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# PHYSICO-CHEMICAL CHARACTERIZATION OF VANGA BHASMA PREPARED BY THREE DIFFERENT METHODS

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## ABSTRACT

In the current era, *Rasaushadhies* have given *Ayurveda* a complete novel health care look. The innate qualities like quick action, lesser dose, tastelessness, prolonged shelf life, better palatability of *Rasaushadhies* have helped them to conquer the demand of patients as well as pharmaceutical properties. Among the *Rasaushadhies*, *Bhasmas* are used mostly and occupy the highest attention. *Vanga bhasma* is one of it, mainly indicated in Genito-urinary tract diseases and Diabetes mellitus. There is necessary to fix some standards for manufacture of drugs for that characterization is very essential. Hence in the present study Vanga bhasma was prepared by 3 medias using *Parada, Kashtoushadi (Shatavari swarasa) and Ariloha (Haratala)* and was analyzed on the parameters described in Ayurvedic texts and modern technology. All the 3 samples of Vanga bhasma were in the range of nanometer and the drug was converted into its oxide form. *Vanga bhasma* prepared by *Parada* as a media is having lesser particle size when compared to other 2 medias used. In all the 3 samples major component was Tin Oxide. EDAX revealed the presence of various trace elements with the major percentage being Tin oxide. The major finding in FTIR was that the *Bhasma* is an organometallic compound.

**KEYWORDS:** *Vanga bhasma*, Particle size, SEM, XRD, EDAX, FTIR.

## INTRODUCTION

*Bhasma* is considered as one of the most effective and important preparations in *Rasashastra*. *Vanga* is one among *Putilohas*, having *Tikta rasa, Ruksha guna, Ushna veerya*, with high therapeutic utility in cases of *Prameha, Kapha Rogas, Medho Rogas, Shukra Kshaya* and other diseases which are difficult to treat. In the current scenario, demand of *Ayurvedic* drugs is increasing. Characterization of bhasma using modern analytical methods provides objective parameters to set the standards for quality control of raw drugs as well as finished products. In order to provide a standardized drug to the needy, characterization and standardization of raw materials and finished products is essential.

Hence to understand the rationality of using various medias during *Marana* and to characterize *Vanga bhasma* using modern analytical techniques, the present work has been carried out.

## MATERIALS AND METHODS

Genuine raw materials was collected from market, after assessing *grahya lakshanas* as mentioned in classical texts books. Pharmaceutical study was conducted in Rasashala, JSSAMC, Mysuru.

### Pharmaceutical study

1. *Shodana* of *Vanga* was done by *Dhalana* of *Vanga* in *haridra churnayuktha nirgundi swarasa* for 3 times.[4]
2. *Shodhana* of *Parada* was done by triturating *Parada* with *nishachurna* and *kumari swarasa* and then subjected to heat in *urdhva patana yantra* for 6 hours.[5]
3. *Shodhana* of *Gandhaka* was done by melting *Gandhaka* with *Ghrita* and then it is poured into vessel containing milk through a cloth and then washed with hot water, this process was repeated for 3 times.[6]
4. *Shodhana* of *Haratala* was performed by boiling *Haratala* in *dola yantra* containing *churnodaka* for 6 hours.[7]
5. *Jarana* was conducted by melting *Shodita Vanga* in wide mouth iron pan and *Chincha* and *Ashwatta twak churnas* was added and stirred with *loha darvi* (iron ladle) till whole metal turns into powder form.[8]

6**. Marana**

1st method (VB-1)- *Shuddha Vanga* was melted and poured into khalwa yantra and *Shuddha Parada* was added and trituration was done rigorously till the formation of amalgam, then it was taken in an iron pan and *Jarana* was done using *Ashwatta twak churna*. To this *Jarita Vanga* double quantity of *Shuddha Gandhaka* was added, triturated with *Kumari swarasa, Chakrikas* were prepared, dried and placed in *sharava*, *samputa* is made and *laghu puta* is given.

