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Analytical Study of *Abhrak Bhasma*: A Review

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ABSTRACT

Abhraka Bhasma is a unique and important Bhasma preparation used in Ayurveda therapeutics. With the help of analytical study, presence of elements, compounds, organic and inorganic matter in the *Abhrak bhasma* can be confirmed. Traditionally *Abhrak Bhasma* is tested on the basis of organoleptic characteristics and classical *Bhasma pariksha*. Now day's modern analytical parameters are practiced to characterize *Abhrak Bhasma* in order to get safety data which can be accepted universally. So the present study reviewed previous researches on analytical study of *Abhraka Bhasma***.** This review focuses on published research articles on analytical studies of *Abhrak Bhasma*. Review on *Abhrak Bhasma* observed that most of the studies followed both classical and analytical parameters of Abhrak bhasma. Analytical study was done with classical *Bhasma pariksha* such as *Varitartwa, Rekhapurna, Nishchandratwa* etc whereas modern analytical parameters such as XRD, XRF, EDS, SEM, TEM, TGA, UV-Vis-IR, FTIR, DLS, BET and FTIR were done. These studies confirms physical and chemical characteristics of Abhrak Bhasma by means of its various stages, chemical composition, presence of trace elements and functional groups, particle size reduction especially in *Shataputi* and *Sahastraputi* Abhrak Bhasma. This modern sophisticated study also supports classical parameters of *Bhasma pariksha* which are gold standard in *Rasashashtra*. So this technique needs to be followed along with classical parameters at various stages of Bhasma preparation. This will help to get more analytical data of *Abhrak Bhasma*.

Key Words *Abhrak Bhasma, Shataputi, Sahastraputi,* XRD

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INTRODUCTION

Ayurveda is the great knowledge in which the holistic ancient Indian system of medicines is recited. Ayurvedic medicines are prepared from plants, animals and metals/minerals origin[1]. *Rasashastra* is a branch of Ayurveda in which detailed knowledge of metals and minerals have been explained. However, due to requirement of higher dosage, non-palatability and less shelf-life, the herbal medicines have their own limitations. To overcome this, *Bhasmas* are the best alternatives as they can be prepared from the natural minerals and metals along with herbs by the process of *Bhasmikarana* in which toxic compounds are converted into nontoxic and bio-acceptable form. Moreover, they can be easily acceptable, palatable, fast acting and effective in small dosages and have long shelf life without losing their potency[2]. *Abhrak Bhasma* is an excellent cellular regenerator and nerve tonic. It

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is indicated in various chronic diseases such as tuberculosis, COPD and many types of cardiac diseases[3]. With the help of analytical study, presence of elements, compounds, organic and inorganic matter in the formulations can be confirmed. Analysis of *Abhraka bhasma* makes to find easier to understand physicochemical changes occurred after repeated incinerations in the compound. Different steps present in the preparation of *Bhasma* with the help of analytical study, its formation and breaking of chemical bond, compound, and elements are clearly visualized. Although classical *Bhasma pariksha* are well defined for the quality control of *Abhrak Bhasma*, still there needs the modern analytical techniques to ensure the quality of *Bhasma* so that its toxicity and safety can be rule out. Hence in the present study, classical and modern analytical techniques have been explored and its importance is been highlighted by reviewing the previous research studies. In this review, various modern analytical techniques such as XRD, XRF,EDS,SEM ,TEM,TGA,UV-Vis-IR,FTIR, DLS,BET and FTIR is been discussed.

AIM AND OBJECTIVES

To review the analytical studies published in Research Articles, Thesis databases, online research databases and print media on *Abhraka Bhasma*.

