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PIXE analysis of some Ayurvedic medicines

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Abstract : The elemental analysis of a group of Ayurvedic medicines known as Bhasmas was carried out using particle induced X ray emmision (PIXE) technique. This study reveals that many other elements are also present in addition to the ones already reported in literature In order to understand the bio-compatibility of these drugs, there is a need to study the chemical states of the elements present, in addition to their concentrations

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1. Introduction

A group of Ayurvedic medicines called bhasmas is taken for elemental analysis using Particle Induced X-ray Emission (PIXE). The term bhasma is found in the records after 1200 A.D. Bhasmas are usually reduced metals intended for internal use or these are the alkaline ashes derived from organic substances. Bhasmas involve physico-chemical action in order to make the inorganic substances bio-compatible. Various medicinal herbs are allowed to act on the metals and other inorganic substances which may produce the complex molecules to render innocuous the metallic poisons.

In recent times, even in allopathic system of medicines importance of metals has been recognized *e.g.* iron for iron deficiency, lithium for depression, gold for joint inflammation, mercury for skin disorders (but applied only locally) etc. Bhasmas include organometallic compounds which are known to have remarkable therapeutic activities. However, the rationality of bhasma is largely unknown.

In Ayurveda, a great emphasis is laid on the way a bhasma is prepared. The metals are first purified in vegetable oils and juices of different plants. They are then roasted in air tight earthen pots and finally ground and reduced in size to such a degree that the particles usually float over the surface of water, and this is the popular test in Ayurveda to see that bhasma

becomes 'Varitara' (floating over the water surface) and it should be so fine so as to get easily into the finger lines (Rekhapurnatwam). The number of steps involved in the preparation of bhasmas are described in ref [1]. Many times Ayurvedic drugs may differ in action from one pharmacy to another depending upon the method of preparation of the drug [1].

Ayurvedic formulations are extremely complex involving a large number of constituents and so their composition cannot be explored easily. Presently, elemental composition is found for twelve different bhasmas obtained from different pharmacies in final fine powder form, by the PIXE method. Elemental analysis of these medicines can be helpful in understanding the effect of these drugs on the normal distribution of elements in the living system after administration.

2. Analytical methods

PIXE method is used to analyze a group of bhasmas. Elements with Z higher than sodium can be detected using 29 MeV alpha particles from isochronous cyclotron at Bonn, Germany. PIXE analysis is suitable and has the following advantages : It is nondestructive, multielemental, sensitive and gives absolute concentration values. The concentration values are obtained using the fundamental parameter method; starting with particle stopping powers, X-ray production and attenuation cross sections and with geometric factors one calculates the relative X-ray intensities for a given composition. In an iterative process, the composition is varied until calculated and measured intensities agree. Matrix effects and enhancement corrections are included [2].Therefore, no tedious calibration measurements with different standards are necessary. However, following assumptions must be fulfilled :

(1) As only relative intensities are used for the calculation, one has to assume that the sum of the concentrations of the elements seen in X-ray spectrum corresponds to 100%. In present samples some low Z materials like carbon, hydrogen and oxygen etc are also expected to be present as bhasmas are reduced metals. However, this will not cause any problem in the evaluation of the matrix effects as they depends only on the high Z which constitutes the major matrix in present samples. As a test, we evaluated the relative weight concentrations of some of the samples assuming the metals to be present in oxide form. Table 1 shows the comparison of relative weight concentrations of pure and oxides of metals present in samples.

(2) The elements must be distributed homogenously with in the target which is true for these samples as bhasmas are always homogenised and tested for the fineness of the final powder.

(3) The target surface has to be flat and the angle between the beam and the target surface must be known. Since all the targets were in the form of pellets made by mixing the medicine with cellulose in the ratio 3 : 1 and pressing using a hydraulic press under the pressure of 30 kN, this was no problem. The targets are fixed on a frame one by one

Table 1. Comparison of weight concentration of metals relative to major element present in samples when metals considered to be present in oxide and pure form.

Sample name	Element	Major element	Relative conc. of elements in oxide form	Relative conc. of elements in pure form
Vanga	Fe	Sn	0.00083	0.0011
Bhasma	As		0 00023	0.0003
Ajmodadi	Cl		0.363	0.337
	K		0.475	0.449
Churna	Mn	Ca	0 0055	0.0056
	Fe		0.0766	0 077
	Zn		0.0028	0.0028
Godanti	S	Ca	0.351	0.341
Bhasma	Sr		0 0015	0.0012
Sranga	Cl		0.0037	0.0077
Bhasma	Mn		0 0024	0.0020
	Fe	Ca	0.0092	0.0078
	Sr		0.0019	0.0013
	Sn		0 0646	0.0366
Tamra	S		0.0788	0.0795
Bhasma	Cr		0 00086	0 00092
	Fe	Cu	0.032	0.032
	As		0.149	0.161
	Sn		0 052	0.044

outside the chamber for the irradiation. To assure that the targets were 45° to the beam, the targets were adjusted until a laser beam reflected from the target, was seen on the detector window.