2nd method (VB-2)- *Jarita Vanga* was grounded with *Shatavari swarasa* and *chakrikas* are prepared and dried. This is kept in *sharava, samputa* is made and *ardha gaja puta* is given. This process was repeated for 16 times.[9]

3rd method (VB-3)- *Jarita Vanga* was mixed with *Haratala churna* (*Ariloha* of *vanga*)[10] and grounded well in *nimbu rasa*. *Chakrikas* are prepared, dried and placed in *sharava samputa* and *ardha gaja puta* is given. This process is repeated for 12 times. 1/4th part of *shuddha Haratala* was added to *Vanga* from the second *puta* onwards.[1]

**FIGURES**

**Fig. 1- Shodhana of Vanga.**

**Fig.2- Shodhana of Parada.**

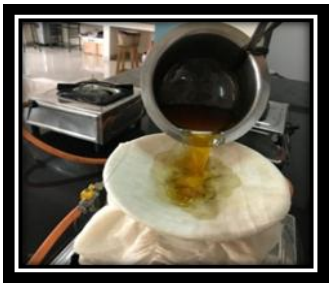


**Fig.3-Shodhana of Gandhaka.**

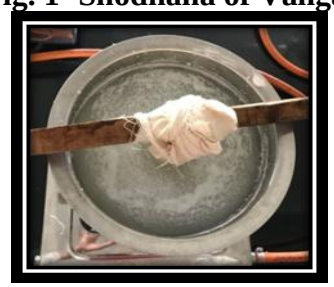


**Fig.4 – Shodhana of Haratala.**

**Fig.5-Jarana of Vanga.**

**Fig.6- Puta.**

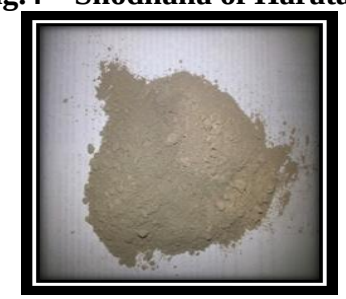


**Fig.7-VB-1.**

**Fig.8- VB-2.**

**Fig.9-VB-3.**

### Analytical study

Analytical study was conducted at Ganesh consultancy and analytical services, Mysuru and Vijnana bhavan, Manasagangothri, Mysuru.

### Characterization

Physico-Chemical analysis was performed as per API standards. Particle size analysis was done using Dynamic light scattering technique and zeta potential measurement. SEM was performed using model Hitachi s 3400n, XRD using Regaku smart lab, EDAX using Thermo scientific instrument and FTIR using Pranklin model.

## OBSERVATIONS AND RESULTS

**Table No.1 - Showing Numerical results of *Shodhana* of *Vanga.***

| | |
|---|---|
| Quantity of *Vanga* taken for *Shodhana* | 650g |
| Quantity obtained after *Shodhana* | 640g |
| Amount of loss | 10g |

**Table No.2: Showing Numerical results of Jarana of *Vanga.***

| | |
|---|---|
| Quantity of *Shuddha Vanga* taken for *Jarana* | 400g |
| Quantity obtained after *Jarana* | 415g |
| Amount of gain | 15g |

**Table No.3: Showing numerical results of Vanga marana.**

| Samples | Quantity of Jarita Vanga taken | Quantity of Vanga bhasma obtained | Total number of putas required |
|---|---|---|---|
| **Vanga bhasma 1** | 70 | 46 | 4 |
| **Vanga bhasma 2** | 180 | 245 | 16 |
| **Vanga bhasma 3** | 180 | 100 | 13 |

**Table No.4- Comparing the results of Classical *Bhasma pareekshas* of 3 samples.**

| Parameters | Results- Positive | | |
|---|---|---|---|
| | VB-1 | VB-2 | VB-3 |
| *Rekhapurna* | 2nd puta | 3rd puta | 3rd puta |
| *Varitara* | 3rd puta | 15th puta | 12th puta |
| *Unnama* | 4th puta | 16th puta | 13th puta |
| *Nischandrata* | 3rd puta | 2nd puta | 5th puta |
| *Apunarbhava* | 4th puta | 16th puta | 13th puta |
| *Niruttha* | 4th puta | 16th puta | 13th puta |
| *Nirdhumatwa* | 4th puta | 10th puta | 10th puta |

**Table No.5- Comparing bhasma colours of 3 samples.**

| Samples | Colour |
|---|---|
| Vanga bhasma 1 | Dull white |
| Vanga bhasma 2 | Pinkish white |
| Vanga bhasma 3 | Greyish white |

