

# Bhasma: The ancient Indian nanomedicine

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## ABSTRACT

Ayurveda and other Indian system of medicine use metals, but their use is also amply described in Chinese and Egyptian civilization in 2500 B.C. *Bhasma* are unique ayurvedic metallic/minerals preparation, treated with herbal juice or decoction and exposed for Ayurveda, which are known in Indian subcontinent since 7<sup>th</sup> century A.D. and widely recommended for treatment of a variety of chronic ailments. Animal's derivative such as horns, shells, feathers, metallic, nonmetallic and herbals are normally administered as *Bhasma*. A *Bhasma* means an ash obtained through incineration; the starter material undergoes an elaborate process of purification and this process is followed by the reaction phase, which involves incorporation of some other minerals and/or herbal extract. There are various importance of *Bhasma* like maintaining optimum alkalinity for optimum health, neutralizing harmful acids that lead to illness; because *Bhasma* do not get metabolized so they don't produce any harmful metabolite, rather it breakdowns heavy metals in the body. Methods including for *Bhasma* preparation are parpati, rasayoga, sindora, etc., *Bhasma* which contain Fe, Cu, S or other manufacturing process plays a specific role in the final product(s). Particle size (1-2  $\mu$ ) reduced significantly, which may facilitate absorption and assimilation of the drug into the body system. Standardization of *Bhasma* is utmost necessary to confirm its identity and to determine its quality, purity safety, effectiveness and acceptability of the product. But the most important challenges faced by these formulations are the lack of complete standardization by physiochemical parameters.

**Key words:** Ayurveda, *bhasma*, *marna*, nano-particle, *shodhna*, standardization

## INTRODUCTION

Ayurveda is the science made up of *Veda* (knowledge) and *Ayush* (life) i.e. knowledge of life. An Ayurvedic system adopts a holistic approach towards health care by balancing the physical, mental and spiritual functions of the human body. *Rasa-Shastra* (vedic-chemistry) is

one of the parts of Ayurveda, which deals with herbo-mineral/metals/non-metals preparations called *Bhasmas*. Rasayana<sup>[1]</sup> (immunomodulation and anti-aging quality) and yogavahi (ability to target drugs to the site) are characteristics of a properly made herbo-mineral/metals/non-metals preparation, which is also nontoxic, gently absorbable, adaptable and digestible in the body.<sup>[2]</sup>

*Bhasma*, is a ayurvedic metallic/mineral preparation [Table 1], treated with herbal juices or decoction and exposed for certain quantum of heat as per *puta* system of Ayurveda, which itself is well known in Indian subcontinent since 7<sup>th</sup> century A.D. and widely recommended for the treatment of many disease conditions [Table 2]. *Bhasma* are claimed to be biologically produced nanoparticles, which are prescribed with several other medicines of Ayurveda.

The concept of using nanometal particle is prevailing since *Charakasamhita*.<sup>[3]</sup> For a metallic preparation of *Lauhadi Rasayana*, iron is used to heat up until red hot and quenched in some liquid media immediately until flakes of iron become in fine powder form.<sup>[4]</sup>

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**Table 1: Company and marketed formulation of Bhasma**

Company name	Marketed formulation of Bhasma
Shree Siddhashram Pharmacy, Jaipur, Rajasthan	Abhrak Bhasma, Bang Bhasma, Kashish Bhasma, Ropya Bhasma, Tamra Bhasma, Swarna Bhasma
Shree Baidyanath Ayurved Bhawan (P) Ltd. Kolkata	Abhrak Bhasma, Akik Bhasma, Vaikrant Bhasma, Godanti (Harital) Bhasma
Dindayal Aushadhi Pvt. Ltd. Dindayal City Mall, Gwalior	Kashish Bhasma, Ropya Bhasma, Tamra Bhasma, Swarna Bhasma, Naga Bhasma
Gurukul Kangri Pharmacy, Haridwar	Swarna Bhasma, Ropya Bhasma, Tamra Bhasma
Unjha Ayurvedic Pharmacy, Unjha, Gujarat	Abhrak Bhasma, Bang Bhasma, Kashish Bhasma, Dhanwantary Prasad, Ropya Bhasma, Tamra Bhasma, Swarna Bhasma

