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X-ray Diffraction study for chemical analysis of *Rajat* based *bhasmas*

Case Report

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Abstract

X-ray diffraction analysis of the *Rajat* based selected *bhasmas* was one of the advanced parameter for detailed scientific scrutiny in this study. *Ayurvedic* literature is enriched with various techniques for establishing dimensions to quality control for achieving standard acceptable form of *bhasma*. X-ray diffraction is modern and sophisticated method which provides relevant chemical database of the herbo-metallic drugs. Quality of *bhasma* determines on the basis of chemical composition, processing and applications, so it can be used safely. X-ray diffraction pattern data detects size, physical state and surface properties. For *Rajat* based selected *bhasmas*, reduced particle size was observed in this study which will be useful to determine extent of therapeutic effectiveness of particular *bhasma* as per amount of quantity and quality in each dose. *Rajat* based selected *bhasmas* are herbo-mineral complex compounds which are recommended for treatment of several ailments from reputed pharmacies. Systematic pathways for the synthesis of *ayurvedic bhasmas* from heavy metals include Lead, Iron, Gold, Copper, Zinc, Silver, Mercury and Arsenic. The potential of *ayurvedic* literature and drugs need to be validated by assessing quality and purity on the basis of modern medicine protocol for treatment. During drug delivery, absorption as well as assimilation capacity enhances with particle size of drugs in the body. Hence selection of drug associated with physical parameter for best result as per prescribed doses in treatment. *Bhasmikarana* is the significant step in the preparation of *bhasma*. The idea underlying the process of "*bhasmikarana*" is to convert the substance into ash having the resultant properties in an active state. The *bhasma* not only radically remove the root cause of the disease, but also enhances the immune system inherent in the human body. Now market is having a wide range of *bhasmas*, as required to be processed according to unique, standard and advanced *ayurvedic* method.

Key Words: *Rajat bhasma*, *Bhasmikarana*, EDAX, XRD.

Introduction

XRD analysis reveals the nature, chemical constituents and information about crystal lattice and presence of some other minerals with selected *Rajat* based *bhasmas*. This article was related with chemical characterization of *Rajat* based *bhasmas* using XRD technique, so it could be applied as one of the standard parameter in preparation of metal based *bhasmas*.

Selected samples of *Rajat bhasma* were investigated with physicochemical characterization by using XRD analysis. Physicochemical characterization provides validation for analysis of pharmaceutical formulations of *bhasmas*. With prescribed technique for *Swarna*, *Rajata* and *Naga bhasmas*, controlled heating conditions were vital part to provide specific parameters for good yield of *bhasmas* (1). These research articles have tried to explore the elucidation and applicability of the traditional *ayurvedic* methods for the acceptance as per advanced period (2,3). *Rasashastra* is utmost part of *ayurveda*. Standard verification concept promotes significant demand towards traditional *ayurvedic* drugs. *Ayurvedic* metallurgy concerned with *bhasma* preparation on the basis of metals, products from animal, minerals and plants with toxic elements (4). Advanced analytical techniques provide evidence for safety and efficacy of non-allopathic drugs. Herbo-mineral drugs with active principles of herbs are acting as chemotherapeutic radical which enhances potential of non-allopathic traditional drugs. Collaborations between *ayurvedic* and allopathic pharmacies definitely improve the risk benefit assessment of the drugs (5).The important medicines prescribed in *Ayurveda*, are of course *bhasmas* of seven metals. In the stepwise synthesis of *ayurvedic* medicines from heavy metals, crude product treated with prescribed herbs. This technique involves detoxification, conversion to easily assimilated product and to improve the potency with efficacy of the *bhasma*. The *bhasmas* not only radically remove the root cause of the disease but also increase the preventive power inherent in the body. As per literature review on the effectiveness of *bhasmas* available in the market, the result aimed at as above cannot be achieved. The screening methods like XRD

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technique, EDAX etc; would be platform for acceptance of standardized *bhasmas* at national as well as international market level.

