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X – RAY DIFFRACTION ANALYSIS OF YASHADA BHASMA: AN AYURVEDIC METALLIC PREPARATION

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ABSTRACT
Bhasmas are unique and potent Ayurvedic preparations, which are prepared after various samskaras (processing) like Shodhana (purification), Jarana (roasting), Marana (incineration), Amrutikarana (nectarisation) etc. They are said to be prepared properly if they pass certain bhasma parikshas (tests) enlisted in classical Rasashastra texts. But in this modern era only bhasma parikshas may not satisfy the scientific world hence Yashada bhasma was prepared as per Rasa chandamshu text and its step by step XRD analysis was done and reported. The XRD peaks of Yashada bhasma were identified as Zinc oxide (ZnO).
Key words: Yashada, XRD of Yashada bhasma, Shodhana, Jarana, Marana

INTRODUCTION

"Alpamatropayogitvat arucheraprasangata
Kshipramarogyadayitvat aushdhebhyadhiko rasa"

The above verse from Rasendra sara sangraha highlights the enormity of Rasoushadhis which say that they are used in very minute doses, easily palatable 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 is one such bhasmas which 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[1] (best). Hence Yashada bhasma was prepared as per Rasa chandamshu text and its XRD analysis was done.

A number of modern analytical techniques are available for material characterization of bhasmas. Among them XRD analysis is one of the important technique by which compounds of material and free metals can be detected. Hence the changes in the material during samanya shodhana (general purification), vishesha shodhana (specific purification), jarana (roasting) and marana (incineration) of the Yashada was observed by using XRD which confirm the authenticity of the transformation of material into a compound or orally administrable form.

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[2] (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. After samanya shodhana, Vishesha shodhana[3] (specific purification) was carried out in Churnodaka (lime water) for seven times. After shodhana, the metal became more brittle and was then subjected to Jarana[4] (roasting) using Apamarga panchanga churna (*Achyranthes aspera*). 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[5] 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 with 1000 dried cow dung cakes). After two Gajaputas, Yashada bhasma of a yellowish colour with all the desired characters mentioned in the classical literature was obtained.

X-Ray Diffraction analysis

XRD of Shodhita samples

After samanya shodhana of Yashada, the obtained product was major quantity of Zinc 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: 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)

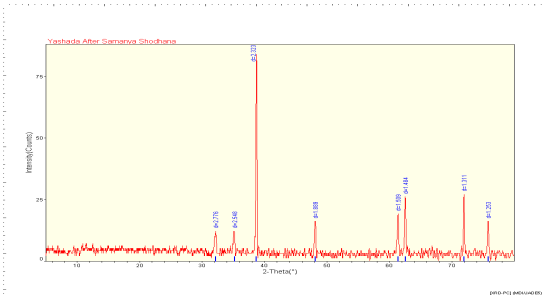

Figure 1: XRD of samanya shodhita yashada

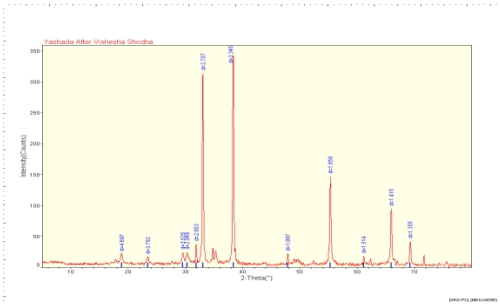

Figure 2: XRD of vishesha shodhita yashada

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)

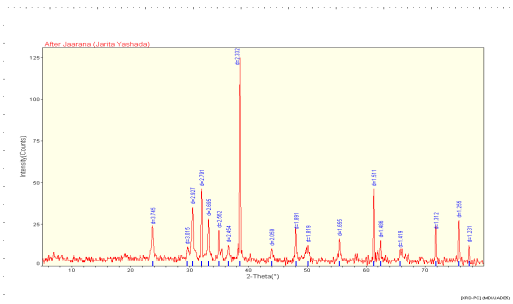

Figure 3: XRD of jarita yashada

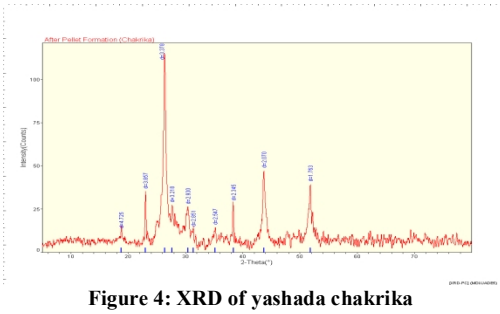

Figure 4: XRD of yashada chakrika

After the first puta, the sample showed strongest peaks which were identified as Zinc Sulphide (ZnS) and also minor peaks of Zinc oxide. But after 2nd puta the strongest peaks were identified as Zinc oxide (Zinc oxide) with very few peaks of low intensity of Zinc sulphide (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)

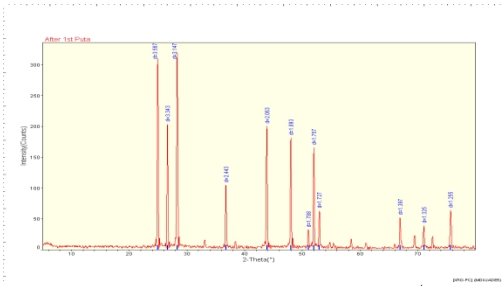

Figure 5: XRD of yashada bhasma after 1st puta

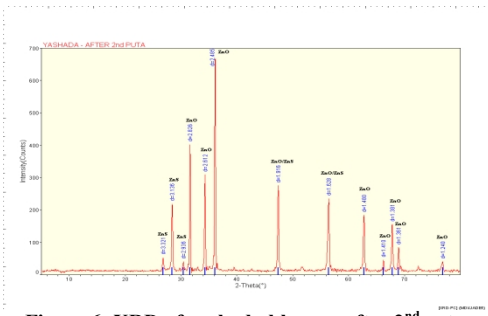

Figure 6: XRD of yashada bhasma after 2nd puta

OBSERVATION AND DISCUSSION

During samanya shodana, Yashada (Zinc) was melt at 420°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 mass along with some fine particles. Yashada melts at 420°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 in little quantity frequently 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 colour 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 and very weak peak identified as Zinc sulphide. Weak peak of Zinc which was seen in XRD of jarita yashada sample was not seen in Yashada bhasma sample.

CONCLUSION

The structural and chemical transformation of metal into metal compounds start from the shodhana step itself but in very minute quantity. Apamarga is rich with potash and it reacts with Yashada to form its compounds. Zinc will oxidize quickly when treated with alkali in presence of heat and open atmosphere. Jarana is pre stage of marana where in metal converts to its compounds maximum. After marana the free metallic Zinc which was seen in jarita yashada sample was not detected in XRD. Hence bhasmas, which are more advantageous over herbal drugs by virtue of their stability over long period, lower doses, easy storability, fast action, palatability, are the compound forms of metals or minerals with no traces of free metals.

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