## CHARACTERIZATION OF BHASMA

### Physical characteristic

1. Color (*Verna*): A specific color is mentioned for each *Bhasma*. *Bhasmas* are generally white, pale, or red. The color of the preparation primarily depends on the parent material
2. Lusterless (*Nishchandravam*): *Bhasma* must be lusterless before therapeutic application. For this test, *Bhasma* is observed under bright sunlight whether luster is present or not, if luster is still present, it indicates further incineration
3. Lightness and Fineness (*Varitara*): *Bhasma* floats on stagnant water surface. This test is based on law of surface tension. Properly incinerated *Bhasma* need to float on water surface
4. Tactile sensation: Tactile sensation can be absorbed and assimilated in the body without producing any irritation to mucous membrane of gastrointestinal tract
5. Particle size: Prepared *Bhasma* should be in powder form. Particle of *Bhasma* should be like pollen grains of *Pondanus odoratissimus* flower (*ketaki rajah*).

### Chemical characteristic

1. *Apunarbhavata*: It means incapability to regain original metallic form. For this test *Bhasma* is mixed with equal quantity of seeds of *Abrus precatorius*,<sup>[5]</sup> honey, ghee, borax then sealed in earthen pots and heated with similar grade of heat. Thereafter particular *Bhasma* is observed on self-cooling
2. *Niruttha*: *Niruttha* is to test inability to regain metallic form of metallic *Bhasma*. In this test *Bhasma* is mixed with a fixed weight of silver leaf and kept in sealed earthen pots, then similar grade of heat is applied and after selfcooling, the weight of silver is taken. Increase in weight of silver leaf indicates improperly prepared *Bhasma*.<sup>[6]</sup>

## QUALITY CONTROL OF BHASMA

Traditionally, the end points of incineration of a metal and its conversion to a *Bhasma* state are evaluated based on the following criteria:

1. Lusterless: There should be no *chandrika* or metallic luster (*nischandrika*)
2. *Rekhapurnatvam*: When a *Bhasma* is spread between the index finger and thumb and rubbed, it should be so fine as to get easily into the lines and crevices of the fingers and should not be washed out from the lines of the fingers
3. *Varitaratavam*: When a small quantity is spread on cold and still water, it should float on the surface
4. *Apurnabhava*: The *Bhasma* should not revert to the original state
5. Tasteless: *Bhasma* should be tasteless
6. *Avami*: The *Bhasma* should not produce nausea on administration.

(14A technique known as the phased spot test has been developed by the investigators of Central Council for Research in Ayurveda and Siddha (CCRAS) of India to identify *Bhasmas*. This technique is very effective and accurate in identifying genuine quality of *Bhasmas*) [Figure 1].<sup>[7]</sup>

## CLASSIFICATION OF BHASMA

- Metal-based *Bhasma*
- Mineral-based *Bhasma*
- Herbal *Bhasma*.

## BHASMA AS A NANOPARTICLE

Animal derivatives such as horns, shells, feathers, metallic and nonmetallic minerals are normally administered as *Bhasma*. A *Bhasma* means an ash obtained through incineration. The starter material undergoes an elaborate process of purification (*shodhana*), followed by the reaction phase, which involves incorporation of some other mineral and herbal extracts. Then the material in pellet form is incinerated in a furnace. The end product is expected to be a nontoxic material. Examples are *Swarna Bhasma*, *Shankha Bhasma*, *Tamra Bhasma* etc. Gold in tradition Indian ayurvedic medicine as *Swarna Bhasma* (gold ash) has been characterized as globular particles of gold (56-57 nm). Mercury compound contains mercury sulfide (crystalline size 25-50 nm) [Figure 2].<sup>[8]</sup>

## IMPORTANCE OF BHASMA

1. Maintain optimum alkalinity for optimum health
2. Provide easily absorbed and usable calcium
3. Cleanse the kidneys, intestines and liver
4. Maintain stronger bones and healthier teeth
5. Alleviate insomnia, depression