Material and Methods

In this study, five *Rajat bhasma* samples were selected for XRD analysis. Four samples were purchased from reputed pharmacies like *Baidynath* [Ag^1], *Dhootpapeshwar* [Ag^2], *Unza* pharmacy [Ag^3] and *AyurvedArkashala* [Ag^4]. One sample was synthesized in our laboratory in *Kaduindravana* [Ag^0] for research purpose. *Rajat bhasma* samples were investigated using EDAX machine for observing the atomic percentage of constituent elements on machine JEOL JSM – 6360A Analytical SEM.

In this article, the XRD analysis recorded on RIGAKU Max-II VC Model X-Ray diffracto-meter using Cu K alpha radiation filtered by Ni foil over the diffraction angle range (2-Theta) 10-90 with an accuracy of 0.001°. The wave length of radiation was 1.5405A°.

Study, Observations and Results

This article revealed physico-chemical evaluation with EDAX analysis and X-ray Diffraction patterns, which may overcome risks related in therapeutic use of selected *Rajat bhasmas*. In this article, highlight has been given to detect chemical changes after preparation of *Rajat bhasmas* by applying X-ray Diffraction.

On the basis of EDAX study, selected *Rajat bhasmas* could be a composition of metallic silver, free sulphur, ferric oxide, calcium with traces of copper, cadmium and silicon etc. Synthesis of *bhasmas* is associated with use of medicinal herbs which get detected in the presence of these elements (6,7). [Figure No.1 to 5]

The XRD analysis of Ag^0 sample is shown in Figure No-6 and Table No-1. In the XRD spectra of Ag^0 sample, the strong peak would be seen at the 2θ values of 38.09815, 44.15155, 64.50656 and 77.45985 degree, which is detected and compared with JCPDS (Joint Committee on Powder Diffraction Standards) Silver file no. (04-0783). The XRD analysis confirms presence of silver nanoparticles in the Ag^0 sample (8).

Reviewing *ayurvedic* literature, silver has multivalent states like AgO, Ag_2O, Ag_2O_3 and Ag_3O_4, but AgO and Ag_2O has been reported as most stable forms. The diffraction peaks obtained in Figure No- 9 and 10 for Ag^3 and Ag^4 samples, it can be indexed with pure hexagonal phase Ag_2O [JCPDS no. 72-2108] (9). For all *Rajat bhasma* samples Ag^1, Ag^2, Ag^3 and Ag^4, observed two sharp peaks near 28.54 and 37.06, which compared with standard α-Sulphur particle direction patterns (10). In the XRD patterns of Ag^1 and Ag^2 samples, obtained three sharp peaks near 31.45, 34.48 and 53.87 are matched with Joint Committee Powder Diffraction Standards no. (01-080-0006) of pure hexagonal Cadmium sulphide (11,12). Efficacy of *Rajat* based *bhasmas* is not usually due to single active component, but complex forms of components which decide the pathological manifestations with various dimensions. The discrepancy regarding the small difference in the peak values determined from the XRD patterns for commercial *Rajat bhasma* samples, which is associated with various preparation techniques.

Illustrations: Figures and Tables

Tables :

Table No. 1 : XRD patterns of *Rajat Bhasmas*

Sample	2θ of the sharp and intense	hkl	FWHM	d-spacing nano-meter
Ag^0 Sample was synthesized in our laboratory in *Kaduindravana*	38.09815	111	0.30875	2.36
	44.15155	200	1.83165	2.05
	64.50656	220	3.00333	1.44
	77.45985	311	0.69877	1.23

Table No. 2 : XRD patterns of *Rajat Bhasmas*

Sr. No.	Sample	2θ of the sharp and intense peak	FWHM
1	**Ag^1**	28.54101	13.80846
		31.45779	0.25654
		34.48139	1.02664
		37.06179	1.34592
		40.02174	4.25241
		43.40479	0.01734
		45.35798	7.3127
		53.8765	5.27342
2	**Ag^2**	34.42577	0.92739
		36.95543	1.47924
		31.53829	1.26351
		28.89191	0.7309
		40.71279	1.14763
		43.57557	1.59307
		53.31052	6.01314
3	**Ag^3**	34.44	0.90224
		36.9725	1.50785
		31.53521	1.3333
		28.87321	0.85366
		40.70992	1.1973
		43.57837	1.61758
		53.31443	6.82663
4	**Ag^4**	28.88668	0.66725
		31.51893	1.01358
		34.45223	0.75192
		36.95844	1.40912
		37.48907	0.84768
		43.57515	1.68022
		53.3121	6.47164