**Table No.6: Physico-chemical Analysis.**

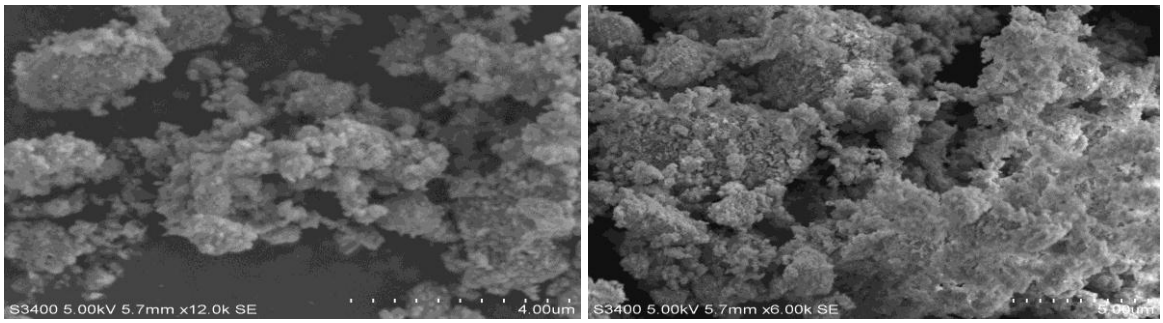
| Parameters | Results | | |
|---|---|---|---|
| | VB-1 | VB-2 | VB-3 |
| pH Value (1% Solution) | 6.80 | 7.88 | 8.47 |
| Ash Value | 98.11 | 99.59% | 99.46% |
| Water soluble ash | 12.09% | 3.88% | 4.89% |
| Acid insoluble ash | 68.99% | 75.76% | 83.64% |
| Loss on ignition | 0.69% | 0.47% | 0.25% |

**Table No.7: Showing results of particle size of samples.**

| Samples | Size (nm) |
|---|---|
| *Vanga bhasma- I* | 74.50-45.20 |
| *Vanga bhasma- II* | 1729-1323 |
| *Vanga bhasma- III* | 786-86.5 |

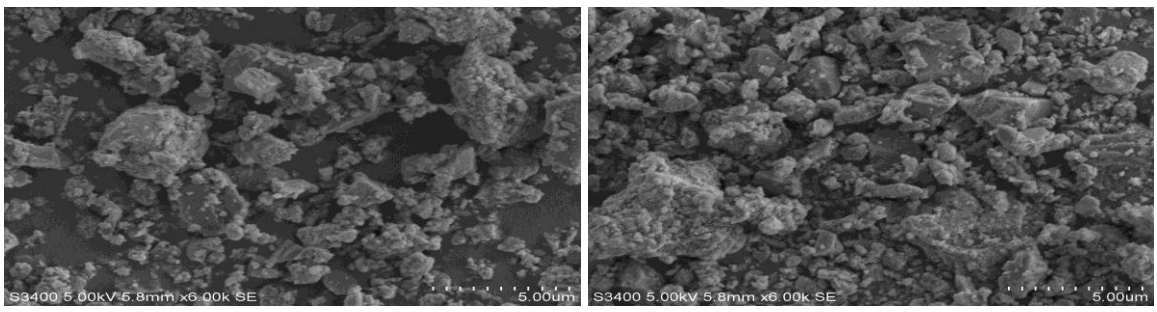
**SEM**

**VB-1**



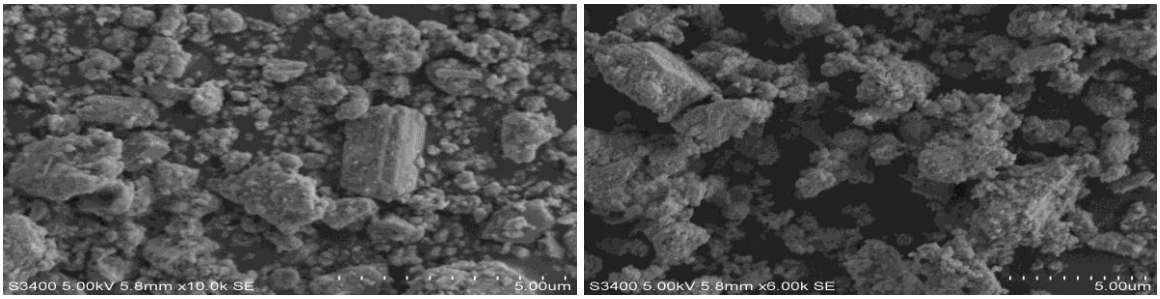

*Bhasma* on scanning showed Micro particles with granular appearance

**VB-2**




*Bhasma* on scanning showed Irregular cluster of particles which are randomly arranged, with uneven particle size**.**