**Table 2: Marketed *Bhasmas* products and their uses**

Name	Ingredients	Dosage	Uses
<i>Navrattankalp amrit ras</i>	Calcined ash of expensive gems, minerals like ruby, sapphire, emerald, cat's eye stone, pearl, coral, silver, gold, iron, zinc	62.5 mg twice daily	Cancers of all types, anemia, complications of diabetes
<i>Heerak Bhasma</i>	Diamond	12.5-25 mg twice daily	Useful in cancers, immunity disorders, crippling rheumatoid arthritis, bone marrow depression
<i>Tsailokyachintamani ras</i>	Diamond, gold, silver, iron	62.5 mg twice daily	Severe respiratory tract infections, bone marrow depression, ovarian cysts, uterine fibroids
<i>Swarna basant malti ras</i>	Gold, <i>piper-nigrum</i> , white pear powder	62.5 mg twice daily	Tonsillitis, fevers, cough, bronchitis, decreased immunity, cancers, auto-immune disorders
<i>Kamdudha ras</i>	Ochre, <i>Tinospora cordifolia</i> , mica (calcined)	250-500 mg twice daily	Hyperacidity, headache, fever, blood pressure
<i>Vasant kusumakar ras</i>	Gold, silver, coral	62.5-125 mg twice daily	Complications of diabetes, neuropathy, general weakness
<i>Kumar kalian ras</i>	Gold, iron, mica, copper pyrite, red sulfide of mercury	62.5-125 mg twice daily	General debility in children, fever, respiratory tract infections
<i>Tamra Bhasma</i>	Copper, mercury, sulfur	62.5-250 mg twice daily	Anemia, jaundice, digestive disturbance, abdominal disorders
<i>Loha Bhasma</i>	Iron, cinnabar	125-250 mg twice daily	Enlargement of liver, anemia, jaundice
<i>Vaikrant Bhasma</i>	Manganese, sulfur (Tourmaline)	62.5-125 mg twice daily	Diabetes, can be used in place of diamond ash in case of poor patients
<i>Loknath ras</i>	Mercury, sulfur, conch shell	62.5-125 mg twice daily	Diarrhea, respiratory disorders, immunity disorders, cancers, ovarian cysts
<i>Abhrak Bhasma</i>	Calcined purified mica ash	125-250 mg twice daily	Respiratory disorders, diabetes, anemia, general weakness
<i>Swarna Bhasma</i>	Ash of gold (Calcined gold)	12.5-62.5 mg twice daily	Improves body immunity, general weakness, anemia, energetic
<i>Rajat Bhasma</i>	Silver ash (Calcined silver)	62.5-125 mg twice daily	Irritable bowel syndrome, acidity, pitta disorders
<i>Ras raj ras</i>	Red sulfide of mercury, mica, gold, iron, silver, with ania somnifera, <i>Syzygium aromaticum</i>	62.5-125 mg twice daily	Paralysis, hemiplegia, rheumatism, insomnia, stroke
<i>Shwaskuthar ras</i>	Black sulfide of mercury, aconitum ferox, sodium bicarbonate, piper nigrum, 'Trikatu'	125-250 mg twice daily	Cough, pneumonia, bronchitis
<i>Swarnmakshik Bhasma</i>	Copper pyrite (calcined), mercury, sulfur	125-250 mg twice daily	Anemia, jaundice, stomatitis, chronic fever
<i>Kaharva pishti</i>	Amber of succinite (trinkantmani), rosa centifolia (rose)	125-250 mg twice daily	Bleeding
<i>Yogender rasa</i>	Red sulfide of mercury, gold (calcined), magnetic iron, mica, myristica fragrans	62.5-125 mg twice daily	Polio, paralysis, muscular weakness, insomnia, headache
<i>Bolbadh ras</i>	Black sulfide of mercury, <i>Tinospora cordifolia</i> , <i>Commiphora mukul</i>	125-250 mg twice daily	Bleeding
<i>Praval pishti</i>	Purified powder of corals	125-250 mg twice daily	Calcium deficiency, blood pressure, insomnia, agitation
<i>Praval panchamrit</i>	Powder of corals, pearls, conch shells	125-250 mg twice daily	Richest source of natural calcium, agitation, acidity, burning sensation
<i>Jaharmohra pishti</i>	Powder of serpentine orephite	125-250 mg twice daily	Natural source of calcium, useful in burning sensation, acidity, heart burn
<i>Sarvatobhadra Vati</i>	Mercury, sulfur (purified and calcined), with gold	62.5-125 mg twice daily	Renal failure, nephrotic syndrome, dialysis, high urea and creatinine

(Contd...)

Table 2: Contd...

