Original Research

Pharmaceutical Standardization of *Swarna Bhasma* (Incinerated Gold) by Adopting Traditional Method

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Abstarct

Swarna Bhasma (SB) (incinerated gold) is one of the most potent and popular medicine among all Ayurvedic Medicines. Several procedures of its preparation are mentioned in the classical texts of *Rasashastra*. In the present study *Swarna Bhasma* is prepared and anlysed to develop its standard parameters. Three batches of SB were prepared and analyzed. Its different procedures like *Shodhana* (purification), *Marana* (incineration) were followed as per mentioned in texts. Specialized heating pattern was adopted for the preparation of SB. 18% loss was observed after the completion of thirty subsequent *Putas* (heating procedure). As a result, finished product contains 52.33 % elemental gold.

Keyword: Swarna Bhasma, Incinerated gold.

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Introduction

Rasashastra (Indian traditional alchemy) is mother of number of potent and therapeutically active medicines. *Swarna Bhasma* (incinerated gold) (SB) is one of them. Classical text of Ayurveda mentioned number of disorders would be cured by SB and increase longtivity of life [1]. *Charaka* also quoted its property against poisoning[2] and for the purpose of *Pusanvahan Vidhi* [3]. *In the context of Swarna Prashana Sanskara* to neonates Kashyapa narrated its action for increase immunity of neonates.

Uses of SB is mentioned in many disorders like, *Kshaya* (~Tuberculosis)[4], memory, rejunuvator[5], cures all diseases, suicidal tendencies, increases blood circulation in brain, osteoporosis, syphilis, sprue, anemia[6]. Its therapeutic properties well assessed by the some scholars[7,8] like analgesic[9] anticataleptic, anti anxiety and antidepressant[10], antioxidant[11], augmenting effect[12]. Recent studies of gold nanoparticles observed its antiangiogenic properties[13-14]anti cancer property[15] showed encouraging results. Blood compatibility studies of Swarna Bhasma[16].are also done. Quantity of gold was observed in semen of healthy fertile men[17-18]. Its role on a *normozoospermia*[19] male infertility[20]oligoazospermia[21] was found having significant results. Safety, toxicity and efficacy studies of Swarna Prashana which contains incinerated gold as an ingredient found nontoxic and safe having specific role in immunity[22-23].

That is the reason of wide range of formulations of gold mentioned in Ayurveda in various dosage forms. About 700 formulations of gold have been mentioned in classical texts of Ayurveda where gold in different forms is used. Out of which 544 are *Rasa Yogas*, 10 are *Parpati*, 21 are *Pottali*, 4 are in powder *Yoga*, 58 are in *Vati* form and rest are in various dosage forms namely *Taila*, *Lepa*, *Drava*, *Pishti* and *Kshara*. Among all 42 gold containing formulations mentioned in AFI[24], 33 are *Rasa Yogas*, 3 each are *Kupipakva* and *Lauha*, 1 each is *Parpati*, *Asava* and *Bhasma*. There are 157 formulations of gold in Bhaishajya Ratnavali.

It was observed that incinerated gold is used directly as a medicine so sages concentrated more on the purification

and incineration of gold. By using different metals and minerals with herbal juices, numbers of procedures were mentioned in the classical texts for its incineration. Likely, its *Shodhana* (purification) was found in two types i.e. *Samanya* (general) and *Vishesh* (Specific)[25]. *Ayurvedic* drug purification not only detoxifies the material but also enhances its therapeutic efficacy too[26]. Gold is a worldwide-accepted noble metal. Here an attempt is made to validate parameters for standard manufacturing procedure of incineration *(Swarna Bhasma Nirmana)* of gold.

Materials and Methods

Cinnabar (*Hingula*), sulfur (*Gandhaka*), Cow ghee (*Goghruta*), Sesame oil (*Til taila*) and *Dolichos biflorus* Linn (*Kulatha*) were obtained from pharmacy of Gujarat *Ayurved* University, Jamnagar. 24 Carat pure gold (*Swarna*) was collected from local authenticated hallmark certified jeweler of Jamnagar. *Citrus medica* Linn (*Nimbu*) and Cow Milk (*Godugdha*) were procured from local market of Jamnagar. Cow urine (*Gomutra*) was collected from local cowshed of Jamnagar. Bark of *Kanchanra* (*Bauhinia variegate*) was collected from herbal garden of Gujarat Ayurved University, Jamnagar. All the herbal medicinal plants were identified and authenticated in the pharmacognosy lab of the Institute.