3. Experimental setup

At the 's-way' beam line of the Bonn isochronous cyclotron, the beam spot is determined by the final diaphragm and the last quadrupole triplet (Figure 1).

The diaphragm consists of two piezo strips which bend apart if voltage is supplied. By the 'v'-form of the two aperture jaws a simultaneous reduction in horizontal and vertical directions is obtained. The exact movement of the aperture is controlled by an inductively coupled position sensor [2]. The quadrupole triplet is adjusted to focus an image of the diaphragm at the position of the target. The beam spot can be varied with the piezo-diaphragm

and was of about 0.25 mm in these measurements. The beam passes a chamber containing collimators of different diameters, a removable mirror and a rotating Ta-foil. Carbon collimators are used to minimize background due to high energy gamma-rays and X-rays

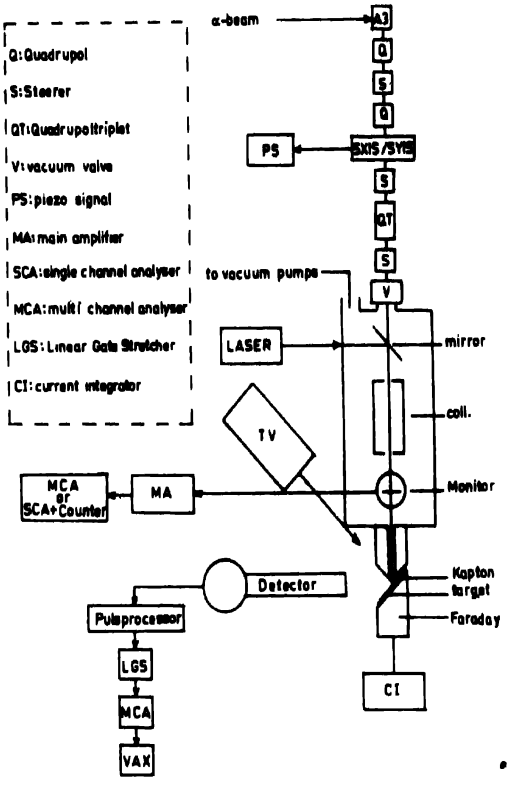

Figure 1. Block diagram of the experimental setup for PIXE analysis.

and reduce the scattering of particles. A laser beam reflected by the mirror is used to determine the beam position on the target. The alpha particles scattered by the rotating Ta-foil (that intercepts the beam at a rate of 5 Hz and with a duty cycle of 5%) are detected by a silicon surface barrier detector mounted below the foil and used to monitor the beam current, which was of the order of 0.1 nA.

The X-ray detector is a Si (Li)-type of 10 mm^2 area, an active thickness of approximately 3 mm, an energy resolution of 133 eV at 5.9 keV and an 8 μm beryllium window. The detector is placed at 90° to the beam and at a distance of about 3 cm from the target, which is symmetric to the beam and detector direction. An 80 μm Al absorber with 0.2 mm pinhole was used to reduce the low energy bremsstrahlung background and to increase the relative efficiency in high energy region. During the measurements, the count rate was kept between 400 and 600 Hz to reduce the dead time effects. Each sample was run for

approximately 15 minutes. A typical characteristic X-rays spectrum of kasisa bhasma is shown in Figure 2.

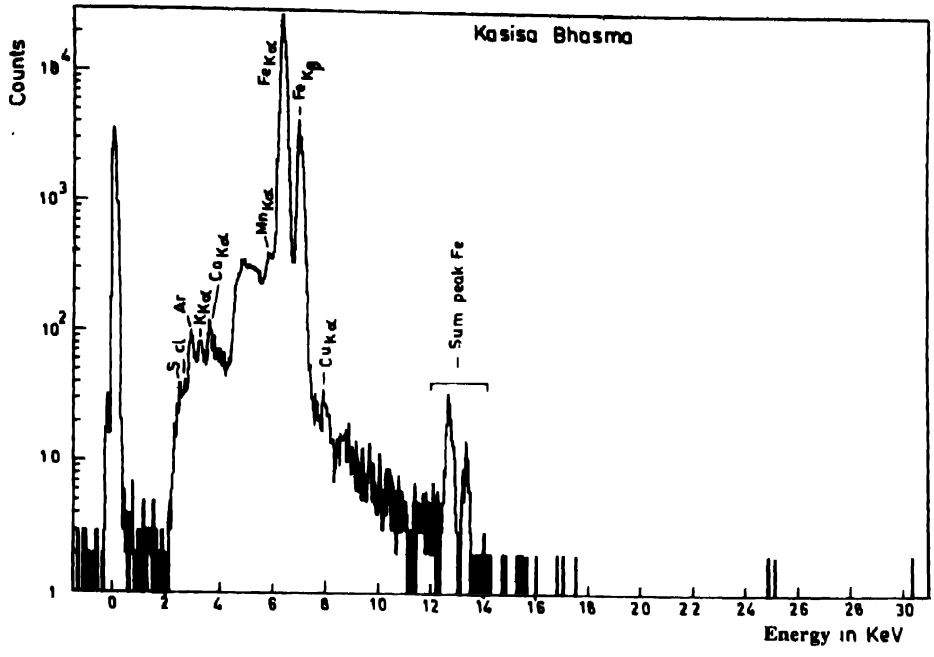

Figure 2. Typical characteristic X-rays spectrum of Kasisa Bhasma.