Name	Ingredients	Dosage	Uses
<i>Punarnavam andoor</i>	Iron ore ash, <i>Boerhavia diffusa</i> , <i>Picrorhiza Kurroa Embelia ribes</i>	125-250 mg twice daily	Diuretic, anemia, swelling around joints, blood pressure, liver cirrhosis, ascites
<i>Akikipishti</i>	Agate stone calcined	125-250 mg twice daily	Heat/pitta diseases, blood pressure, acidity, ulcers
<i>Mukta pishti</i>	Pearls powder (moti pishti)	62.5-125 mg twice daily	Calcium, cooling and soothing, blood pressure, acne, headaches, acidity, ulcers, heat disorders
<i>Vriht vat chintamani ras</i>	Herbs and minerals for vitiated vata- calcined mercury, sulfur (purified) and other metals and minerals	62.5-125 mg twice daily	Stroke, paralysis, parkinsonism, epilepsy, tetany, muscle stiffness, joint pains

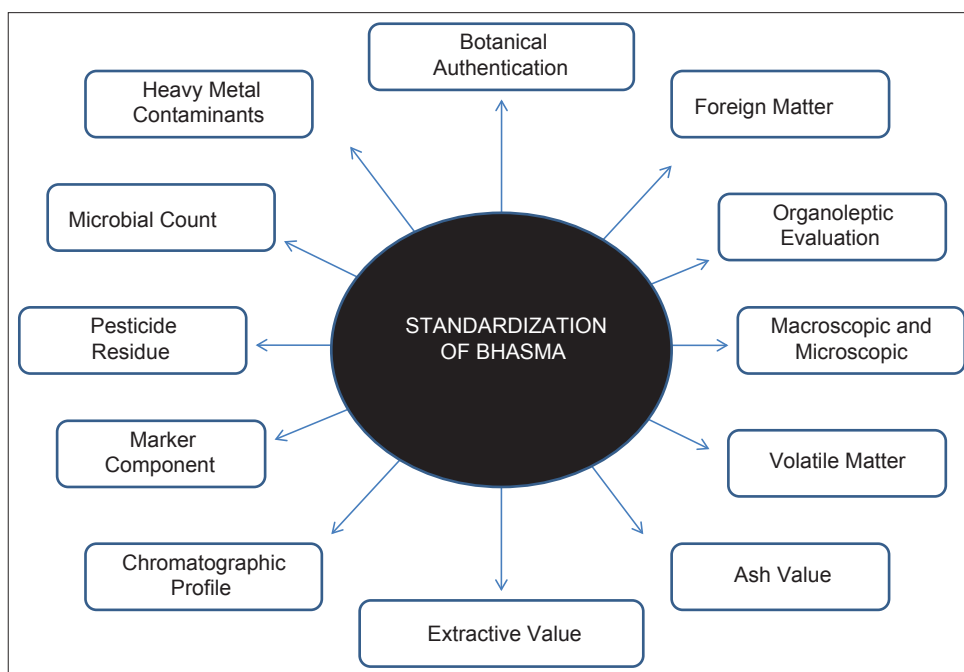
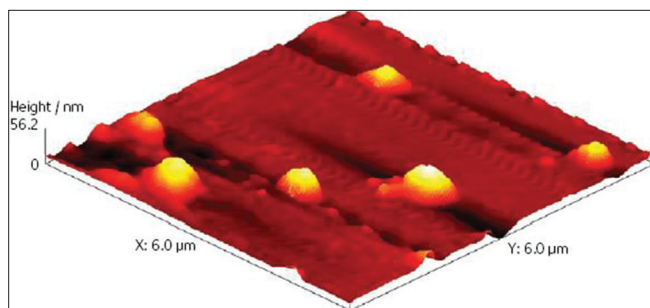
Figure 1: Standardization of *Bhasma*

Figure 2: Atomic force microscopy image on a Nanonics Multiview 1000

6. Keeps rhythmic heart beating
7. Keeps arrhythmias and minerals balance
8. Help metabolize iron in body
9. Aid nervous system
10. Breakdown heavy metals and drug residues in body
11. Neutralize harmful acids that lead to illness

12. Achieve a healthy alkaline level by neutralizing acid
13. Protect body from free radical damage.<sup>[9]</sup>

## PREPARATION OF *BHASMA*

### General procedures

The name *Bhasma* is generally applied to all metallic and nonmetallic substances that are subjected to the process of incineration and reduction into ash [Table 3]. Here it is applied to the scientific basis for ayurvedic therapies metals, minerals, and animal products that are, by special processes, calcinated in closed crucibles in pits with cow dung cakes (*puttam*).<sup>[10]</sup>

### Steps used to prepare *Bhasmas*

#### *Shodhana*

In Ayurveda, purification is called *Shodhana*. *Shodhana* is the process through which the external and internal impurities of metals and minerals are removed.

