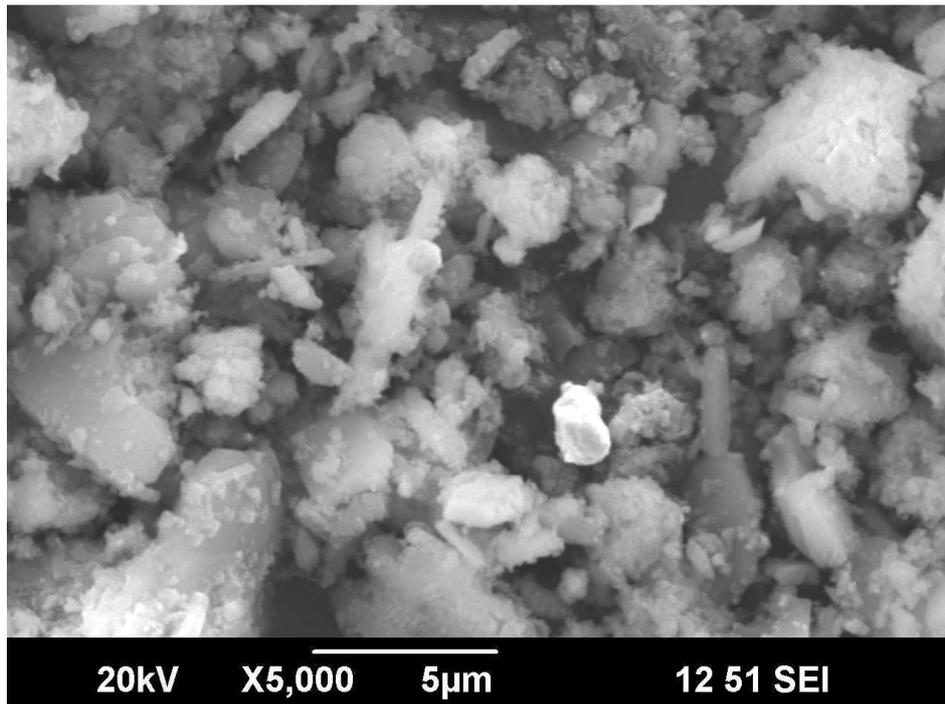


Fig 2 spot magnification photographs of Swarna Bhasma (At 5000 resolution) shows particle of microcrystalline structure within range in 5 µm

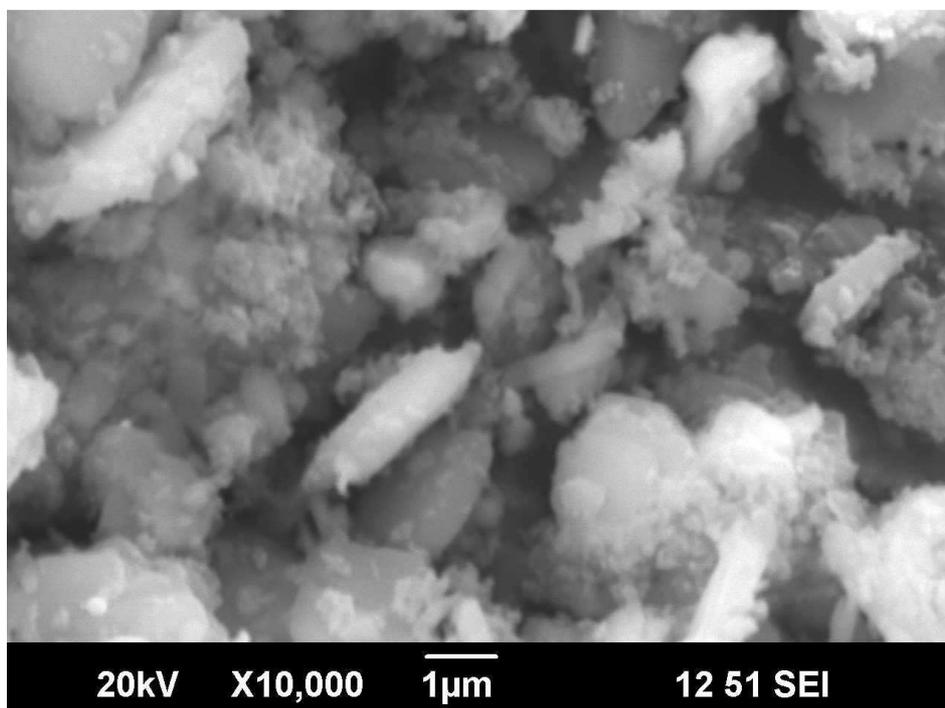


Fig 1 spot magnification photographs of Swarna Bhasma (At 10,000 resolution) shows particle of microcrystalline structure within range in 1 µm