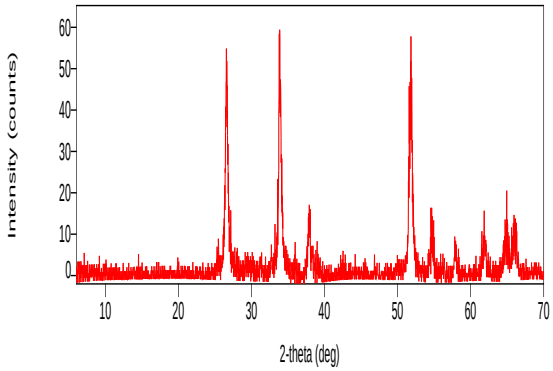
**VB-3**



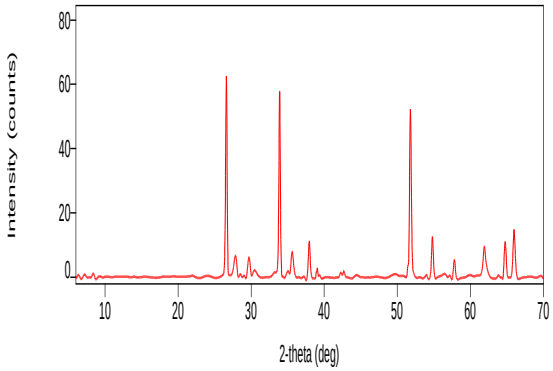

*Bhasma* on scanning showed that the particles are elongated and rod shaped and the size is not uniform.

**XRD- Graphs**

**VB-1**




**VB- 2**




**VB-3**

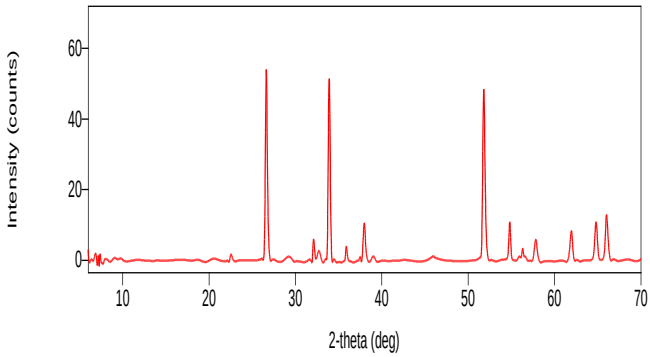
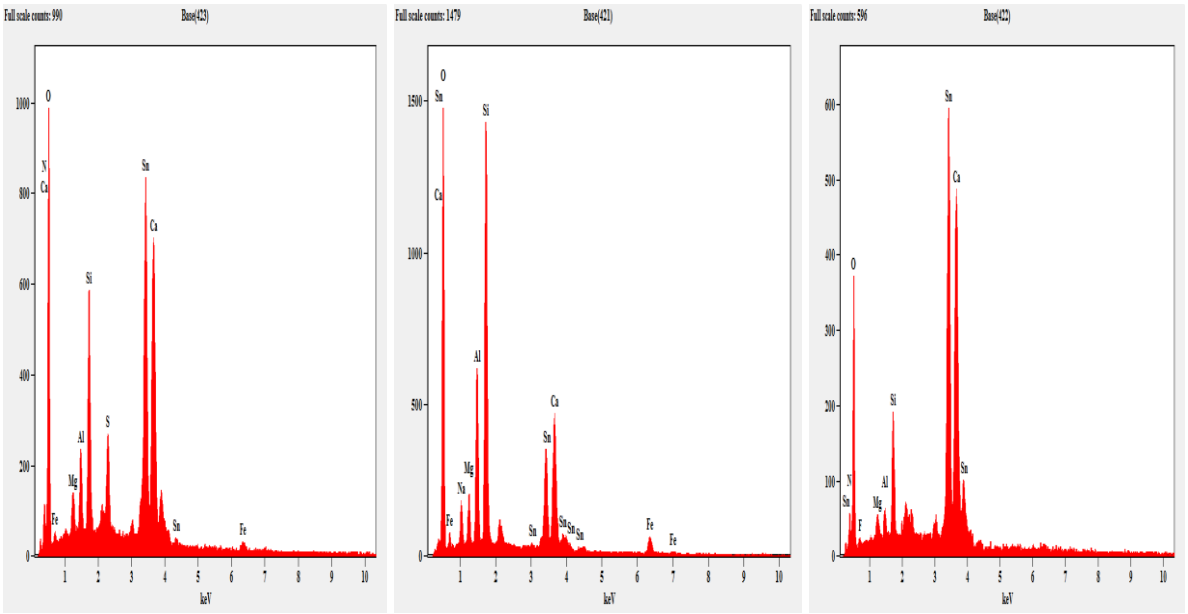