The following processes are involved:

1. Elimination of harmful matter from the drug
2. Modification of undesirable physical properties of the drug
3. Conversion of some of the characteristics of the drug to different stages
4. Enhancement of the therapeutic action.

### Marana

*Marana* is basically a burning process or calcination.<sup>[11]</sup> The purified metal is placed into a mortar pestle and grounded with the juice of specified plants or kashayas, mercury (in metallic state), or a compound of mercury such as mercury perchloride (*sauviram*), an amalgam of sulfur and mercury (*kajjali*) for a specified period of time. The metal that is intended for *marana* is known as a primary metal (*pradhandhatu*); the other metal, which is taken in small proportions for the *marana* of the primary metal, is known as secondary metal (*sahayadhatu*). *Marana* differs with the nature of the substance to be calcinated. For example, organic substances such as herbs are burnt in open air, whereas inorganic substances such as metals like *rajata* (silver) are burnt in closed containers. In either case, the end product is a *Bhasma* of substance taken for *marana*. For example, the end product in the case of silver (*rajata*) is called as *Rajata Bhasma*. *Marana* of inorganic substances is called *puta* and the process of *marana* of herbs in closed freshly made containers is known as *puta-paka*. *Bhasma* obtained by *marana* from primary metals together with herbs (*mulika*) are called *Mulikamarita Bhasma*.<sup>[12]</sup>

### Gold (Swarna) Bhasma

The general preparation of *Swarna Bhasma* involves the three processes of *shodhana*, *dravana*, and *marana*. The leaves of gold are heated over fire and dipped in *sesa* (*Sesamum indicum*) oil when its red hot, process is continued seven times separately.<sup>[13]</sup> The soft leaves are processed with buttermilk/cow's urine and the decoction of *kulattha* (*Dolichous biflorus*), *kanji* (sour gruel processed from rice [*Oryza sativa*]), and radish (*Raphanus sativus*). Finally, the leaves are dried by heat.<sup>[14]</sup> The mixture is triturated and the paste thus obtained is dried under sunlight. The process of triturating and drying under sunlight is repeated 7 to 14 times using fresh aliquots of latex, and the final product is obtained.

Its organoleptic characteristics are as follows color dark brown, fine in touch and tasteless.<sup>[15]</sup> It should contain sulfur (<3.33% w/w), calcium (<1.625% w/w), sodium (<0.922% w/w), potassium (<0.370% w/w), sulfate (<3.00% w/w), copper (<17.2% w/w), iron oxide (ferric) (<85.0% w/w), iron oxide (ferrous) (<5.7% w/w), phosphate (<1.101% w/w), silica (<3.8% w/w), acid insoluble (<11.93% w/w), ash value (<98.20% w/w), acid-insoluble ash value (21.20-31.18% w/w).<sup>[16]</sup> It shows following pharmacological activity like analgesic activity

against chemical, thermal, electrical and mechanical stimulation, stimulatory effect on peritoneal macrophages and antioxidant activity [Table 4]. Assessment of liver function test (enzymes) and histological investigation show no toxic effect of chronic administration of *Swarna Bhasma*. The particle size of the raw material was between 6 and 8  $\mu$  while that for the *Bhasma* particles was 1- and- 2  $\mu$ .<sup>[17]</sup>

### Mukta Shouktic Bhasma

*Mukta shouktic Bhasma* (MSB) is a calcium-containing *Bhasma* consisting of pearl (mote), *Aloe vera* Linn. (*Guarpatha*) and vinegar (*kanji*).<sup>[18]</sup> This *Bhasma* is prepared from the outer covering of the shell (pearl-oyster), and is grounded and triturated with *A. vera* and vinegar in sufficient quantity to make a homogeneous paste.<sup>[19]</sup> The recommended proportion of pearl-oyster and *A. vera* is 1:4. Standardization parameters of MSB are [Table 5] (1) bulk density and tapped density (used to indirectly calculate the flow properties by deriving Carr's index. The static angle of repose was determined by the funnel method). (2) Particle size analysis with dynamic light scattering method (particle size of MSB ranges from 1.22 to 10.20  $\mu$ m having a mean