Figures :

Figure No- 1: EDAX spectra of *Rajat* sample Ag^0

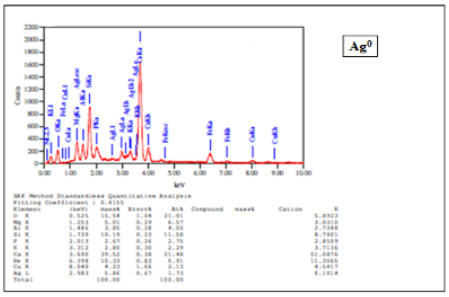


Figure No- 2: EDAX spectra of *Rajat* sample Ag^1

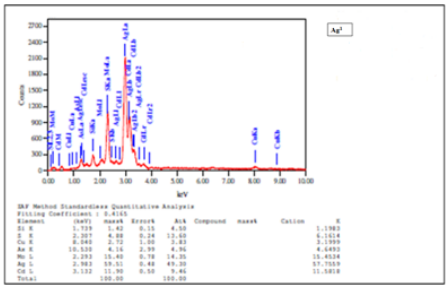


Figure No- 3: EDAX spectra of *Rajat* sample Ag^2

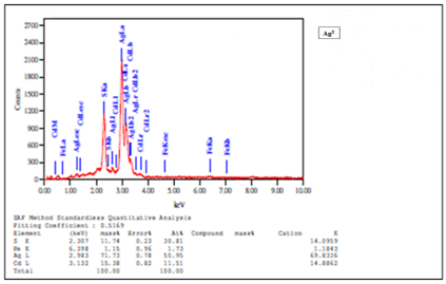


Figure No- 4: EDAX spectra of *Rajat* sample Ag^3

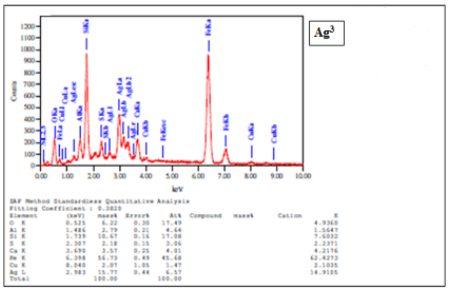


Figure No- 5: EDAX spectra of *Rajat* sample Ag^4

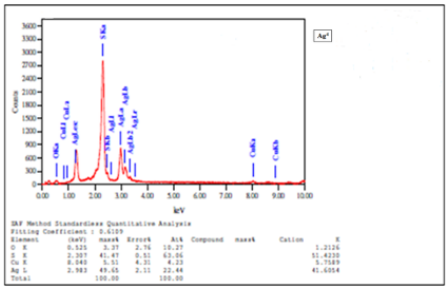


Figure No- 6: X-ray Diffraction pattern of *Rajat* sample Ag^0

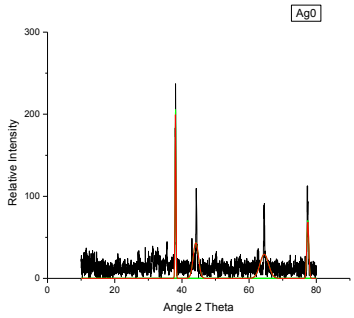


Figure No- 7: X-ray Diffraction pattern of *Rajat* sample Ag^1

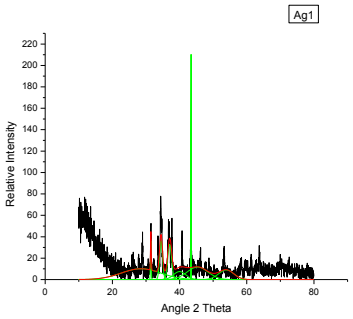


Figure No- 8: X-ray Diffraction pattern of *Rajat* sample Ag^2

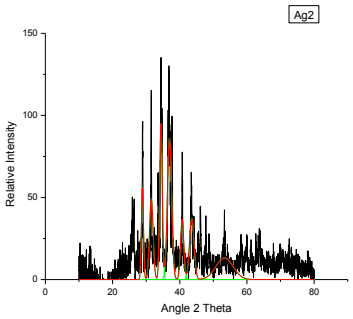


Figure No- 9: X-ray Diffraction pattern of *Rajat* sample Ag^3

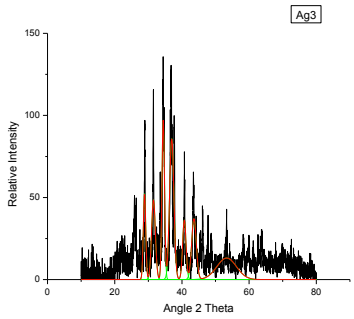
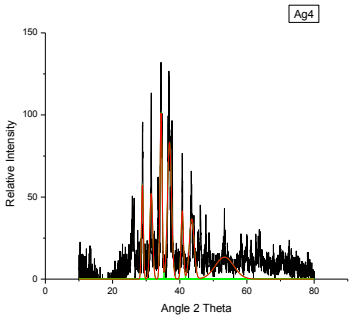


Figure No- 10: X-ray Diffraction pattern of *Rajat* sample Ag^4



Discussion

Rasa-shastra proposed three different methods for the preparation of *bhasmas*. The first method is suitable to prepare *bhasmas* of seven main metals [like Gold, Silver, Copper, Iron, Lead, Tin and Zinc] through the medium of *Parada bhasma*. Plants and herbs are used as medium in the second method. The third method is based on medium of *Kajjali* of pure Sulphur and Mercury. Allopathic drugs have adverse side effects, this drawback has been practised to overcome by application of *ayurvedic* preparations which motivates mankind to think about natural products. Hence production of *bhasma* would be carried out with accurate and appropriate preparations protocols that lead to yield best quality medicine. Due to lack of valid standardized procedure, in spite of its outstanding merits, *ayurvedic bhasma* has yet remarked as a traditional medicine in the global market.

Selected *Rajat bhasmas* were already examined through traditional parameters of analysis and then investigated on the basis of modern scientific parameter with the help of XRD analysis in this study. XRD patterns for selected *Rajat bhasmas* comprise large number of peaks, which was the evidence for decreased symmetry of sample