Process Validation of *Swarna Samnya Shodhana* (General purification of gold)

Gold flakes were prepared from gold biscuits under the compression machine (fig 1). General purification (*Samanya Shodhana*) of gold was done as per the text (fig 2)[27]. The gold flakes were heated on gas blower and then dipped in to prescribed liquid media for thrice. Small pieces of purified gold flakes were prepared by scissor (fig 3).

Process Validation of *Gandhaka Shodhana* (purification of sulfur)

Sulfur was purified[28] by melting along with cow ghee and pouring in cow milk. It was heated (*Swedana*) in same for three hours. After completion, it was washed with hot water for seven times, dried and stored in glass bottle.

Process Validation of procurement of mercury (*Parada*) from cinnabar (*Hingulotha Parada Nirman*)

For the purification of cinnabar (*Hingula*), it was levigated with juice of *citrus medica* Linn. Process was repeated for three times. It was washed and dried and collected in glass Jar[29]. Required amount of mercury was extracted from the cinnabar by *Naad Yantra* Method[30].

Process Validation of *Swarna Bhasma* (incinerated gold)

Accurately weighing 100 g pieces of purified gold were added with 100 g purified mercury and triturated in granite mortar and pestle (fig 4). Juice of *citrus medica* Linn was added to mixture and grinded. Process was continued until semisolid, soft mass (amalgam of gold) amalgam preparation (fig 5). 100 g purified sulfur (fig 6) was blended with amalgam of gold and triturated in mortar and pestle. After entire procedure black, smooth homogeneous mass (*Kajjali*) was prepared. Mixture was milled with decoction of bark of *Bauhinia variegate (Kanchanara Twaka Kwatha)* (Table 1) for three hours. Flat circular pellets (*Chakrika*) of levigated material were prepared and shade dried (fig 7). Dried pellets were placed inside an earthen plate (*Sharava*). Pot of earthen plate (*Sharava Samputa*) (fig 8) was prepared by placing another earthen plate over earthen plate containing the pellets. Pot was sealed wit1h mud of soil and cotton cloth, dried under Sunlight [31].

For first *Puta* (heating device) *Kapota Puta*[32] was prepared by using 8 cow dung cakes (wt 1300 gms). Dried earthen pot was placed in between cow dung cakes. Heating device was ignited (fig 9). Its temperature was noted with help of pyrometer. After self- cooling, the earthen pot was taken out and pellets were collected. The pellets were again grinded to prepare powder.

For next *Puta* purified mercury was reduced in 1/16th of

the original quantity (i.e. reduced 6 gm from 100gm) acquired for first *Puta* and purified sulfur was took in equal quantity of first *Puta* i.e. 100 g [33]. The whole mixture was grinded to obtain uniform soft mixture. Decoction of *Bauhinia variegate* was added to this mixture and trituration was performed until the mixture became soft. Pellets were prepared and subjected to heating process. Number of cow dung cakes was increased as per the necessity which will be discussed in discussion. Likewise, similar cycles were followed for all consecutive *Putas*. After sixteen *Puta's* purified mercury was not added to mass only equal quantity of purified sulfur was added to mixture and triturated with decoction of *Bauhinia variegate*. It is discussed in discussion part. The prepared soft material was subjected for *Puta* procedure. Details of consecutive *Putas* described in table (Table 2).

Analysis of Finished product

Spectrometry by Inductive Coupled Plasma – Optical Emission Spectrometer (ICPOES) and X-ray Diffraction (XRD) were carried outr for the finished product (SB).

Observations and Results

Brightness of gold flakes was increased after completion of general purification. Weight of gold flakes neither decreased nor increased during the procedure.

For first *Puta* procedure, amalgam was prepared by trituration of purified gold and mercury. Total eight hours required for the proper amalgamation. Thin black layer was found over the amalgam after completion of procedure. Shining of amalgam was increased after washing with juice of *citrus medica* Linn. After addition of purified sulfur to amalgam and trituraion color of mixture was changed from yellowish. Total eighteen hours required for completion of procedure. For the levigation of this mixture; 75 ml decoction of *Bauhinia variegate* was added. Three hours was required for the completion of levigation.