**Table 3: Bhasma and their ingredients**

Bhasma	Ingredients
Abhrak Bhasma	Mica
Halthiana Bhasma	Charcoal of elephant tusk
Jasada Bhasma	Zink oxide
Loah Bhasma	Iron oxide
Mandura Bhasma	Iron oxide
Mayrapicha Bhasma	Ash of peacock feather
Mukta Bhasma	Oxide of pearl
Nag Bhasma	Lead
Parade Bhasma	Mercury compound
Pravala Bhasma	Oxide of coral
Rajata Bhasma	Silver oxide
Sankha Bhasma	Oxide of conch Bhasma
Mukta Shukti Bhasma	Oxide of pearl, oyster shell
Talaka Bhasma	Arsenic sulfide
Tamra Bhasma	Cupric oxide
Vanga Bhasma	Tin compound
Varatika Bhasma	Oxide of cowrie shell

**Table 4: Biologically active gold compounds**

Name	Gold concentration
Gold sodium thiomalate	50.5
Gold thioglucose	50.5
Gold thioglycoanilide	54.2
Calcium aurothiothioglycolate	64.1
Sodium-2-aurothiobendazole-4- carboxylate	47.8
Sodium-auroallylthiourea-m-benzoate	43.4
S-triethylphosphine gold 2,3,4,6	29.1
tetra-O-acetyl-1-thio-B-D-glycopyranoside	
Chloro (triethylphosphine)	56.2



particle size of  $22.52 \pm 0.45 \mu\text{m}$ ). (3) Transmission electron microscopy (particles are irregular rod shaped). It shows following pharmacological activity like antacid, anti-pyretic and as a source of calcium.<sup>[20]</sup> It is also used in tuberculosis, cough, asthma, dysmenorrheal, arthritis, rheumatism, conjunctivitis. Recent studies have shown that adding heated oyster shells to the diet of elderly patient increased the bone mineral density of the lumbar spine. MSB is one-third to one-half as potent an anti-inflammatory as the amino salicylic acid further, even as MSB is widely used for its antipyretic activity.<sup>[21]</sup>

### Varatika Bhasma

*Varatika* is identified as the external shell of sea animal *Cypraea moneta* Linn.<sup>[22]</sup> It occurs in the coastal areas of the sea. *Cypraea moneta* is commonly known as the money cowry [Figures 3-5]. Chemically it is carbonate of calcium.

**Table 5: Quality assessment of MSB**

Test parameter	Test	Interference
Identity	Macroscopic test	No luster, grayish white, fine powder
Physical properties	Bulk density	$9.08 \pm 0.031 \text{ g/cm}^3$
	Tapped density	$1.218 + 0.047 \text{ g/cm}^3$
	Particle size	$1.22 - 10.20 \mu\text{m}$
	Angle of repose	$36.17 \pm 1.28$
	Carr's index	$46.21 \pm 0.5$
	Loss on ignition	$< 0.05\% \text{ w/w}$
	Loss on drying (100°C)	$< 0.5\% \text{ w/w}$
Purity	Yeast and mould	$< 1 \times 10^4 \text{ CFU/g}$
	Total aerobic count	$< 1 \times 10^5 \text{ CFU/g}$
	<i>Escherichia coli</i>	Absent
	<i>Salmonella spp.</i>	Absent
	<i>Staphylococcus aureus</i>	$< 1 \times 10^2 \text{ CFU/g}$
Quantity	Arsenic	$< 0.14 \text{ mg/kg b.w./day}$
	Cadmium	$< 0.09 \text{ mg/kg b.w./day}$
	Lead	$< 0.29 \text{ mg/kg b.w./day}$
	Total mercury	$< 0.29 \text{ mg/kg b.w./day}$
	Calcium	$40.22 \pm 0.05\%$

