



**International Journal of Biology, Pharmacy  
and Allied Sciences (IJBPAS)**

*'A Bridge Between Laboratory and Reader'*

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**PHARMACEUTICAL AND ANALYTICAL STUDY OF SWARNA  
MAKSHIKA BHASMA PREPARED BY USING TWO DIFFERENT  
SHODHANA METHODS**

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Received 15<sup>th</sup> Oct. 2024; Revised 5<sup>th</sup> Dec. 2024; Accepted 3<sup>rd</sup> Feb. 2025; Available online 1<sup>st</sup> Feb. 2026

<https://doi.org/10.31032/IJBPAS/2026/15.2.9816>

**ABSTRACT**

**Background:** *Swarna Makshika* (Copper Pyrite) is one of the widely used mineral in Ayurvedic Pharmaceutics. The *Bhasma* prepared from *Swarna Makshika* has been used in many disorders by various *Acharyas* since ancient times. The aim of present study was to prepare *Swarna Makshika Bhasma* (SMB) by using two different methods of *Shodhana* and compare these two varieties of *Bhasma* using analytical parameters.

**Objectives:**

1. To Prepare *Swarna Makshika Bhasma* by using two different methods for *Shodhana* as mentioned in *Rasaratnasamucchaya*.
2. Physicochemical and instrumental analysis of both samples of *Swarna Makshika Bhasma*.

**Methodology:** One sample of powdered raw *Swarna Makshika* was roasted in iron pan using *Erand Taila* (Castor oil) to prepare *Shodhita Swarna Makshika* (SSM1) and another sample was treated with *Matulunga Swarasa* (Citrus Medica Juice) to prepare *Shodhita Swarna Makshika* (SSM2). Both the samples SSM1 and SSM2 were subjected to same *Marana* procedure i.e. *Marana* with *Gandhaka* (Sulphur) using *Varaha Puta* to prepare *Swarna Makshika Bhasma* 1 (SMB1) and 2 (SMB2) respectively. The temperature profile of *Varaha Puta* was mapped with Muffle furnace before the *Marana* Procedure. Both the varieties SMB1

and SMB2 were analysed using traditional tests for *Bhasma* and other analytical tests viz. physicochemical tests, XRD, SEM-EDX.

**Results:** SEM study showed considerable reduction in the particle size while EDX showed reduction in the Wt% of sulphur and increase in the Wt% of oxygen in both samples. XRD studies of SMB1 shows partial chemical decomposition of  $\text{CuFeS}_2$  into  $\text{Fe}_2\text{O}_3$  and  $\text{Cu}_2\text{O}$  while SMB2 shows the complete chemical decomposition of  $\text{CuFeS}_2$  into  $\text{Fe}_2\text{O}_3$ ,  $\text{Cu}_2\text{S}$  and  $\text{Cu}_2\text{O}$ .

**Conclusion:** The results obtained revealed that SMB2 shows complete physico-chemical transformation and can be clinically better than SMB1

**Keywords:** *Swarna Makshika*; Chalcopyrite; SEM-EDX, XRD

## 1. INTRODUCTION

*Swarna Makshika* is one of the important minerals mentioned in *Rasashastra* under the category of *Maharasa*. It has a wide range of therapeutic value which makes it one of the favourite medicines among Ayurveda Practitioners. *Swarna Makshika Bhasma* has been used in *Pandu*, *Raktapitta*, *Arsha*, *Shotha*, *Kasa*, *Prameha*, *Mutraroga* etc. [1-3] since the era of Acharya Charaka. There are plenty of methods (eg. *Shodhana*, *Marana*) to prepare *Swarna Makshika Bhasma*. These different methods for the preparation of *Bhasma* are responsible for the variations in the physicochemical and therapeutic properties of *Swarna Makshika Bhasma*. The pharmaceutical study was planned to prepare the *Swarna Makshika Bhasma* by using two different *Shodhana* methods as mentioned in *Rasaratna samuchchaya* [4]. After *Shodhana*, the *Marana* of both samples was done with the help of *Gandhaka* (Sulphur) in *Varaha Puta* as per the reference of *Rasaratna samuchchaya* [5]. The temperature profile in

Electric muffle furnace for *Varaha Puta* was set according to AFI [6] and P.M.Y.S. Pathiraja *et al* [7]. The results were analysed with modern tools like physicochemical analysis, XRD and SEM-EDX.