Eight cow dung cakes were used for the *Kapota Puta* preparation. It were weighing 1300 g. After ignition of heating device, highest temperature was recorded 880^0C, and it was above 750^0C for 5 min. after which it reduced gradually. During the heating procedure pungent smell of Sulfur vapors' and bluish colored flames were observed. Following self-cooling of heating device mud smeared cotton cloth was removed from the earthen plates. Shape of pellets was found broken after Puta and material was found in powder form in lower earthen plate. The powdered material was collected neatly and used for the further procedures.

For the second Puta powdered material (remaining of first Puta) was not amalgamated with purified mercury after eight hours trituration. So purified sulfur was added directly to it and process continued further. As per the requirement of procedure quantity of decoction, cow dung cakes, trituration hours were increased or decreased (Table 2). It is to be discussed later on. After completion of thirty subsequent *Putas* brick red colored, smooth incinerated gold (Swarna Bhasma) was prepared (fig 15). SB has passed *Bhasma Pariksha* (examinations) like *Varitartva*, *Rekhapurnatva* and *Varna* as mentioned in classical texts. Total 82 g of incinerated gold was observed after the completion of procedure (Table 4).

Same procedure was repeated for remaining two other batches. Average 17.66 % loss was observed in the finished product of all three batches. Average Highest temperature was observed for the last Puta was 992^0 and maintained over 750^0 for 29 min (Table 3) (Graph 1 and 2).

Spot magnification photographs revealed the particle size of incinerated gold ranging between 1-10 ìm. XRD pattern of SB sample reflects gold element as the major phase. The element corresponding to peaks are marked in graph and sample is composed of O, Mg, K, Ca, Fe and Au calculated by EDS (Table 5), (Graph 3 and 4). ICPOES (Inductive Coupled Plasma – Optical Emission Spectrometer) revealed that apart from presence of 52.33 %Gold; Arsenic and Mercury were detected in part per million levels in incinerated gold samples (Table 6). Lead

and cadmium were below detection limits in incinerated gold.

Discussion

As per the reference of *Swarna Bhasma* preparation[34]; it was mentioned that tiriturate purified mercury and gold upto amalgam preparation. Then this amalgam is to be kept in earthen plate containing half quantity of purified sulfur which is covered by another half quantity of sulfur. *Sharava Samputa* is to be prepared and then subjected to heat. Total 16 *Putas* was described. After each *Puta* quantity of mercury is told to reduce by 1/16th from quantity of initial first *Puta* and purified sulfur was described in equal quantity of purified gold up to last puta. According to this procedure in pilot study an sample was prepared but it was observed that the prepared *Bhasma* was not completing the tests prescribed in the texts like lusterless, smooth and fineness etc. So to improvise it here this method is modified for better results. In this modified method first amalgam was prepared then purified sulfur was added and *Kajjali* was prepared followed by levigation of decoction of *Bahuina verigate*[35]. Pellets was prepared from this material and then dried in Sun. These pellets then kept in earthen plates followed by *Kapota Puta* of eight cow dung cakes. This procedure was repeated 30 times up to *Bhasma* preparation. After each *Puta* mercury was reduced by 1/16th from quantity of initial first *Puta* up to 16 *Putas*. Purified sulfur was obtained in equal quantity of gold up to last *Puta*. *Kajjali* was prepared as it binds the molecules with each other in compact manner which increases the time of interaction between gold, mercury and sulfur when subjected for *Puta*. Levigation by decoction of *Bauhinia variegate* was given because it binds the molecules properly and minimizes the loss during trituration. Furthermore adds some new properties to the former compound. It is also supported by classical reference. After the first *Puta* it is observed that pellets got insufficient amount of heat to evaporate unwanted mercury and sulfur. Due to this, there was increase in unwanted weight of material. Therefore, for proper sublimation of mercury and sulfur number of cow dung cakes were increased after each *Puta*.

