Research Article

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CHEMICAL ANALYSIS OF VANGA BHASMA

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ABSTRACT
Vanga bhasma is an Ayurvedic formulation used for various diseases. An attempt was made to analyze it chemically which includes XRF, XRD, EDAX and ICP-MS techniques. Vanga Bhasma drug contained mainly tin as tin oxide. The content of tin was found to be 80 percent. XRF analysis revealed that the bhasma contained 17 elements at different levels of concentration. XRD studies exhibited that the major phase composition is cassiterite tin oxide in tetragonal structure. The crystallite size of the compound calculated from Scherrer's formula was 52.94 nm. ICP-MS studies revealed the presence of calcium, arsenic, iron, silicon, phosphorus, aluminium and chloride. A combination of XRF, XRD, EDAX-SEM and ICP-MS was very useful in concluding that vanga bhasma is in cassiterite form of tetragonal structure. It is possible that the practical clinical application of the drug may be due to the different trace level elemental spectra besides tin. Data generated in the present study can be considered for laying down the pharmacopoeial standards for Vanga bhasma.
Keywords: Vanga bhasma, XRD, XRF, ICP-MS.

INTRODUCTION

Bhasma are the powder substances obtained by calcination of the purified metals, minerals and animal products by special processes. They are calcined in closed crucibles in pits and with cow dung cakes (puta). The drug vanga bhasma in Ayurvedic Formulations of India (AFI) is prescribed for Kasa (cough), svasa, kapharoga (disease due to kapha dosas), medo dosa (disorder of adipose tissue), prasveda (excessive sweating), ksaya pandu (anaemia), krmi (worm infestation), prameha (urinary disorders), garbhasayacyuti (uterine prolapse), svetapradara (leucorrhoea), akta pradara (menorrhagia), agnimandya (digestive impairment), aruci (tastalessness), buddhimandata (low intelligence), vrana (ulcer) and svapnadosa (nocturnal emission)[1]. The drug is reported to have the action of diuretic, expectorant, tonic, sedative and antimicrobial. It is used in coughs, bronchitis with powder of three pungents, lesser galangal, cloves and with some honey. In diabetes mellitus and insipidus, it is given with powders of nutmeg, mace and saffron, calx of silver, tanners, cassia flower, bamboo manna, tinospora starch and cardamoms[2]. In the routine programme of standardisation of Ayurveda drugs with a view to standardize Vanga bhasma, an attempt has been made to analyze chemically for the major inorganic constituents and also trace elements which are attributing for the therapeutic activities. Thus the present study includes the Ayurvedic tests, wet lab analysis, X-ray Fluorescence (XRF), X-ray Diffraction (XRD) and Inductively Coupled Plasma –Mass Spectroscopy (ICP-MS) studies on Vanga bhasma.

MATERIALS AND METHODS

Vanga bhasma was procured from the Indian Medical Practitioners Co-operative Pharmacy and Stores Ltd (IMPCOPS), Chennai, India and analyzed. The ingredients included in the formulation are 1) Vanga - one part; 2) Madhuka Taila -sufficient quantity; 3) Tintrini tvak (Tamarind bark) powder –one part; 4) Asvaththa tvak (Peepal tree bark powder) - one part; 5) Apamarga flowers (Prickly chaff flower)- one part; 6) Talapotaka puspa curna (Tanner's cassia flowers powder)- one part and Kumari svarasa (Aloe juice)- Sufficient quantity. Ayurvedic tests were carried out as per Ayurvedic Pharmacopoeia of India[3]. Physico chemical standards were analysed following the standard procedure[3,4]. Gravimetric analysis for the assay of tin was done by adopting standard procedure[5].

Microstructure Analysis through EDAX-SEM

Morphology of the bhasma was studied using scanning electron microscope. EDAX SEM was further used for elemental studies at Department of Physics, Anna University, Chennai, India.

