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ANALYTICAL STUDY OF *YASHADA BHASMA* WITH *AYURVEDIC* AND MODERN PARAMETERS

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ABSTRACT

Rasashastra is a specialized branch of *Ayurveda* which deals with the pharmaceutics of its unique and potent preparations. *Bhasmas* (calx) are one among such preparations which are prepared after various *Samskaras* (processings) like *Shodhana* (purification), *Jarana* (roasting), *Marana* (incineration), *Amrutikarana* (nectarization) etc. They are said to be properly prepared if they pass certain *bhasma parikshas* (tests) enlisted in classical *Rasashastra* texts. But in this era, only *bhasma parikshas* are not ample to satisfy the modern scientific world. Hence the present study was carried out to evaluate an *Ayurvedic bhasma* with both modern and ancient parameters.

Yashada bhasma, a Zinc based Ayurvedic metallic preparation, was prepared as per *Rasa chandamshu* text and it was tested with both ancient and modern analytical parameters to know how the basic metal was transformed into bio-absorbable *bhasma* form and also to know its physical nature as to in which form the final product is. The ancient *bhasma parikshas* revealed that the *bhasma* prepared after two *gajaputas* (heating system) passed all the tests and thus ascertaining it was properly formed and modern analytical techniques like XRD (X ray diffraction) identified the final product as Zinc oxide (ZnO). SEM (Scanning electron microscopy) revealed the amorphous nature of the *bhasma* with particle size range 5 – 20 micrometer. ICPAES (Inductively coupled plasma atomic emission spectroscopy) showed the presence of Zinc in major portion (95.08ppm) and other elements like Sn (0.27), Pb (0.14), Fe (1.69), Ca (1.82), Mg (1.00), Cu, Co and Mn < 0.5 ppm in the final product.

Hence it can be concluded that ancient tests are handy in the qualitative aspect where as modern tests are useful for quantitative aspect but both of them are practically suited to test the proper formation of *bhasma.*

Keywords: *Yashada*, XRD of *Yashada bhasma, Shodhana, Jarana, Marana*

INTRODUCTION

The significance of *Rasoushadhis* is in the fact that they are used in *Alpa matra* (minute doses) and fast acting. *Bhasmas* are one among such *Rasoushadhis* which are complex compound forms of metals or minerals obtained by repeated incineration with liquid extracts. *Yashada bhasma,* Zinc based Ayurvedic metallic preparation is indicated specially in *Prameha* (diabetes) and associated complications. Various methods are described in classical *Rasashastra* texts to prepare *Yashada bhasma* but the *bhasma* prepared by using *Parada* (mercury) is believed to be *Sreshta* (best).[1] Hence *Yashada bhasma* was prepared as per *Rasa chandamshu* text and its analysis was done using both ancient and modern parameters.

Classical texts have enumerated certain tests which ensure the proper transformation of basic metal in to bio-absorbable *bhasma* form. But today due to questions arose about the safety of *Rasoushadhis* it is advised to use the advanced modern technology to ensure the proper formation of *bhasmas.* A number of modern analytical techniques are available to know the material characterization of *bhasmas.* Among them XRD (x ray diffraction) is one of the important technique by which, compounds of the material and free metals in it (if in detectable limits) can be detected. SEM (Scanning electron microscopy) deals with the surface structure of the material and even the particle size of the material can be calculated. ICPAES (Inductively coupled plasma atomic emission spectroscopy) is one of the most common techniques used for elemental analysis.

MATERIALS AND METHODS

Yashada (Zinc metal) and the associated materials used for the preparation of *Yashada bhasma* were collected from the PG Dept of Rasashastra, K. L. E. Shri B. M. K. Ayurveda Mahavidyalaya, Shahapur, Belagavi, Karnataka, India. Methods adopted for the preparation of *Yashada bhasma* include *Dhalana* (a process where molten Zinc was poured into specific liquids), *Jarana* (roasting purified Zinc with *Achyranthes aspera* powder) and *Marana* (adding roasted Zinc with 1/4th Mercury and Sulphur and triturating with *Aloe vera* – *Citrus limon* juices and subjecting to *Gajaputa*).