For the preparation of SB *Kapota Puta*[36] as heating device was mentioned by texts of *Rasashastra*. Eight number of cow dung cakes are required for its preparation. However, it was obsereved that the quantity is insufficient for the preparation of SB. As described earlier the mixture prepared for the *Puta* contains gold and mercury sulfide. It is necessary to evaporate the unwanted mercury sulfide by heating. After completion of first *Puta* the observed weight of finished product was 250 g whereas before ignition of *Puta* weight of material was 310 g. it was showing that incomplete evaporation of mercury sulfide. It was concluded that heat provided for the procedure is insufficient. By considering this for the next *Puta* number of cow dung cakes were increased. Increase in duration of heat increased the evaporation of unwanted materials in later procedures.

Subsequent to completion of first *Puta* it was monitored that incinerated gold was not easily amalgamated with the mercury through second *Puta* procedure. It might be due to oxides of gold prepared during the procedure, which are incompatible for the process of amalgamation. During the procedure of first milling of sulfur with amalgam of gold, it was easily converted to the black homogenate mass. Nevertheless, after first *Puta* it took more time and colored dull too. It would be happened due to decreased quantity of mercury in succeeding *Putas* and increased incineration of gold excessively.

SB passed *Varitaratva*[37] (Sprinkled particles of *Bhasma* floats over water) test of *Bhasma* after completion of seventeenth *Puta*. It shows that expected weightlessness of *Bhasma* was achieved. It was continued until last *Puta*. In earlier *Putas* after heat treatment, pellets were hard and required efforts and pressure to break it for powdering. It might be possible due to incomplete combustion caused by inappropriate heat duration. After fifteenth *Putas* pellets were softened and easily crushed. It shows that *Puta* procedure gets the required amount heat after fifteenth *Puta*.

Classical texts of *Rasashastra* mentioned that SB having color like *Kumkuma Varna* (Brick red) [38]. This color was achieved to *Bhasma* after sixteenth *Puta*. Later on shade of *Bhasma* turns to lighter after each subsequent *Puta*. In earlier *Putas* color of mixture after *Puta* was found darkened and dark red. It may be possible due incomplete heat as discussed earlier.

Nischantdratava[39] i.e. lusterless is one of the test was mentioned in the texts for the examination of *Bhasma's*. It was observed that in the earlier procedures large particles of gold were shined in the mixture after *Putas*. As per the reference, it was revealed that after sixteen consecutive *Putas Bhasma* should be prepared. Nevertheless, here in this study it was not observed as like. After sixteen *Putas* it was found that shining of gold particle was remain present by naked eye examination. To achieve its successful preparation it was decided to continue further until its lusterless examination. In this regard, it was decided to add equal amount of sulfur to gold and levigate it with decoction of *Bahuina Verigate*. During this procedure it was scrutinized that shining of gold particles was reduced after later on up to twenty six *Putas*. After twenty-six *Putas* few gold particles were remain present inside the *Bhasma* that were never reduced until thirty *Putas* by magnifying glass examination. At this point it was decided to finish up the procedure. it was revealed that shining of gold particles will be reduced up to some extent but not completely. The same observation was monitored in all three batches of SB.

Rekhapurnatva[40] test of *Bhasma* furthermore described in the texts for the examination of *Bhasmas*. In the contexts of present study it was observed after thirteen *Putas*. From the first successive *Puta, Bhasma* was established smooth but the complete *Rekhapurnatva* was not achieved. Smoothness of *Bhasma* was observed more after the sixteen *Putas*. In addition to this volume of *Bhasma* was also increased after the same. It might be possible that presence of mercury increases the binding of gold molecules and hardens its particles.

For the first *Puta* 8 cow dung cakes were used. The highest temperature was recorded 880^0C and maintained over 750^0C for 5 minutes only. It was observed that increase in cow dung cakes increased the temperature as well as its maintaining time over 750^0C. in all three batches of Bhasma it was observe that after tenth *Puta* weight of mixture was gradually decreased and the examinations of *Bhasma* were passed by the mixture after fifteenth *Puta*. It means for the proper combustion or incineration of material ample amount of heat required.