**Table no.8: Showing results of XRD analysis.**

| Bhasma samples | 3 strongest peaks observed at 2 theta |
|---|---|
| **VB-1** | 26.55, 33.8 and 51.7 |
| **VB-2** | 26.59, 33.8 and 51.7 |
| **VB-3** | 26.56, 33.8 and 51.7 |

The 3 strongest peaks observed at 2 theta in all the 3 samples of Vanga bhsma represents $SnO_2$, Sn and $SiO_2$. The major component (over 95%) is Tin Oxide, possibly Cassiterite.

**EDAX- Graphs**



**VB-1** **VB-2** **VB-3**

**Quantitative Results of EDAX-**

**VB-1**

| *Element Line* | *Weight %* | *Weight % Error* | *Atom %* |
|---|---|---|---|
| ***N K*** | 5.24 | ± 0.72 | 9.53 |
| ***O K*** | 42.87 | ± 0.89 | 68.21 |
| ***Mg K*** | 1.31 | ± 0.19 | 1.37 |
| ***Al K*** | 2.18 | ± 0.22 | 2.06 |
| ***Si K*** | 6.46 | ± 0.19 | 5.85 |
| ***Si L*** | --- | --- | --- |
| ***S K*** | 2.15 | ± 0.16 | 1.71 |
| ***S L*** | --- | --- | --- |
| ***Ca K*** | 5.95 | ± 0.37 | 3.78 |
| ***Ca L*** | --- | --- | --- |
| ***Fe K*** | 0.97 | ± 0.20 | 0.44 |
| ***Fe L*** | --- | --- | --- |
| ***Sn L*** | 32.87 | ± 1.19 | 7.05 |
| ***Sn M*** | --- | --- | --- |
| ***Total*** | 100.00 | | 100.00 |