XRD Studies

Bhasma was studied for its diffraction pattern using D2 phase XRD instrument at Department of Physics, Anna University, Chennai, India. Powder X-ray diffraction is widely applied for the characterization of crystalline materials. This method has been used for phase identification, quantitative analysis, extraction of three-dimensional micro structural properties and determination of structure imperfections and crystal structures of a crystalline material. XRD can also provide information on unit cell dimensions. High-resolution PAN analytical X' pert PRO powder XRD instruments with Cu K α radiation (λ = 1.5418 Å) were used for the analysis. The finely powdered samples were placed for recording the diffraction pattern. All the diffraction patterns were

recorded at the 2θ angular range of 10° to 80° with a step size of 0.02 2θ and scan step time of 1 sec [6, 7] .The particular size of the bhasma was calculated using the formula.

$$\text{Particle size} = \frac{0.9x\lambda}{B \times \cos\theta}$$

Where λ is the wavelength = 0.15418 x 10^{-9} m.
B = w = the width of the diffraction peak in radiams background and the peak maximum.

ICP-MS analysis

ICP-MS analysis was aimed for trace elements. The sample was prepared in microwave digester by digesting the sample (0.5g) with 3 ml con.HNO_3.

Table 1: XRF analysis of elemental composition

Elements	Percentage
MgO	0.017
CO_2	97.4
Al_2O_3	0.0163
SiO_2	0.138
P_2O_5	0.0641
SO_3	0.2604
Cl	0.0137
K_2O	0.0384
CaO	0.2306
As_2O_3	0.03888
SrO	0.000904
CdO	0.0047
SnO_2	1.796
WO_3	0.00035
Os	0.00248
Ir	0.00242
PbO	PbO

Table 2: ICP-OES analysis of Vanga bhasma for trace elements

Parameters	mg / kg
Calcium	22506.7
Iron	18994
Arsenic	619.6
Silicon	793.6
Phosphorus	669.7
Aluminium	2488.2
Chloride ion	570

RESULT AND DISCUSSION

The bhasma was a grey coloured fine powder, odorless with chalk like taste. The bhasma answered the following tests showing that it was properly processed. There was no Metallic luster or niscandrika; when taken between the index finger and thump and spread, it was so fine as to get easily into the finger lines (rekha purita); when a small quantity of the bhasma was spread on cold and still water, it floated on the surface (varitaram); the bhasma did not revert to the original state (apunarbha). The ash content of 99.06 % indicated that the drug contained inorganic matter and negligible amount of organic substances. Acid-insoluble ash was 77.85 % revealing that the bhasma contained acid insoluble silica and salts of tin. Gravimetric analysis of the bhasma showed the presence of 80.09 % of tin.

XRF Analysis

XRF analysis showed that tin was the major elemental composition in the bhasma besides sixteen other minor elements (Figure 1).

EDAX Analysis

EDAX-SEM analysis results are shown in Figure 2. The bhasma on scanning showed peaks of tin, calcium, iron, aluminium, silicon, arsenic, phosphorus, sulphur, chloride ion, besides carbon and oxygen. These were present in XRF analysis also revealing that it is a natural mineral component of tin (Figure 2).

XRD Studies

The X-ray diffraction pattern obtained for vanga bhasma is shown in Figure 3. The cent percent intensity was found at 26.565 with a *d* spacing of 3.5548 Å. The full width half maximum (FWHM, 2θ) was observed to be 0.0984. The XRD pattern of the bhasma was compared with Joint Committee on Powdered Diffraction Standards (JCPDS) file No. 77-0452, it was observed that the compound drug vanga bhasma gave an identical XRD pattern as that of cassiterite form of tin oxide revealing that the major phase composition is same as that of cassiterite tin oxide. The chemical name was tin oxide. The diffraction also showed the compound crystals are in tetragonal structure. The crystallite size of the compound calculated from Scherrer's formula was 52.94 nm (Figure 3).

ICP Analysis

ICP analysis of the sample for the trace elements revealed the content of the as detailed below (Table 2). The content of calcium was found to be high among the trace elements analyzed whereas aluminium and iron were comparatively in moderate amount. Presence of the trace elements such as calcium, aluminium, iron, arsenic, phosphorus and silicon along with tin might be attributing for the therapeutic activity of the bhasma.