## 2. MATERIALS AND METHODS

The Materials and methods can be divided into two sections –

### 2.1 Pharmaceutical Study

#### 2.2 Analytical study

### 2.1 Pharmaceutical study –

- a) Materials – i) Raw *Swarna Makshika* – 300 gm ii) *Erand Taila* (Castor Oil) iii) *Matulunga* (Juice of Citrus Medica fruit) iv) Instruments and equipment viz. Gas stove, lighter, Iron *tava*, spatula, pyrometer, thermometer, weighing Machine, Electric muffle furnace
- b) Methods –
  - i. *Shodhana* of *Swarna Makshika* with roasting in *Erand Taila* (Castor oil) to prepare Sample 1 (SSM1)

- ii. *Shodhana* of *Swarna Makshika* with roasting in *Matulunga Swarasa* to prepare Sample 2 (SSM2)
- iii. *Marana* of *Shodhita Swarna Makshika* (SSM1 and SSM2) – *Shodhita Swarna Makshika* was mixed with equal quantity of *Shodhita Gandhaka* (Sulphur) and pellets were prepared by levigating it with *Matulunga Swarasa*. These pellets were dried in shadow. Then the pellets were kept in the *Sharava* (earthen saucer) and closed with another *Sharava* to form *Sharava samputa* which was then subjected to Muffle furnace for *Putana Samaskara*. The quantity of *Shodhita Gandhaka* (Sulphur) mixed in *Shodhita Swarna Makshika* is reduced from equal quantity to half quantity,  $\frac{1}{4}$ <sup>th</sup> quantity in subsequent *Putana* upto 3<sup>rd</sup> *Putana*. No *Shodhita Gandhaka* added from the fourth *Putana*. The procedure of *Putana Samaskara* was repeated separately several times for both samples till acceptable quality of *Swarna Makshika Bhasma* is obtained.

## 2.2 Analytical Study –

Table 1: Observations during the preparation of *Swarna Makshika Bhasma*

Sample	Weight	No. of <i>Bharjana</i> required during <i>Shodhna</i>	Total wt. of <i>Shodhita Gandhaka</i> required for <i>Marana</i>	No. of <i>Putana</i> Required
Raw <i>Swarna Makshika</i>	150 gm for each sample	-	-	-
SSM 1	125.5 gm	5	-	6
SSM 2	122.5 gm	4	-	7
SMB 1	77.71 gm	-	205.25 gm	-
SMB 2	71.21 gm	-	197.7 gm	-

The Analytical study is divided into three sections –

a) Classical tests for analysis of *Bhasma* (*Bhasma Pariksha*) -

Various classical analytical tests mentioned by *Rasashastra* scholars for qualitative analysis of *Bhasma* viz. *Varitaratva*, *Rekhaipoornatva*, *Nischandratva*, *Nirutthatva*, *Apunarbhavatva*, *Niswadutvam*, *Amla Pariksha*, *Uttam*, *Dantagrekachkachabhawam*, *Avami* were conducted.

b) Physicochemical Analysis –

The Physicochemical tests like Moisture content (LOD), Total ash, Acid insoluble ash, Water soluble ash, Specific gravity, pH were conducted in reputed lab.

c) Advance Analytical tests –

Advanced modern analytical tests like SEM-EDX and XRD for qualitative and quantitative analysis of *Bhasma* were conducted in the reputed analytical lab.