Presence of mercury, Arsenic, lead and cadmium in finished product was again a question. As described earlier mercury was not added to the process after sixteen Putas. Afterward fourteen times material was heated without mercury. It might be possible that some permanent alloys of mercury and gold were prepared and continued until end up of procedure. But the reason is unknown. Presence of arsenic, lead, and cadmium may be due to earthen pot used for the procedure. It may possible that soil from which earthen pot is prepared contains some amount of arsenic, lead, and cadmium. According to amalgamation, property of mercury it might be taken part in chemical reaction happened in presence of mercury and sulfur during the heating procedure. After sublimation of mercury and sulfur lead, arsenic and cadmium may not be sublimed due to insufficient heat and further alloyed with gold. The reason behind incorporation of these heavy metals to SB is unknown.

ICPOES (Inductive Coupled Plasma – Optical Emission Spectrometer) revealed that SB contains 52.33 % presence elemental gold. It was well supported by previous study[41].

Conclusion

Quantity of fuel mentioned in the classical text for the incineration of gold should be increased as per the necessity. For the proper incineration of gold it requires thirty subsequent *Putas* (Heating procedures). 52.33 % presence elemental gold was found in *Swarna Bhasma*.

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Table - 1 : Showing ingredients used in incineration of gold

Sr.No.	Ingredient	Wt for 1 batch	For 3 batches
1	Purified gold	100 g	300 g
2	Mercury procured from cinnabar	844 g	2532 g
3	Purified sulfur	2900 g	8700 g
4	Juice of *citrus medica*	320 ml	960 ml
5	Decoction of *Bauhinia variegate*	1925 ml	5775ml

Table - 2 : showing the observations during preparation of incineration of gold SB- 1,2,3(Mean)

Sr.No.	Wt of gold and gold containing mixture g	Wt of Purified mercury g	Wt of Purified sulfur g	Quantity of Levigation liquid (ml)	Period of trituration (h)	No. of Pellets	Wt. of Pellets after drying g	Wt of Pellets after Puta (g)
1	100	100	100	75	18	32	310	250
2	250	94	100	100	18	36	452	180
3	180	88	100	100	18	38	398	142
4	142	82	100	75	18	36	332	130
5	130	76	100	75	18	32	314	128
6	128	70	100	75	18	35	306	124
7	124	64	100	75	18	36	297	124
8	122	58	100	75	18	30	288	122
9	121	52	100	75	18	29	276	121
10	119	46	100	75	18	28	270	119
11	115	40	100	75	18	26	252	115
12	113	34	100	75	18	27	248	113
13	109	28	100	75	18	28	237	109
14	105	22	100	75	18	25	232	105
15	101	16	100	75	18	26	230	101
16	98	10	100	75	18	24	225	98
17	96	—-	100	50	4	27	206	96
18	95	—-	100	50	4	25	198	95
19	93	—-	100	50	4	22	199	93
20	92	—-	100	50	4	21	198	92
21	89	—-	100	50	4	21	201	89
22	87	——	100	50	4	21	197	87
23	84	—-	100	50	4	21	195	84
24	84	——	100	50	4	21	190	84
25	85	—-	100	50	4	21	192	85
26	85	—-	100	50	4	21	189	85
27	85	—-	100	50	4	21	192	85
28	85	—-	100	50	4	22	190	84
29	84	—-	100	50	4	21	193	83
30	83	—-	—-	25	4	12	85	82

Table - 3 : showing the observations of Temperature pattern during preparation of incineration of gold SB-1,2,3 (Mean)

No. of subsequent Puta	No of cow dung cakes	Wt of cow dung cakes g	Highest temperature record (^{0}C)	Highest temperature duration above 750^{0}C
1	8	1300	880	5
2	10	1410	896	5
3	12	1520	902	7
4	14	1618	912	7
5	16	1720	925	8
6	16	1732	926	7
7	18	1840	932	7
8	18	1838	931	8
9	20	1920	942	9
10	20	1946	944	8
11	22	2083	956	10
12	22	2060	950	9
13	24	2120	962	11
14	24	2158	960	12
15	26	2216	964	12
16	26	2236	966	13
17	28	2386	970	14
18	28	2310	968	13
19	30	2570	972	15
20	30	2512	973	20
21	30	2560	972	21
22	30	2510	974	19
23	30	2538	971	19
24	30	2516	972	20
25	30	2580	972	20
26	30	2562	972	21
27	40	3060	986	26
28	40	3010	983	27
29	50	3740	994	30
30	50	3726	992	29