CONCLUSION

Chemical analysis of Vanga Bhasma indicated that the drug contained mainly tin as tin oxide. The content of tin was found to be 80 percent. XRF analysis revealed that the bhasma contained 17 elements at different levels of concentration. From the XRD pattern it was concluded that the drug vanga bhasma gave an identical pattern as that of cassiterite form of tin oxide revealing that the major phase composition is cassiterite tin oxide in tetragonal structure. The crystallite size of the compound calculated from Scherrer's formula was 52.94 nm. ICP-MS studies revealed the presence of calcium, arsenic, iron, silicon, phosphorus, aluminium and chloride. A combination of XRF, XRD, EDAX and ICP-MS was very useful in concluding that vanga bhasma is in cassiterite form of tetragonal structure and it contains tin as the major elements besides these trace elements. It is possible that the practical clinical application of the drug may be due to the different trace level elemental spectra besides tin. Data generated in the present study can be considered for laying down the pharmacopoeial standards for Vanga bhasma.

Sample: Vangabhasma

Compound Formula	nZ	Concentration	Prepared Elt.	Line 1	Concentr. 1	Stat. Dev. 1	Depth 1	Status	Raw Int 1	Bkg 1
MgO	12	0.017	0.0081	Mg KA1-HS-Min	0.017	0.0013	14 um	Line 1	1.913	0.512
CO2	6	97.4	21.3	C KA1	97.4	5	4.9 um	Line 1	0.754	0.209
Al2O3	13	0.0163	0.00692	Al KA1-HS-Min	0.0163	0.0004	23 um	Line 1	1.5	0.066
SiO2	14	0.138	0.0515	Si KA1-HS-Min	0.138	0.0013	35 um	Line 1	9.989	0.123
P2O5	15	0.0641	0.0224	P KA1-HS-Min	0.0641	0.00087	53 um	Line 1	4.994	0.249
SO3	16	0.2604	0.08343	S KA1-HS-Min	0.2604	0.0013	78 um	Line 1	35.28	1.175
Cl	17	0.0137	0.011	Cl KA1-HS-Min	0.0137	0.00033	0.11 mm	Line 1	4.462	1.545
K2O	19	0.0384	0.0255	K KA1-HS-Min	0.0384	0.00033	0.22 mm	Line 1	14.101	1.187
CaO	20	0.2306	0.1318	Ca KA1-HS-Min	0.2306	0.0008	0.30 mm	Line 1	74.199	2.946
As2O3	33	0.03888	0.02356	As KB1-HS-Min	0.03888	0.00019	7.9 mm	Line 1	62.828	13.182
SrO	38	0.000904	0.000612	Sr KA1-HS-Min	0.000904	0.000014	14 mm	Line 1	28.006	15.771
CdO	48	0.0047	0.0033	Cd KA1-HS-Min	0.0047	0.00034	63 mm	Line 1	8.433	4.81
SnO2	50	1.796	1.131	Sn KA1-HS-Min	1.796	0.00098	82 mm	Line 1	2793.571	41.267
WO3	74	0.00035	0.00023	W LA1-HS-Min	0.00035	0.000061	2.9 mm	Line 1	6.14	5.576
Os	76	0.00248	0.00198	Os LA1-HS-Min	0.00248	0.000051	3.5 mm	Line 1	12.285	6.363
Ir	77	0.00242	0.00194	Ir LA1-HS-Min	0.00242	0.000041	3.8 mm	Line 1	14.824	6.967
PbO	82	0.01276	0.009477	Pb LB1-HS-Min	0.01276	0.000027	9.8 mm	Line 1	224.356	14.377