4. Results and discussion

To check the accuracy of the present analytical method alloys of different metals (*e.g.* 75% Ag and 25% Cu or 80% Cu and 20% Ag etc.) and the glass standards Nos. SRM-610 and SRM-611 consisting of various trace elements with concentration of the order of 500 ppm, from National Bureau of Standards, Washington, USA, were analysed. A good agreement between the experimental and the certified results was found.

In the present investigations the elemental analysis of eleven Bhasmas named Kasisa, Vanga, Yasda, Pravala, Godanti, Mandura, Sranga, Loha, Sankha, Abharaka, and Tamra and Ajmodadi churna obtained from different pharmacies in the form of fine powder was performed. The elements detected in these samples are S, Cl, K, Ca, Ti, Mn, Fe, Cr, As, Cu, Zn, and Sr. The concentrations of various elements were obtained using Fundamental Parameter approach [2].

The relative elemental composition of all the bhasma samples is shown in Table 2. In addition to the elements quoted in literature, many additional elements are found in small amounts as shown in Table 2. Error is quoted as high as upto 50% in case of minor elements. This error is due to the poor detectability of the weak peaks seen in the spectrum.

This study shows that many other elements are also present in addition to the ones already reported in literature [1]. One cannot say whether the concentrations of these other

Table 2. Weight concentrations of major and minor elements in Ayurvedic samples. Matrix assumed to be 100% seen in the PIXE spectrum

Sample name	Element	Measured conc	Quoted conc	Element	Measured conc	Quoted conc.
Kasisa	S(16)	2 68±1.08		Mn(25)	1 96±0 11	–
Bhasma	Cl(17)	0.96±0 25		Fe(26)	92.54±1.21	45 to 54
	K(19)	0.91±0 31		Cu(29)	0.26±0 09	–
	Ca(20)	0 72±0 07				
Vanga	Fe(26)	0 11±0 03		Sn(50)	99 87±0.10	65 to 70
Bhasma	As(33)	0 03±0 01				
Yasada	S(16)	0 60±0 20		Ca(20)	0.33±0 08	–
Bhasma	Cl(17)	0 42±0 20		Zn(30)	98.66±0.40	70 to 75
Ajmodadi	Cl(17)	19 88±1 89		Mn(25)	0 45±0 15	–
Churna	K(19)	26 58±2 60		Fe(26)	4.29±0.24	–
	Ca(20)	48 66±4 75		Zn(30)	0 13±0 04	–
Pravala	Cl(17)	0 77±0 22		Fe(26)	0 76±0.30	–
Bhasma	Ca(20)	97 81± 25	35 to 40	Sr(38)	0 68±0 06	–
Godanti	S(16)	25 91±2 00		Sr(38)	0 10±0 01	
Bhasma	Ca(20)	73 91±0 60	27 to 30			
Mandura	K(19)	0.25±0 08		Fe(26)	98 60±0.50	35 to 40
Bhasma	Ca(20)	0 99±0 09				
Sranga	Cl(17)	0 52±0.22		Fe(26)	0 79±0 08	–
Bhasma	Ca(20)	95 13±0 37	35 to 38	Sr(38)	0 11±0.03	
	Mn(25)	0 30±0 10		Sn(50)	3.17±0 40	–
Loha	K(19)	0 14±0.06		Fe(26)	99.04±0 06	65 to 70
Bhasma	Ca(20)	0.82±0 07				
Sankha	Cl(17)	0 60±0 23		Sr(38)	0 29±0 04	–
Bhasma	Ca(20)	99 12±0 20	38 to 40			
Abharaka	S(16)	2 12±0 22		Cr(24)	0 19±0.03	
Bhasma	Cl(17)	0 16±0 05		Mn(25)	0 59±0 06	–
	K(19)	9.64±0 52		Fe(26)	79.28±2 00	14 to 16
	Ca(20)	2 92±0.20		Zn(30)	0.39±0 04	
	Ti(22)	4.75±0.22				
Tamra	S(16)	6 80±0.80		Cu(29)	74.86±2 00	60 to 65
Bhasma	Cr(24)	0 07±0 01		As(33)	12.36±0.93	–
	Fe(26)	2.54±0 13		Sn(50)	3 40±0 30	–

elements will be constant or vary for a given bhasma sample, obtained from different pharmacies. As we do not have such samples with us, at present we can not find this variability, if any. The determination of chemical state of the elements in addition to their concentration, can help in understanding the bio-compatibility of these drugs.

We may conclude by saying that although the present study has not helped in establishing the rationality of these drugs, but it has opened many questions which needs to be answered before the rationality of the drugs can be established.

References

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