**VB-2**

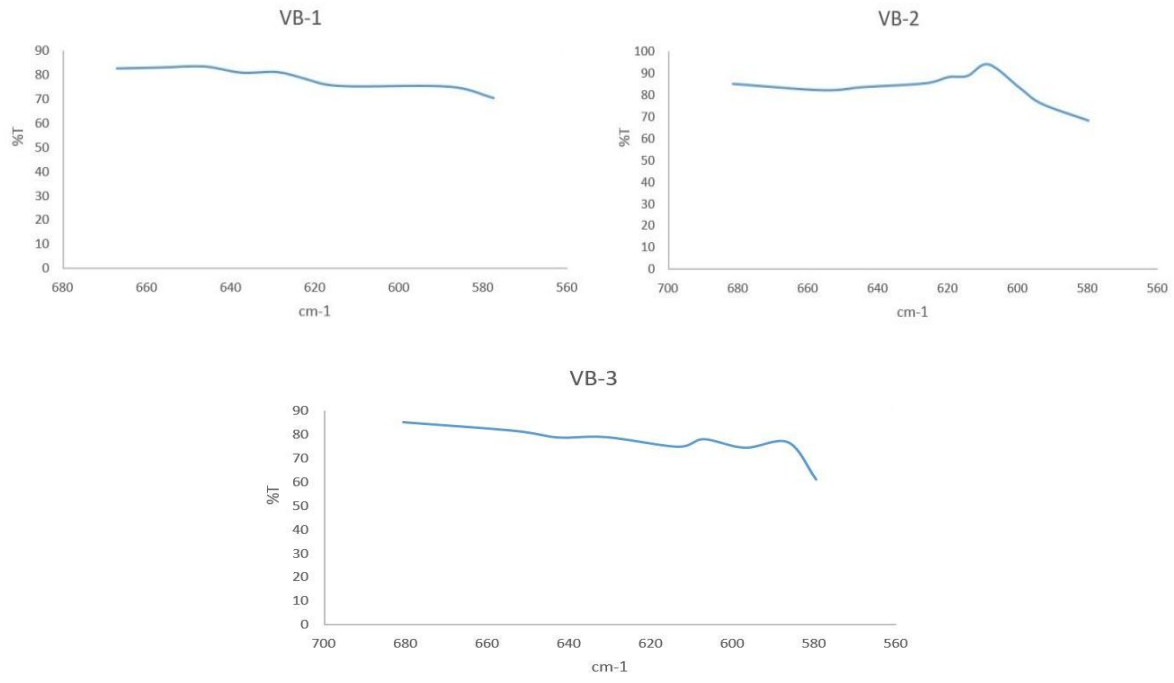
| *Element Line* | *Weight %* | *Weight % Error* | *Atom %* |
|---|---|---|---|
| ***O K*** | 46.21 | ± 0.61 | 67.32 |
| ***Na K*** | 3.32 | ± 0.30 | 3.36 |
| ***Mg K*** | 1.65 | ± 0.21 | 1.58 |
| ***Al K*** | 6.28 | ± 0.27 | 5.42 |
| ***Si K*** | 6.74 | ± 0.23 | 3.90 |
| ***Si L*** | --- | --- | --- |
| ***Ca K*** | 6.30 | ± 0.29 | 3.67 |
| ***Ca L*** | --- | --- | --- |
| ***Fe K*** | 4.16 | ± 0.38 | 1.74 |
| ***Fe L*** | --- | --- | --- |
| ***Sn L*** | 25.34 | ± 0.44 | 13.01 |
| ***Sn M*** | --- | --- | --- |
| ***Total*** | 100.00 | | 100.00 |

**VB-3**

| *Element Line* | *Weight %* | *Weight % Error* | *Atom %* |
|---|---|---|---|
| ***N K*** | 4.94 | ± 0.55 | 11.07 |
| ***O K*** | 31.69 | ± 1.30 | 62.19 |
| ***F K*** | 0.14 | ± 0.85 | 0.23 |
| ***Mg K*** | 1.22 | ± 0.12 | 1.58 |
| ***Al K*** | 1.19 | ± 0.11 | 1.39 |
| ***Si K*** | 4.32 | ± 0.12 | 4.83 |
| ***Si L*** | --- | --- | --- |
| ***Ca K*** | 7.28 | ± 0.54 | 5.70 |
| ***Ca L*** | --- | --- | --- |
| ***Sn L*** | 49.22 | ± 0.88 | 13.02 |
| ***Sn M*** | --- | --- | --- |
| ***Total*** | 100.00 | | 100.00 |

EDAX confirmed the presence of Tin, Oxygen, Nitrogen, Allumium, Silica, Calcium, Sulphur, Magnesium and Iron in VB-1, Tin, Oxygen, Aluminum, Silica, Calcium, Sodium, Iron and Magnesium in VB-2 and in VB-3-Tin, Oxygen, Nitrogen, Aluminium, Silica, Calcium and Magnesium. In all the 3 samples, the major percentage was Tin oxide.

**FTIR-Graphs**




The resultant FTIR graphs of all the 3 samples of *Vanga bhasma* revealed various functional groups in the samples. It was observed that organo-metallic bonds were formed in the

*Bhasma.* The Sn-O bonding at wave number 646.41 and Sn-C bonding at wave number 588.05 is present in *Vanga bhasma.*

**Table No.9: Quantitive analysis of Tin.**

| Samples | Sn % |
|---|---|
| Raw *Vanga* | 78.84 |
| *Vanga bhasma- I* | 32.87 |
| *Vanga bhasma- II* | 49.22 |
| *Vanga bhasma- III* | 25.34 |