I. CLASSICAL ANALYTICAL METHODS OF ABHRAKA BHASMA

Table 1 *Panchboutik Pariksha* (Organoleptic characteristics) of *Abhraka* bhasma[4]

Sr. No	**Organoleptic characteristics**	**Characteristic**
1.	Color (*Rupa*)	*Sindurabha*
2.	Odor (*Gandha*)	Odorless
3.	Taste (*Rasa*)	Tasteless (*Niswadu*)
4.	Sound (*Shabda*)	
5.	*Sparsha* (Touch)	Soft smooth powdered form

Ayurvedic Parameters for *Abhraka Bhasma pariksha*

The *Abhraka Bhasma* should be subjected to certain tests in order to assess the standard character as per textual references. If the *Bhasma* are prepared with different media and different *bhavana dravya* the characteristic features for *Bhasma Pariksha* will be the same but the color & therapeutic properties will be different.

The following tests should be observed for *Bhasma Pariksha*[5]

According to *Rasendra Chudamani* and *Rasa Prakash Sudhakar Abhraka Bhasma* should have the following signs :

1.*Nischandratva* (Lusterless)

There should not be shining in the *Abhraka Bhasma*, if shining is present then *Marana* process should be continue till *Nischandratva* achieved. This is the most important sign of *Mritabhraka*.

2. *Sindurabh Varnata* (Redness)

This is the important sign of *Abhraka Bhasma* which indicates its color i.e. the *Abhraka Bhasma* should have red or brick color. This is probably the result of a chemical change which takes place during process (i.e. Oxidation) and formation of compound.

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3. *Susukshmatwa* (Fineness)

This is third important sign which indicates fineness of the particles. Due to process of levitation & incineration the surface area of *Abhrak* increases and size of particles reduces with the increase of puta till to very fine state. This is important from the point of view of its absorption & assimilation in the body. Ancient *Acharyas* had developed a few tests to measure the fineness of *Bhasma* which are as follows.

i. *Varitaratva* (Floating on water)

According to *Rasa Prakash Sudhakar* the term *"Jalaplava"* is also used for this. In this test a perfectly prepared *Bhasma* powder when sprinkled in a beaker full of water floats upon the surface i.e. the particles are so fine that the surface tension of water cannot be broken with the pressure of their fall.

ii. *Lochanjana Sannibhavatva* (Collyrium like)[6]

This is another test for measuring the fineness. In this test the few particles of the *Bhasma* powder are applied to the eyelids just like *Anjana*. If the *Marana* is complete and the *Bhasma* is of good quality the person should not feel any irritation in the mucous membrane of eyelids. This shows that the particles of metal/mineral have attained the desired state of fineness otherwise the process should be continued till the *lochanjana sannibhavatva* attains & then the *Marana* process will be considered complete.

4. *Unnama*[7]

It is the reassessment test of the floating character of Bhasma. A grain is to be kept carefully on the film formed on the *Varitartwa* tests in water to see and note whether the film can resist the weight of the grain. If the grain remains on the film and does not sink in water the Bhasma can be considered as excellent.

5. *Rekhapurnatva*[8]

When a small quantity of *Bhasma* powder is picked up between the first finger and thumb and on rubbing *Bhasma* enters in to the furrows of fingers it is said to be having *Rekhapurnatva* property.

6 . *Nirdhumatvam*[9]

If sprinkling on red hot coal, it does not emit smoke, then it can be considered as excellent Bhasma. The emission of fumes indicates the presence of some inorganic substances in the Bhasma.

7. *Apunarbhavatva*[10]

This test is applicable to metallic *Bhasma* only. The *Bhasma* after mixing with *Mitra-panchak* is subjected to *Puta*. The intensity of temperature should be same in both i.e. incineration during *Bhasma* preparation and *Bhasma pariksha* process. on self-cooling the product is to be observed for the presence of free metal in the *Bhasma* it& cannot be considered proper preparation.

8. *Niruttha*[11]

This test is also meant for detection of the regaining characters of metallic *Bhasma*. Take a measured quantity of silver and mix it with *Bhasma* which is to be tested. It is heated in crucible until silver is melted. After cooling down the weight of silver is observed if there is no gain or loss in weight of silver which indicates

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that *Bhasma* is not converting into metallic form absence of free metal.