## 3. OBSERVATION & RESULTS

The observations during the pharmaceutical study are as follows –

### 1. General Observations –

Table 2: Percentage of loss of weight in different samples after procedures

Sample	% of weight loss
SSM1	16.34 %
SSM2	18.34 %
SMB1	38%
SMB2	42%



Figure 1: Diff. stages during preparation of SMB1 & SMB2 in Pharmaceutical Study

Observation and results during Analytical study are as follows –

Table 3: Classical Bhasma Pariksha

Bhasma Pariksha	Observations	SMB 1	SMB 2
<i>Varitaratva,</i>	Positive after Puta	Puta 6	Puta 6
<i>Rekha poornatva</i>		Puta 5	Puta 5
<i>Nischandratva,</i>		Puta 5	Puta 5
<i>Nirutthatva</i>		Puta 6	Puta 7
<i>Apunarbhavatva</i>		Puta 6	Puta 7
<i>Niswadutvam</i>		Puta 5	Puta 5
<i>Utam</i>		Puta 6	Puta 7
<i>Dantagrekachkachabhawam</i>		Puta 6	Puta 7
<i>Avami</i>		Puta 6	Puta 6
<i>Amla</i>	Negative after Puta	Puta 5	Puta 7



Figure 2: Classical Bhasma Pariksha

Table 4: Physico-chemical Analysis

Analytical Tests	Raw Swarna Makshika	SMB 1	SMB 2
Moisture content (LOD)	1.14%	1.18%	0.93%
Total ash	74.8%	94.55%	96.72%
Acid insoluble ash	24.5%	21.33%	22.%
Water soluble ash	6.7%	6.90%	4.36%
Specific gravity	3.4	2.37	2.14
pH	5.8	6.3	5.78

Table 5: Advance Analytical Tests (XRD)

Position ( <sup>o</sup> 2 Thita)	d-spacing	Rel. intensity (%)	Compound
<b>Raw Swarna Makshika</b>			
29.7449	3.03456	100.00	CuFeS <sub>2</sub>
49.5468	1.83491	25.24	CuFeS <sub>2</sub>
58.3072	1.57905	75.52	CuFeS <sub>2</sub>
<b>SMB 1</b>			
25.5303	3.48911	39.99	Cu <sub>2</sub> O
33.2014	2.69305	100.00	Fe <sub>2</sub> O <sub>3</sub>
35.6163	2.51329	75.32	Fe <sub>2</sub> O <sub>3</sub>
54.3977	1.69241	38.16	CuFeS <sub>2</sub>
<b>SMB 2</b>			
33.2053	2.69495	89.24	Fe <sub>2</sub> O <sub>3</sub>
35.7026	2.51490	100.00	Fe <sub>2</sub> O <sub>3</sub>
48.1922	1.98938	27.06	Cu <sub>2</sub> S
53.9791	1.77566	32.56	Cu <sub>2</sub> O