MSB: Mukta shouktic *Bhasma*

**Table 6: Observation during Sodhana process with kulatha kashaya**

Properties	Raw material	Purified material
Color	Yellowish white	Grayish white
Chemical compound	$\text{CaCO}_3$	$\text{CaCO}_3$
Habit	Amorphous	Amorphous
Nature	Hard	Brittle
Luster	Pearly	Pearly
Cleavage	Absent	Absent
Fracture	Conchoidal	Conchoidal

Its *kashaya* (decoction) was prepared for the purification process [Table 6]. Fresh *Aloe-vera* was collected and its juice was used for making cakrikas or pellets to be used in the incineration process of *Varatika*. Ingredients are the raw *Varatika*, *Kulattha kashaya* (Horse gram decoction for purification), *Kumari svarasa* (*Aloe-vera* juice) for grinding during incineration. It shows following organoleptic



**Figure 3: Varatika (before purification)**



**Figure 4: Varatika (after purification)**



**Figure 5: Varatika Bhasma (Final product)**

properties color is dull white fine powder, odorless, tasteless soluble in dilute HCl and physio-chemical analysis showed Loss on drying (0.6566%). It contains ash (2.06%), organic carbon (1.09%), total nitrogen (0.72%), total potassium (3.49%), total zinc (1.48 ppm), total iron (113.6 ppm).<sup>[23]</sup>

### Mandura (Iron) Bhasma

Iron *Bhasma* contains three basic processes *shodhana*, *dravana*, and *marana*. Iron is prepared by two steps: Purification and quenching by sinking the red-hot leaflet in liquid medium like fresh *Triphala* decoction (*nishechan*) or cow's urine and calcinations with repeatedly 9 times. Coarse pieces of sulfur are taken in *khalva yantra* and some amount of *dewadali svaras* are added for bhavana. It is rubbed thoroughly and the process is repeated for at least 7 days.<sup>[24]</sup> Iron *Bhasma* should always be prepared with mercury; otherwise, it is not absorbed properly in the intestine. Another process includes *lohamarakagana*, *amritkarana*, and *nirutthikarana*. In the *lohamaraka*, fresh lemon juice is prepared and a specific amount of *hingula* powder is added. In the *amritkarana* process, equal amounts of *Loha Bhasma* and *ghrita* are placed in an iron pan and mixed properly under mild heat until the fat disappears.<sup>[25]</sup> It contains following organoleptic characteristics color dark brown, fine in touch, tasteless and having iron as  $\text{Fe}_2\text{O}_3$  (<96.575% w/w), iron as Fe (<75% w/w), ash value (96.8-99.7% w/w), acid-insoluble ash (0.101-2.803% w/w). It shows following pharmacological activity that it has not only in resorting hemoglobin level, but in significantly increasing body weight gain in *Bhasma*-treated animals and also helpful in iron deficiency anemia. It is a powerful hematinic and tonic and is valuable in the treatment of hemolytic jaundice and microcytic anemia.<sup>[26]</sup>

### Naga Bhasma

Processing of the *Naga Bhasma* was done according to the *Shastiputa Naga Bhasma* process listed in the *Grantha Ananda Kanda 2/6/25-28*. Lead is purified through sublimation. Lead metal was melted in iron ladle and poured into a vessel containing lime water (called *Curmodaka*), decoction strength and filtered.<sup>[27]</sup> The process was repeated seven times with fresh lime water each time. In the first *puta* (step), the purified lead thus obtained was melted with equal amount of manahsila ( $\text{As}_2\text{S}_2$ ) and a small amount of *Chichiri* (*Plectranthus cuesta* L Her.), herb (root, stem, leaves, flower and fruit generally all parts were used) until it becomes dried powder. After cooling, powder is triturated with the juice of *Vaasa* (*Adhatoda vasica* Nees.) leaf. Small pellets were made and dried in shade. Dried pellets were packed airtight in two earthen pots one above the other (called *Sharavsamput*). Finally the pots were subjected to heat in the electric furnace at 600° in aerobic condition. This was the first *puta* (step) *Naga Bhasma* sample. Sample thus obtained was used in the next step. In rest of the each steps (remaining 59 step), manahsila was added in 1/20<sup>th</sup> proportion to the prepared *Bhasma*

with juice of *Vaasa* and subjected to heat treatment. The process was repeated sixty times to get the finally prepared *Naga Bhasma*. The final product in the form of the pellets were taken out of the earthen pot and powdered. The powdered material was packed in airtight containers. Physio-chemical characterization powdered *Bhasma* was characterized by powder X-ray diffraction (XRD, IR, TEM, Atomic absorption spectrophotometer was utilized). Histopathological studies of *Bhasma* were done in skin, small intestine, pancreas, testis, brain, lung, kidney and liver.<sup>[28]</sup>