Samanya shodhana (general purification) was done by the *Dhalana* (liquefying and pouring) method in *Kanji* (sour gruel), *Takra* (butter milk), *Kulattha* (*Dolichus biflorus) kwatha* (decoction), *Gomutra* (Cow's urine) and *Tila* (*Sesamum indicum) Taila* (oil). *Dhalana* was carried out three times in each liquid media.[2] After *samanya shodhana*, *Vishesha shodhana* (specific purification) was carried out in *Churnodaka* (lime water) for seven times.[3] After *shodhana*, the metal became more brittle and was then subjected to *Jarana* (roasting) using *Apamarga panchanga churna* (powder of *Achyranthes aspera*).[4] After *Jarana*, the metal was converted into a very fine grey shining powder which was deemed fit for *Marana* (incineration). The powder was then subjected to *Marana* by triturating it with *Shuddha Parada* (purified Mercury) and *Shuddha Gandhaka* (purified Sulphur) both 1/4th quantity of *Yashada*, to form a black powder, to which one *bhavana* (triturating in liquid media) each with *Kumari swarasa* (fresh juice of *Aloe vera*) and *Nimbu swarasa* (fresh juice of *Citrus limon*) was given and *Chakrikas* (pellets) prepared. After drying, they were kept in *sharava* (casseroles), *sandhi bandhana* (sealing) was done and subjected to *Gajaputa* (heating system). After two *Gajaputas*, *Yashada bhasma* of yellowish color was obtained (figure 1).[5]

Figure 1: Yashada Bhasma

Analysis of *bhasma* using ancient parameters (*Bhasma Parikshas*):

The *bhasma* was analyzed for quality control as described in *Ayurvedic* texts and the following observations were made:

1. *Rekhapurnata*: A pinch of *Yashada bhasma* was rubbed in between thumb and index finger. It was observed that *bhasma* enters the furrows of finger.
2. *Varitara*: Clean water was taken in a glass and allowed to standstill. A pinch of *Yashada bhasma* was sprinkled on the surface of water. It was observed that *bhasma* floats on the surface of the water.
3. *Unama*: This is continuation of the above test where in rice grain was placed on the surface of floating *bhasma*. It was observed that the floating still persists (figure 2).

Figure 2: Unama test

4. *Niswadu*: A pinch of *bhasma* was placed on the tongue and its taste was perceived to be tasteless i.e absence of metallic taste.
5. *Nishchandrata*: A pinch of *bhasma* was taken and observed under bright sunlight. There were no shining particles in the *bhasma*.
6. *Nirdhumatva*: A pinch of *bhasma* was sprinkled on the ignited charcoal and observed no fumes emerging out of it.
7. *Apunarbhava*: One gram of *Yashada bhasma* was triturated with *Guda* (jaggery), *Gunja* (*Abrus pricatorius*), *Tankana* (borax), *Madhu* (honey) and *Ghrita* (ghee) one gram each and a paste was prepared. This paste was kept in a Musha (crucible) and *sandhi bandhana* (sealing) was done. It was then subjected to *teevragni* (Intense heat up to 1000^{o}C) for one hour. After *swangasheeta* (self cooling) *musha* was opened and the charred mass was powdered and observed no any shining particles.
8. *Niruttha*: *Yashada bhasma* (5 g) and a silver piece (5 g) were kept in a *musha*, *sandhi bandhana* done and it was then subjected to *teevragni* for one hour. After *swangasheeta*, *musha* was opened and the silver piece was weighed. There was no increase in the weight of the silver piece which indicated the *bhasma* passed the test.
9. Namburi phased spot test of *Yashada bhasma*: In the 1st phase (0-5min), after putting a drop of *Yashada bhasma* solution on the potassium iodide paper, a wet central spot spread outside with immediate formation of bright white glittering surface over the spot. In 2nd phase (5-20min) it was observed that the spreading of the drop stopped. Thin reddish outer ring around the white spot was seen. The white spot was very bright in this stage. Later in the 3rd phase (20 min-24 hours) the brightness of the white spot was maintained. There was a clear yellowish periphery around the centre spot. It was fluorescent under UV chamber (figure 3).