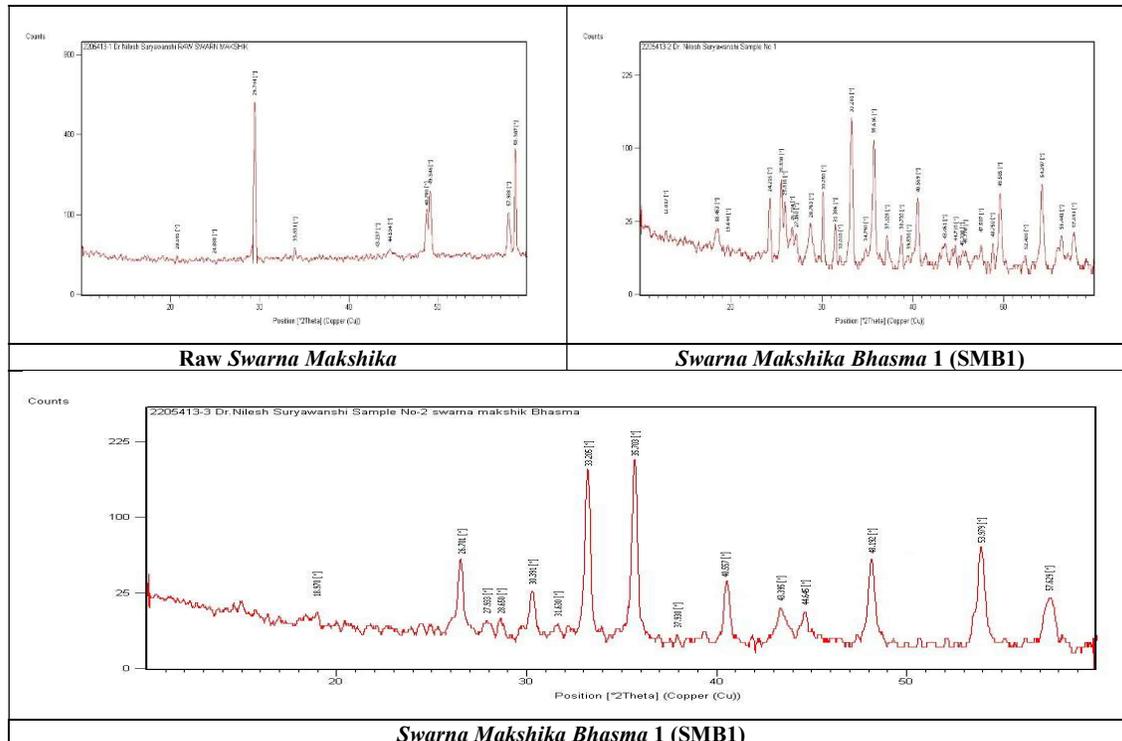


Figure 3: XRD graphs for Raw Swarna Makshika, SMB1 and SMB2

Table 6: Advance Analytical Tests (SEM-EDX)

Elements	RSM		SMB 1		SMB 2	
	Wt %	Atomic %	Wt %	Atomic %	Wt %	Atomic %
CK	20.2	42.61	10.86	19.35	8.46	16.34
OK	7.16	11.33	43.18	57.74	38	55.07
FK	2.6	3.46	--	--	--	--
ALK	-	--	0.52	0.41	1.38	1.18
SIK	-	--	2.3	1.75	4.42	3.64
PK	0.8	0.65	0.3	0.20	3.48	2.60
SK	34.18	26.98	14.98	9.99	10.22	7.38
KK	--	--	0.16	0.08	2.5	0.1
Cak	0.63	0.4	3.08	1.64	0.78	0.45
FeK	15.01	6.8	11.2	4.28	14.37	5.96
CoK	0.3	0.15	0.36	0.13	0.28	1.10
CuK	19.12	7.61	12.58	4.23	12.95	4.72
ZnK	--	--	0.48	0.15	1.2	0.4
NaK	--	--	--	--	1.98	1.99

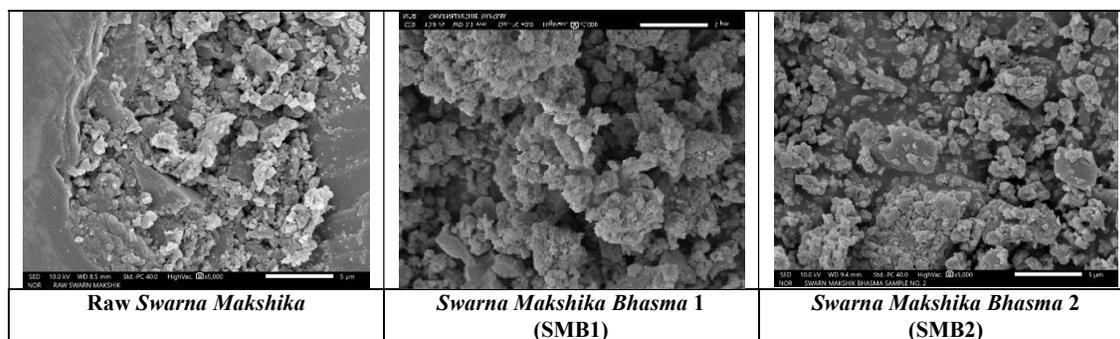


Figure 4: SEM images of Swarna Makshika in 5000X magnification

#### 4 DISCUSSION

Preparation of any *Bhasma* according to standard classical reference is very rigorous procedure. It needs all the procedures and confirmatory tests to be followed meticulously. *Bharjana* procedure plays very important role in the preparation of *Swarna Makshika Bhasma*. Preparation of SMB1 needed less *Putra* than SMB2 shows the considerable impact of *bharjana* in castor oil during the preparation of SMB1. Castor oil posses a high calorific value than hard wood or any other juices like juice of citrus medica creating resulting in the rapid transformation of particles. The SMB1 also