### Copper (Tamra) Bhasma

*Tamra Bhasma* is used as a single drug and also in combination with many medicinal plant juices and then repeated calcinations performed with air so that the metallic state is transformed into the corresponding oxide form, which is traditionally known as *Bhasma*.<sup>[29]</sup> *Tamra Bhasma* is used for the management of liver disorder, arthritis, old age disorders, leukoderma, etc. It shows the following pharmacological activity like (1) hepatoprotective effect on cumene hydro-peroxide-induced per-oxidation, (2) it showed significant reduction in the level of lipid per-oxidation, (3) *Tamra Bhasma* is a strong antioxidant drug and could be used in the management of lipid peroxidation, (4) it showed no acute detectable adverse effects; levels of SOD were also enhanced by *Tamra Bhasma*.<sup>[30]</sup>

### Abhrak Bhasma

*Abhrak Bhasma* is prepared by treating *biotite* (mica) with the juices of a number of re-constituent plants that make it a powerful cellular regenerator. It is a commonly used ayurvedic drug against many diseases including hepatitis (hepatoprotective).<sup>[31]</sup> It is also a nervine tonic and is widely used in respiratory tract infections and anemia. It contains iron, magnesium, potassium, calcium, and aluminum in trace amounts. *Abhrak Bhasma* is an amorphous powder drug. It also contains silicates of iron, magnesium and aluminum.<sup>[32]</sup>

### Yashada Bhasma

*Yashada Bhasma* is specially processed with zinc. It is administered in sprue, diabetes, leucorrhoea and hyperhidrosis. The role of the *Bhasma* in arresting myopia has been examined in one study.<sup>[33]</sup> Contamination of *Bhasmas* directly through the herbs used in the preparation and formation of polycyclic aromatic hydrocarbons (PAHs) is expected. *Bhasmas* were analyzed and found to contain PAH (2.32-9.55 ppm) among the preparation tested. The benzo[a] pyrene level also varied, the highest concentration being 9.7 ppm.<sup>[34]</sup> The studies presented here suggest *Bhasmas* may have a hepatoprotective effect. However, efforts should be made to study their beneficial effects on other systems. Especially, evaluation of their immunomodulatory and neuroprotective actions may prove to be rewarding.<sup>[35]</sup>

### Sankha Bhasma

*Sankha Bhasma* is a powder prepared from the calcinated conch shell. It consists mainly of calcium, iron and magnesium. *Sankha Bhasma* is well known for its antacid and digestive properties. It is useful in hyperchlorhydria, sprue, colic and hepatosplenomegaly.<sup>[36]</sup> A mixture of some ayurvedic medicines that contained *Sankha Bhasma* and the herbs *Glycrrhiza-glabra*, *Terminalia-chebula*, and *Piper-longum* showed protection against duodenal ulcer in rats. Studies show that these drugs act on Bruner's gland by improving its secretary state.<sup>[37,38]</sup>

### CONCLUSION

*Bhasma* which contains metals, minerals, and animal products, the manufacturing process plays a specific role in the raw material mixture in the final product. These could be important chemical markers for *Bhasma* prepared using a particular method. As a result of different stages of processing techniques like *shodhana* (which involves roasting, with addition of herbal juices and continuous stirring) and *marana* [which involves *bhavana* (wet trituration) and *puta* system of heating], the particle size reduces significantly, which may facilitate absorption and assimilation of the drug into the body system. The particle size in the *Bhasma* is 1-2  $\mu$ , which could be specified as the criterion for the final product conforming to all the traditional parameters under *Bhasma* pariksha (examination of properly prepared *Bhasma*). Although *Bhasmas* are complex materials, physicochemical analysis using modern techniques will be most attractive for the standardization of *Bhasma* medicines. This would definitely help in building confidence in use of such products for medication by ensuring safety, efficacy, and batch to batch uniformity.

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