Figure 3: NPST of Yashada Bhasma

Analysis of *bhasma* using modern parameters: All the following tests were conducted in IIT-Bombay with the assistance of concerned subject experts.

X-ray diffraction analysis:

XRD of *Shodhita* samples:

After *samanya shodhana* of *Yashada*, the obtained product was major quantity of *Yashada* only. XRD peaks of this sample correspond to untransformed Zinc metal. This was evidenced by presence of strongest Zn peak. But after *vishesha shodhana*, some part of it was transformed to Zinc oxide which was known by the presence of ZnO peaks in the XRD (Table 1).

Table 1: Showing 2θ value of three strongest peaks of samanya & vishesha shodhita yashada

Yashada	2θ value
Samanya shodhita	38.739 (Zn), 62.560 (Zn), 71.942 (Zn)
Vishesha shodhita	38.360 (Zn), 33.060 (ZnO), 55.320 (ZnO)

XRD of *Jarita* and *Marita* samples:

In *Jarita Yashada* sample, the XRD peaks were identified to be as ZnO, Zn and $ZnCO_3$. The strongest peak corresponds to Zinc and few weak peaks correspond to Zinc oxide and Zinc carbonate peak is very low in intensity. After the *chakrika* (pellet) preparation the XRD was carried out and it was seen that the strongest peaks corresponded to Zinc sulphide (ZnS) (Table 2 and 3).

Table 2: Showing 2θ value of different compounds in Jarita yashada

Sample	2θ value
Jarita Yashada	38.579 (Zn), 33.220 (ZnO), 30.521 ($ZnCO_3$)

Table 3: Showing 2θ value of pellets (chakrika) sample

Sample	2θ value
Chakrika	26.360 (ZnS), 43.7 (ZnS), 38.358 (ZnS)

After the first *puta*, the sample showed strongest peaks which were identified as Zinc Sulphide (ZnS) (figure 4) and also minor peaks of Zinc oxide. But after 2nd *puta* the strongest peaks were identified as Zinc oxide (ZnO) (figure 5) (Table 4).

Table 4: Showing 2θ value of Yashada bhasma samples

Sample	2θ value
After 1st puta	24.941 (ZnS), 28.339 (ZnS), 26.639 (ZnS)
After 2nd puta	31.913 (ZnO), 34.558 (ZnO), 36.362 (ZnO)

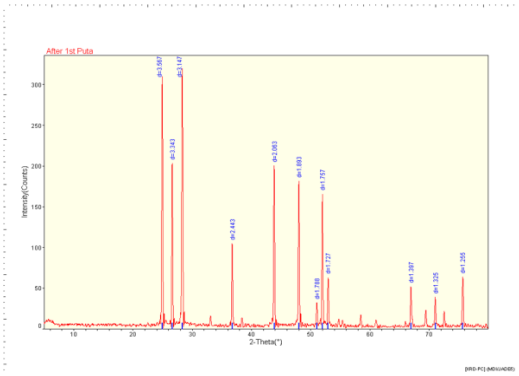

Figure 4: XRD after first puta

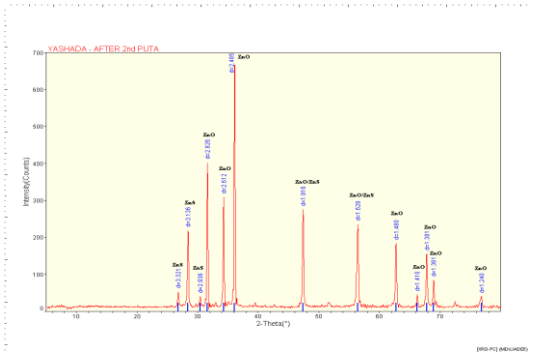

Figure 5: XRD after second puta

Scanning Electron Microscopy:

- *Jarita Yashada*: Average size 5-30 micro meter poly disperse, typical 30 micro meters spherical with coarse surface (figure 6).