## DISCUSSION

### Discussion on Pharmaceutical Study

### *Shodhana* of *Vanga*

During quenching there is sudden fall in the temperature from $250^0$C to $45^0$C due to which there is sudden reduction in the inter molecular space of the molten metal and sudden cooling leads to breaking of the metal and may lead to the formation of coarse grain structure of the metal and this structure is more brittle than the original metal.[12] The time taken for melting of Vanga increases after subsequent dhalana, this is due to increase in melting point of Shudha *Vanga* when compared to raw *Vanga*.[12]

### *Jarana* of *Shuddha Vanga*

According to classics, *Chincha* and *Ashwattha twak churna* are good *maraka dravyas* for *Vanga Jarana*. Over all review of the herbal drugs which are used in *Vanga Marana* contains *Kshara* (Alkaline nature). The *Kshara* is having corrosive & dissociation property, which helps in converting the metal into powder form and also by its *Bhedana* property *Kshara* may make the metal more soft and brittle. These drugs when burnt gets converted into ash, which helps in easy breaking of the metal and also helps in Oxidation process. In this study the time taken for *Jarana* of *Vanga* was 18 hours. The time duration depends on the amount of pressure applied during the procedure. In the final stage of *Jarana*, previous studies revealed that temperature of frying pan and the temperature of *Jarita Vanga* was found to be 670°C & 620°C respectively. After *Jarana* process, increase in weight may be due to oxidation.

### Marana of Vanga

### Role of media in Marana

*Bhasma* prepared with *Parada* as a media is *Shreshta* i.e superior, as it helps in the disintegration of metals & minerals and there will be induction of properties of *Parada* like

*Yogavahi, Rasayana* etc into the prepared *Bhasma. Parada* will enhance the property of the main metal from its *Yogavahi* property. *Bhasma* prepared with *mulika* as a media is *Madhyama*. Here alkaline and acidic contents oushadha moolikas helps in disintegration of atoms but Marana with *Mulika* media needs more number of *Putas* and the *Kshara* property of the product will be increased. This sometimes helps in curing diseases but sometimes it causes *dhatukarshaka* and *pumsatvanashaka.*

*Bhasma* prepared with *Ariloha* as a media is *Durgunaprada*. From classical texts like *Ayurveda prakasha, Rasendra Mangala* and *Rasa Ratna Samucchaya* it is clear that *Ariloha* means *Shatru loha* i.e enemy metal or opposite metal. *Ariloha* helps in faster disintegration of metals and minerals by forming sulphides or oxides and thus *Bhasma* can be easily prepared with less number of *putas*. But the qualities like *ushna, teekshna* & *visha* properties of *Arilohas* will be added into *Bhasmas.* As the prepared *Bhasma* becomes toxic and may leads to many disorders, *Bhasma* prepared with *Ariloha* is considered as *durgunaprada.*

In the present study, the reference of *Bhasma* prepared by *Gandhakadi dravyas* is not taken because there is no proper reference for the drugs which are to be taken and the *Bhasma* prepared out of it is said to be *Kanishta*.

Though, *Ardhagajaputa* was mentioned in reference, but increase in hardness of *Chakrikas* and colour change indicates excess heating and leads to the decrease in the number of cow dung cakes gradually. There was significant amount of weight gain in the final product of Vanga bhasma prepared by Shatavari swarasa. Asparagus racemosa contains huge amount of minerals like Potassium, Calcium, Iron, Manganese, Zinc, Copper, Magnesium, Sodium[13] which may be added to the *Bhasma.* 45% loss was observed in Vanga bhasma prepared by Haratala (Ariloha), this may be attributed to evaporation of Haratala during puta.

## DISCUSSION ON ANALYTICAL STUDY

**Table no.10: Showing the interpretations of *Bhasma pareekshas.***

| Sl.No | Name of *Pareeksha* | Interpretation |
|---|---|---|
| 1 | *Varna* | Specific Chemical Form |
| 2 | *Nischandra* | Absence of free metal |
| 3 | *Rekhapurnatha* | Reduced particle size, fineness |
| 4 | *Varitara, Unama* | No free metal, Lightness and fineness of *Bhasma*, specific gravity less than water, does not break the surface tension |
| 5 | *Apunarbhava* | It indicates the *Bhasma's* irreversible |

| | | |
|---|---|---|
| | | state of becoming again the same metal |
| 6 | *Niruttha* | Absence of free metal |
| 7 | *Nirdhuma* | Indicates absence of organic or volatile matters Present |

**Modern Parameters**

**Physico-Chemical Tests**

**pH (1% solution)-** From pH values of all the three samples, *Bhasma* prepared with *Parada* is acidic in nature, prepared with *Shatavari* is slightly alkaline and prepared with *Haratala* is alkaline in nature.