## DISCUSSION

XRD study shows SB composed of gold, oxygen, calcium, magnesium, and potassium and ferrous. Oxygen (22.35%) and Aurum (64.73 %) were found as major atomic constituent. ICPOES study also supports this in which elemental gold was found 52.33%. It may be possible that elemental gold converted into oxidized form and other conjugation that is reflected in value of elemental gold in SB. Previous studies reported that SB contains elemental gold as 66.12 [9], 92.19% [9] and 92% [12] whereas in this study it was found 52.33%. It may be due to adaptation of different standard operative procedures (Table 2). In present study SB was prepared by using thirty subsequent *Putas* (heat treatment). It may caused excess oxidation of gold which directly resulted to least amount of elemental gold. The prime aim of *Rasashastra* is to convert elements in to such a form, which is permeable and therapeutically effective. Oxidation of metal may be one of such procedures. Increased elemental concentration of oxides in finished product might advantageous for therapeutic efficacy of *Swarna Bhasma* [14]. Oxides in SB might be Aurous oxide ( $Au_2O$ ) or Auric Oxide ( $Au_2O_3$ ) or both of them. Later one is more stable.

Color of Bhasma was found brick red. As per the references found in the texts it was observed that when SB is prepared with mercury turns to red color where as when prepared with sulfur and arsenic turns to violet. In present study it was found red colored.

Inductive Coupled Plasma – Optical Emission Spectrometer is an instrument useful for measuring higher concentrations of individual ingredients in a compound formulation. Few amount of mercury was revealed in the ICPOES study. Here in this study SB was prepared by using purified mercury and sulfur as a media. In this procedure, mercury and sulfur is evaporated during heat treatment. In previous it was not detected [12] as in that procedure mercury was added only for first *Putas*. In present study up to fifteen *Putas* purified mercury is added as a media for SB preparation. It might be possible that few amount of mercury was remain inside the SB during procedure and converted in such a compound which is heat stable. So it was detected in finished product. As quoted in the texts of Indian alchemy that incineration of metals prepared by using purified mercury possess better therapeutic efficacy [10]. Some amount of Arsenic was also detected in the SB. In the present study earthen plates were used for the preparation of SB as per the reference. It might be possible that earthen plates may contains some amount of arsenic. Which was actively participated in the chemical reaction between mercury, sulfur and gold in the presence of heat. Finally, it may contaminated to the finished product. Considering these possibilities no any specific cause behind this is known (Table 2). Previous study supports these findings, as it was found reported that *Swarna Bhasma* contains Realger ( $As_2S_2$ ), Lead oxide ( $Pb_3O_4$ ), Pure gold (Au) and Latex of *Calotropis gigantea*. Qualitative analyses indicated that *Swarna Bhasma* contained not only gold but also several microelements like Fe, Al, Cu, Zn, Co, Mg, Ca, As, Pb, etc. [15]

Size of gold particle in SB was found 1-10  $\mu m$  by spot magnification (Fig 1,2,3). Another study claimed presence of gold particle ranges in between 48 o 135  $\mu m$  in one sample and 3 to 6  $\mu m$  in another sample of *Swarna Bhasma* [9] by SEM study. It shows the difference between particle size. It might be possible that variable instruments, variable incineration temperature and time and procedure affect the particle size of end product. In other study Transmission electron microscopy (TEM) shown average particle size of SB was 57 nm. In this study, 40 *Putas* were applied for the preparation and different procedure was advocated. It might be possible that increase in number *Putas* (incineration procedure i.e. heat duration, temperature and grinding) increases the fineness of particles. Along with this, different technique of scanning were applied. In the present study SEM was applied where as in previous study TEM was applied. TEM has up to a 50 million magnification level while SEM only offers 2 million as a maximum level of magnification. It can scan the minute particle size distribution than SEM.

An interesting observation was studied about gold nano-particles that lesser the size of particles increases the absorption through oral route [11,12]. Classical texts of *Rasashastra* also mentioned the importance of particle size. In the contexts of examination of *Bhasma* examinations like *Rekhapurnatva*, *Laghuta*, *Varitaratva*, *Uttama* [13] etc were mentioned for its particle size.

## CONCLUSION

*Swarna Bhasma* (incinerated gold) prepared by adopting traditional methods of preparation of *Ayurvedic Rasashastra* (Indian Alchemy) contains gold (Au) as a major element. Its particle size ranges in between 1-10  $\mu m$  and contains 52.33% elemental gold.

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