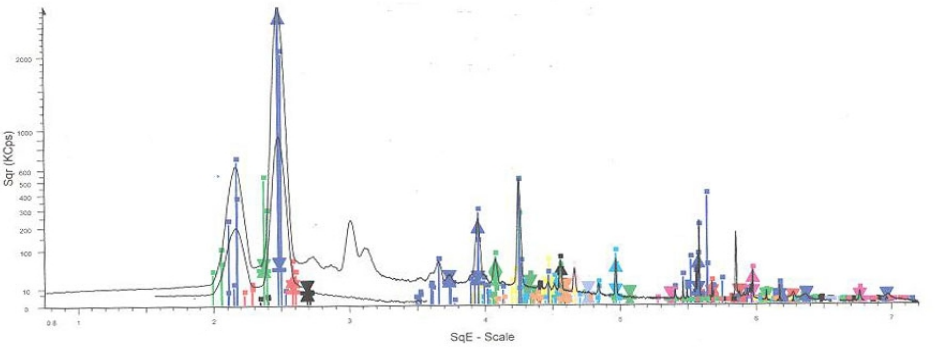
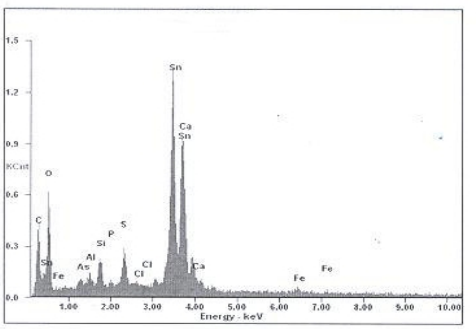


Figure 1: XRF results of Vanga bhasma



Element	Wt%	At%
CK	21.33	45.11
OK	22.82	36.22
AsL	02.33	00.79
AlK	01.32	01.24
SiK	02.06	01.87
PK	00.61	00.50
SK	02.08	01.64
ClK	00.53	00.38
SnL	41.20	08.82
CaK	04.64	02.94
FeK	01.08	00.49
Matrix	Correction	ZAF

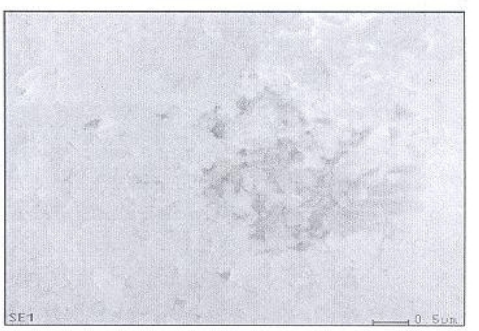
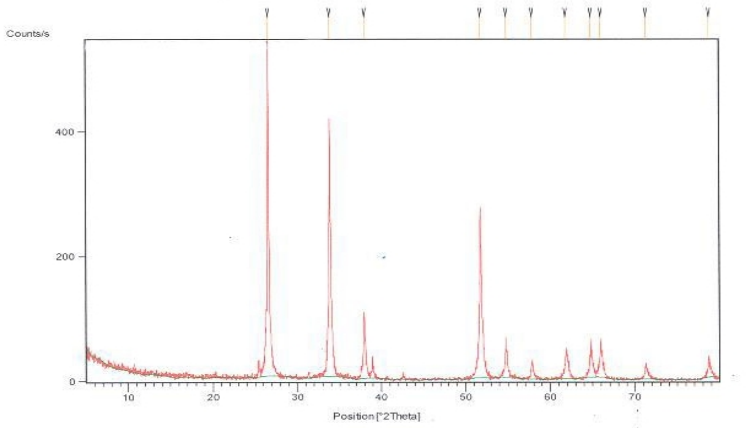


Figure 2: EDAX Microanalysis result of Vanga Bhasma



Peak List:

Pos. [°2Th.]	Height [cts]	FWHM [°2Th.]	d-spacing [Å]	Rel. Int. [%]
26.5653	538.60	0.0984	3.35548	100.00
33.8494	412.53	0.1181	2.64822	76.59
37.9396	83.38	0.3149	2.37161	15.48
51.7590	254.84	0.2362	1.76626	47.32
54.7786	50.07	0.3149	1.67583	9.30
57.8344	27.00	0.3149	1.59434	5.01
61.8837	43.56	0.3936	1.49939	8.09
64.7700	43.55	0.3936	1.43937	8.09
65.9833	54.95	0.3149	1.41582	10.20
71.3406	18.56	0.4723	1.32209	3.45
78.7674	23.38	0.5760	1.21401	4.34

Figure 3: XRD pattern of Vanga bhasma

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