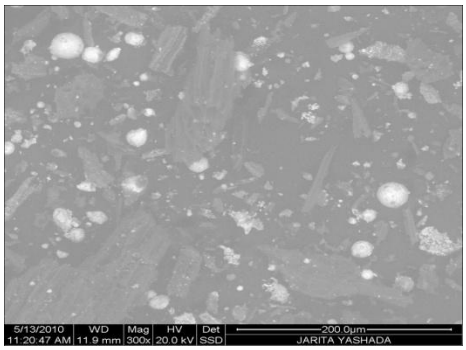

Figure 6: SEM image of Jarita Yashada

- After *Puta* 1: Amorphous in nature with particles in the range of 1-100 micrometer but still some polyhedral particles in the range of 20-30 micro meters were seen (figure 7).

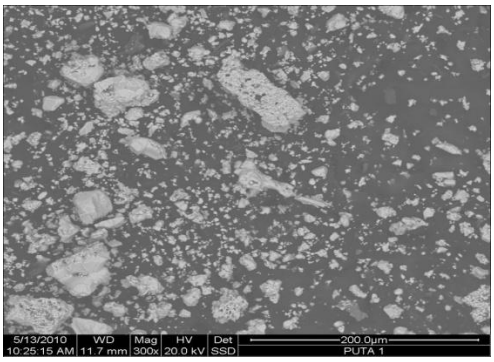

Figure 7: SEM after first puta

- Afetr *Puta* 2: Amorphous in nature with particle size range 5 – 20 micrometer (figure 8).

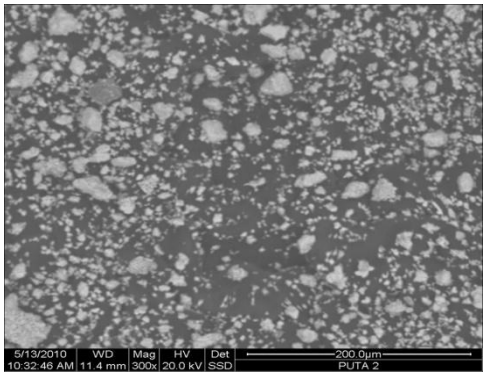

Figure 8: SEM after second puta

Inductively coupled plasma atomic emission spectroscopy:

- Zinc in major concentration was noted with 95.08 ppm and other elements like Sn (0.27), Pb (0.14), Fe (1.69), Ca (1.82), Mg (1.00), Cu, Co and Mn < 0.5 ppm were reported.

DISCUSSION

During *samanya shodana, Yashada* (Zinc) was melt at 420^{o}C and poured into *Kanji, Takra, Kulattha kwatha, Gomutra* and *Tila Taila* for three times in each liquid media. On the completion of this process *Yashada* was converted into solid, brittle, silvery colored along with some fine particles. *Yashada* melts at 420^{o}C but the duration of melting was extended after every *Dhalana.* The XRD analysis of *samanya shodhita yashada* shows the peaks of Zinc metal (Zn). There might be transformation of Zinc into compounds but due to its very small quantity that might not be detected in XRD. These compounds may be present extremely small amounts in the slag floating on the Zinc metal.

Zinc purified by the general method was heated to melt and poured into *Churnodaka* (lime water) for seven times with fresh liquid each time. Molten Zinc when came in contact with liquid media produced loud blasting sound. The melting duration was extended on every *dhalana* procedure due to presence of carbonaceous material. This type of repeated liquefying and pouring in liquid media resulted in the formation of large amount of slag which floated on the surface of molten Zinc. This powder was analyzed and as expected the XRD showed peaks of Zinc oxide and Zinc metal. This substantiates that the metal is transformed to compounds in *Shodhana* step too.