fulfilled the criteria of different classical tests in less *Putra* as compared to SMB2. The heavy loss in the weight of both samples of *Swarna Makshika Bhasma* was observed (SMB2 > SMB1) as there is considerable loss in the quantity of sulphur due to *Putra* procedure. The amount of Oxygen is increased in SMB1 and SMB2 shows the increased presence of Oxygen in *Bhasma* in the form of oxides. This happens due to separation and sublimation of sulphur substituted by oxygen in the molecules during the process. These variations can be confirmed with the wt% of sulphur and Oxygen in the samples obtained by EDAX.

SEM study showed reduction in the particle size after *Bhasma* processes [8]. This significant reduction in particle size is responsible for the phenomenon of *Rekhapurna* and *Varitara*.

X--Ray Diffraction [9] Studies were done to determine structure and composition of the samples. Sample of Raw *Swarna Makshika* shows d-space value as follows 3.0345, 1.8349 and 1.5790 which identified as Copper Iron Sulphide ( $\text{CuFeS}_2$ ) according to JCPDF standards. Sample of SMB1 shows d-space value as follows 2.6930 and 2.5132 which identified as Ferric Oxide or Hematite ( $\text{Fe}_2\text{O}_3$ ). It also shows d-space values 3.4891 and 1.6924 which identified as  $\text{Cu}_2\text{O}$  and  $\text{CuFeS}_2$  respectively. Sample of SMB2 shows d-space value as follows 2.51490 and 2.6949 which identified as Ferric Oxide or Hematite ( $\text{Fe}_2\text{O}_3$ ). It also shows d-space values 1.9893 and 1.7756 which identified as  $\text{Cu}_2\text{S}$  and  $\text{Cu}_2\text{O}$  respectively. Thus SMB1 shows partial chemical decomposition of  $\text{CuFeS}_2$  into  $\text{Fe}_2\text{O}_3$  and  $\text{Cu}_2\text{O}$  while SMB2 shows the complete chemical decomposition of  $\text{CuFeS}_2$  into  $\text{Fe}_2\text{O}_3$ ,  $\text{Cu}_2\text{S}$  and  $\text{Cu}_2\text{O}$ . These results show the conversion of *Swarna Makshika* into less complex, more stable and acceptable forms like Haematite, cupric oxide etc. Thus XRD confirms that when it comes to the percentage of breakdown of *Swarna Makshika* ( $\text{CuFeS}_2$ ) into smaller compounds the SMB2 shows better results than SMB1

## 5 CONCLUSION

This study concludes that the ancient pharmaceutical processes like *Shodhana* and *Marana* are crucial for *Bhasmikarana* of metals and minerals in *Rasshastra*. These procedures play a very significant role in the alteration of *Guna*, physical and chemical properties of the drug. Though the ancient parameters for *Bhasma* are systematic, easy to perform and low cost; the modern analytical methods XRD, XRF and SEM are also crucial for deeper understanding of the concepts like *Shodhana* and *Marana*. After the procedures like *Shodhana* and *Marana*, raw *Swarna Makshika* ( $\text{CuFeS}_2$ ) gets chemically decomposed to further microfine particles of *Bhasma* (e.g.  $\text{Fe}_2\text{O}_3$ ,  $\text{Cu}_2\text{S}$ ,  $\text{Cu}_2\text{O}$ ) which is confirmed by XRD and EDAX. The XRD analysis of SMB1 and SMB2 shows complete chemical decomposition of Raw *Swarna Makshika* in SMB2 as compare to SMB1 which highlights the importance of *Marana* than *Shodhana* (*Putra*:  $\text{SMB2} > \text{SMB1}$ ). Considering all the results and its interpretations it can be hypothesized that the SMB2 can be clinically more effective than the SMB1 which can be further studied through clinical trials.

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