Table 4 : Results of incinerated gold (*Swarna Bhasma*)

Batch no	Wt. of purified gold g	Wt. of incinerated gold g	% of incinerated gold	Loss of gold g	% of loss
SM 1	100	82	82	18	18
SM 2	100	83	83	17	17
SM 3	100	82	82	18	18
Avg.	100	82.33	82.33	17.66	17.66

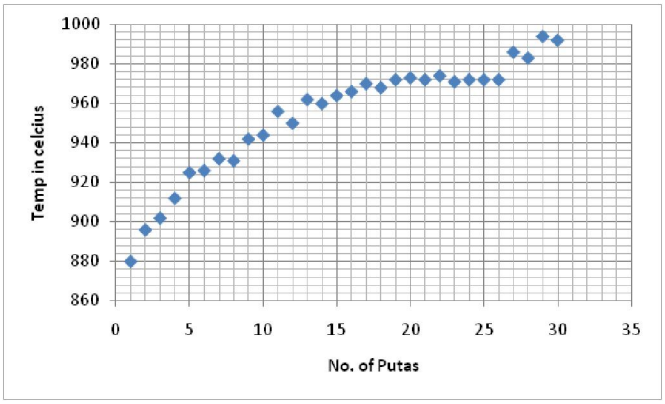
Table 5 : Atom percentage of elements present in *Swarna Bhasma* by EDS

Element	(keV)	Mass%	Atom%	K
O	0.525	2.62	22.35	0.3096
Mg	1.253	0.33	1.87	0.2245
K	3.312	1.43	4.99	0.3526
Ca	3.69	0.99	3.36	0.371
Fe	6.398	1.11	2.71	0.7289
Au	2.12	93.52	64.73	1
Total		100	100	

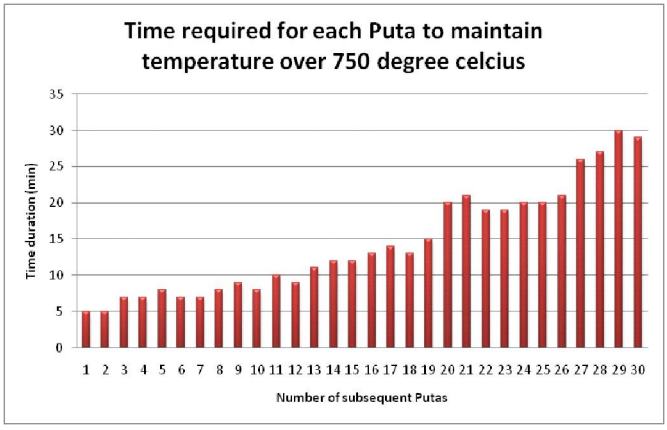
Table 6: Element percentage in *Swarna Bhasma* evaluated by ICP-OES

Sr.No.	Element	Unit	*Swarna Bhasma*	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

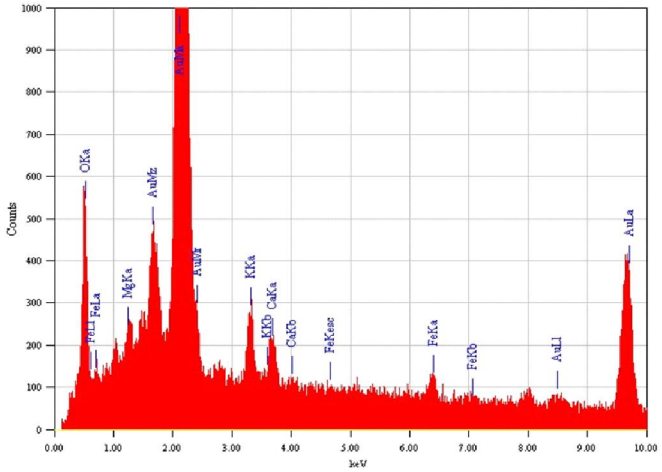
Graph 1 Temperature pattern for Swarna Bhasma (Mean).



Graph 2 Time required for each Puta to maintain temperature over 750 degree celcius for Swarna Bhasma (Mean).



Graph 3 EDAX pattern of Swarna Bhasma



Graph 4: shows peaks of gold in Swarna Bhasma by X-Ray Diffraction Analysis (2-theta-scale)