Vishesha shodhita yashada was melted in an iron pan at the temperature

range of 600 – 700°C and *Apamarga panchanga churna* was added little by little and rubbed with an iron ladle with pressure. The process was continued till it turned to powder form completely. This is known as *jarita yashada.* When *Apamarga* is added to molten *Yashada,* immediately it burns and becomes carbon. While rubbing molten *yashada* along with *Apamarga,* initially the whole material was changed into black powder form, later its color turned to grey. The reactive components of *Ahyranthes aspera* helped in further disintegration of Zinc particles into Zinc compounds in open atmosphere. Potassium being main constituent of *Ahyranthes aspera* will give rise to potassium oxide (alkali) at high temperature.[6] Formation of Zinc compounds depends upon the concentration of potassium oxide which reacts with Zinc during *Jarana* process. But on examining the XRD spectra of *jarita yashada,* it was found that ZnO is the main product with weak peaks of Zn and $ZnCO_3$.

The *Jarita yashada* was added with mercury and sulphur and triturated well to form a uniform mixture which is called *Kajjali*. Then *Bhavana* of *Kumari swarasa* and *Nimbu swarasa* was given and pellets prepared. On analyzing these pellets it was noted that the strongest peaks were that of Zinc Sulphide (ZnS). These pellets were subjected to *gajaputa* (700 – 1000°C) and *Yashada bhasma* was obtained which did not pass *Nishchandrata* (free from shining particles) test. Hence the *puta* was repeated and after second *puta,* the *bhasma* obtained passed all the classical *bhasma parikshas* like *Rekhapurnata* (the *bhasma* particles should enter the furrows fingers), *Varitara* (*bhasma* particles should float on the surface of water), *Niswadu* (tasteless), *Apunarbhava* (*bhasma* should not regain its original metallic lusture) and *Niruttha* (weight of Silver piece heated with the *bhasma* should not increase).

The XRD spectra of *bhasma* after first *puta* showed peaks of Zinc Sulphide which indicates the incomplete transformation of metal to its oxide form which was also supported by the *bhasma pariksha* as it did not pass the *Nishchandrata pariksha.* But after second *puta* the XRD spectra of *Yashada bhasma* shows major peaks which were identified as Zinc oxide (ZnO) compound. Weak peak of Zinc which was seen in XRD of *jarita yashada* sample was not seen in *Yashada bhasma* sample which indicates complete transformation of metal to Bhasma form.

SEM evidenced the reduction in the particle size of the material stage by stage. The average particle size of *jarita yashada* was in the range of 5-30 micro meter, poly disperse, typical 30 micro meters spherical with coarse surface. It was then noted that after *Puta* 1, the material was amorphous in nature with particles in the range of 1-100 micrometer but still some polyhedral particles in the range of 20-30 micro meters. Finally afetr *Puta* 2, the bhasma formed was amorphous in nature with particle size range 5 – 20 micrometer.

ICPAES revealed the presence of Zinc in major concentration with 95.08 ppm. The other elements like Sn (0.27ppm) and Pb (0.14ppm) are well within normal limits and their presence may be attributed to the raw material. Fe (1.69ppm) was noted which may be due to the usage of Iron vessels during *shodhana* and *jarana.* Ca (1.82ppm), Mg (1.00ppm), Cu, Co and Mn < 0.5 ppm were also reported which may be added from the herbal sources like *kumara swarasa*.

CONCLUSION

The structural and chemical transformation of metal into metal compounds (*bhasma*) which are bio absorbable is the main objective of *marana*. To avoid any toxicity and adverse effects of *bhasma,* the complete transformation of base metal into *bhasma* form is prime requisite. To check whether the *bhasma* is properly formed or not, *Rasashastra* texts have laid down certain *bhasma parikshas* (tests). These *bhasma parikshas* are qualitative in nature and they don't reveal anything about the characterization. Hence to overcome this lacuna, modern analytical parameters like XRD, SEM, ICPAES etc are very helpful.

Yashada bhasma prepared classically was subjected to both classical and modern analytical parameters. Classical *bhasma parikshas* undoubtedly approved the *Yashada bhasma* but the modern techniques helped to know the final product in detail. XRD revealed the compound nature of the final product as ZnO. SEM showed the particle size and the surface structure of the *bhasma.* ICPAES detailed about the elemental composition of the *bhasma.* Hence both classical and modern analytical parameters are to be used for justification of the proper preparation of Ayurvedic *bhasma.*

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