particles. Sharp, predominant, intense and distinct peaks reveal the crystalline nature of selected *Rajat bhasmas*. XRD study of the selected *Rajat bhasmas* detected Ag_2O peak, indicating that some part of *Rajat* was converted to silver oxide with traces of silver sulphide. Hence it is necessary to design fingerprints for *ayurvedic bhasma* with advanced scientific parameters. It is observed that the examined data are compatible with the prescribed literature studies.

Conclusion

Popular marketed products are having *Rajat bhasma* as one of the important ingredients which is effective for following aliments like severe respiratory tract infection, marrow depression, ovarian cysts, uterine fibroids, complications of diabetes, neuropathy and general weakness (13). Scientists are fascinated by beneficial properties of silver nanoparticles. Silver based medicines have been enormously applied for treatment of various diseases due to its antibacterial property (14). In the recent studies on COVID-19, MARS, SARS and Swine flu, metal based *bhasmas* are showing enormous potential for medication of these epidemics due to viruses with the help of clinical trials (15). Analytical profile of *bhasmas* could be prepared with the help of XRD analysis, which improves global acceptance of *bhasmas* (16).

This article reveals necessity of advanced parameters to provide scientific base for selected *bhasma* samples, which are the form of metallic compounds through chemical and structural transformation with *bhasmikarana* process.

As per scientific analysis, *bhasma* has simple meaning which is Ash. But metal oxides cannot naturally be administrated to the body. Authentic traditional methods have been applied for the preparation of *bhasmas*. Modern scientific view responsible to provide practical guidelines for more detail and systematic investigations in the preparation of metal based *bhasmas*. The present work is an attempt to provide some significant contribution to this area. Especially for synthesis of a metal based *bhasmas* or any traditional drug on the basis of appropriate experimental support and physicochemical evaluations, are obligatory for their acceptance as approved drugs.

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