**Ash Value-** The ash value of all the three samples was more than 98%, indicating that all the samples are having more inorganic matter.

**Acid Insoluble ash and Water Soluble ash-** The acid insoluble ash value of all the three samples are high, this may be due to the presence of Silica. The Water soluble ash value of all the three samples are very less, which indicates that the *Bhasma* is least soluble in water.

**CHARACTERIZATION**

**Particle size**

Particle size analysis is an objective parameter for the assessment of subjective property of *Bhasma* called *Rekhapurnatva* which is mentioned in *Rasashastra* classics. Smaller the particle size, larger is the surface area and greater are the chances of absorption. Particle size of all the three samples of *Vanga bhasma* were in the range of nanometer. However, *Bhasma* prepared by *Parada* is having lesser particle size when compared to other 2 medias which indicate greater chances of absorption. *Vanga bhasma* prepared by *Hartala* is having lesser particle size when compared to *Shatavari swarasa. Vanga bhasma* prepared by *Shatavari swarasa* is having larger particle size when compared to all other medias.

**SEM**

SEM images of all the samples showed particles which are not uniform in size and shape which may be due to manual handling.

**XRD**

X-ray powder diffraction is a rapid analytical technique primarily used for phase identification of a crystalline material and can provide information on unit cell dimensions.

The XRD pattern of *Vanga bhasma* was compared with powdered diffraction standards and it was observed that the compound drug *Vanga bhasma* gave an identical XRD pattern as that of Cassiterite form of tin Oxide. The XRD of all three samples of *Vanga bhasma* showed crystalline structure. During calcination at high temperature, the amorphous materials are transformed into crystalline materials and also there will be formation of nano sized particles. The 3 strongest peaks of all the 3 samples of *Vanga bhasma* at 2theta are 26.55, 33.8 and 51.7 representing $SnO_2$, Sn and $SiO_2$. The major component (over 95%) is Tin Oxide, possibly Cassiterite. The predominant peaks in the sample corresponds to major phase comprising $SnO_2$.

**EDAX**

It is an analytical technique used for the elemental analysis or chemical characterization of a sample. This analysis confirmed the presence of Tin, Oxygen, Aluminium, Silica, Calcium, Sodium, Iron, Magnesium, Nitrogen and Sulphur in their oxide form. The major percentage was Tin oxide. The source of the other elements can be attributed to the fact that various processes involving different herbal drugs were used in the pharmaceutical manufacturing of *Vanga bhasma*. The processing containers and *Sharava* used during *Puta* may also have contributed to the addition of these elements. Variations in the trace elements is seen between prepared *Vanga bhasma* samples. This may be due to the use of different media during preparation of *Vanga bhasma*. The percentage of Tin decreased in all the 3 samples of *Vanga bhasma* when compared to raw *Vanga*. This may be due to heating process and may due to the formation of Tin oxide.

**FTIR**

FTIR is an effective analytical instrument for detecting functional groups and characterizing covalent bond. FTIR identifies chemical bonds in a molecule by producing an infrared absorption spectrum. The major finding in FTIR was that the *Bhasma* is an organometallic compound. In all the three samples of *Vanga bhasma* there is a formation of bond between Tin (Sn) and Carbon (Sn-C) and between Sn and Oxygen (Sn-O) at different wave number with slight variation, representing the formation of Tin carbide and Tin oxide.

**CONCLUSION**

Particle size of all the three samples of *Vanga bhasma* were in the range of nanometer. *Vanga bhasma* prepared by *Parada* as a media is having lesser particle size when compared to other 2 medias used which indicates the greater chances of absorption. XRD studies revealed that

the major component (over 95%) in all the 3 samples is Tin Oxide, possibly Cassiterite form of Tin oxide. EDAX revealed the presence of various trace elements with the major percentage being Tin oxide. The major finding in FTIR was that the *Bhasma* is an organometallic compound comprising of Sn-C and Sn-O bondings, representing the formation of Tin carbide and Tin oxide.

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