I. MODERN ANALYTICAL METHODS OF ABHRAKA BHASMA

(1) XRD study: X-ray diffraction is useful for evaluating minerals, polymers, corrosion products, and unknown materials. Among the most common tests are the identification and quantification of the crystalline phases, determination of the percent crystallinity, and analysis of the crystal structure. A Research on XRD of *Abhrak Bhasma* with 35 & 37 Puta was observed major diffraction peak which decreases with the process of *Shodhan, Dhanya Abhraka Nirmana* and Marana. After *Amritikarana*, there is again little increase in the crystallite size due to formation of complex with organic moieties from cow ghee[12]. In another study of XRD, there is presence $FeSO_4$, Fe_2O_3 in Bhasma. Also presence of Iron as a major constituent were observed in *Ashuddha Abhraka* (19.55%),*Shuddha Abhraka*(17.31%),*Abhraka Bhasma* (21.16%)[13]. XRD analysis on *Shatputi Abhraka bhasma* observed new structure and molecules as the number of *puta* increases. Also XRD after *Amrutikarana* revealed various forms of elements such Diopside, Sylvine, Magnetite, Forsterite & Cristobalite[14].Research on *Krishna Vajra Abhrak* in which *Abhraka bhasma* revealed the crystalline nature of *Bhasma* with mixture of various individual oxides. Intensity of the peaks becomes sharper in the successive phases from *Shodhan* to each stage of *Maran* [15].

(2) **SEM analysis**: Scanning electron microscope (SEM) is one of the common methods for imaging the microstructure and morphology of the materials. In SEM, an electron beam with low energy is radiated to the material and scans the surface of the sample. A research study of *Abhrak bhasma* in which SEM study observed irregular shape of particle size whereas small particle sediments on larger particle. Particle size found to be from 1 to 200 micron[16]. An another study of *Abhrak bhasma* of two different references by 35 puta and 37 puta were Scanning Electron Microscopy (SEM) study observed particle size was reduced and crystallite increase in *Shuddha Abhraka* & Dhanyabhraka. In *Marana*, fibrous structure disappeared & agglomerated clumps of finite particles seen whereas in *Amrutikarana*, particle shape changes and increased in size, edges were smooth. In method 1 square type particles while in method 2 spherical and rod like particles observed in Scanning Electron Microscopy (SEM) study[17]. A Research on *Krishna Vajra Abhrak*, SEM study observed, square shaped particle size gradually reduces from 174 nm to 87.1 nm from *Shuddha* to bhasma stage[18].

(3) FEG-SEM (Field Emission Gun – Scanning Electron Microscope):- It is provides the very highest resolution imaging compared to regular SEM. It guarantees high brightness, crisp images and stable beam current. One Research study of *Sahasraputi Abhraka bhasma* (100 Putas)) FEG-SEM (Field Emission Gun, Scanning Electron Microscopy) , particle size noticed was unevenly

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arranged (heterogeneous) present between 29nm and 88nm and irregular shape ranging from spherical to obligated[19]. Another research on *Shatputi Abhraka bhasma* FEG-SEM study shown that if the no. of *puta* increases, particle size decreases i.e. particle size after 20 *puta* was from 30 to 398nm, after 50 *puta* it was 30 to 85 nm and after 100 *puta* it reduces again to 24 to 50 nm[20].

(4) XRF (X-ray fluorescence) study: - It is a non-destructive analytical technique used to determine the elemental composition of materials. A research on analytical evaluation of *Abhrak Bhasma* (Babita Bhatia & Purushottam G Kale, 2013) observed presence of elements in oxidized form in ED-XRF. The phase analysis revealed the presence of Fe (22%) as a major element and Ca, K and Si in low concentrations, their concentration being 11%, 8% and 13% separately. Mg (4%), Al (2%) and Ti (1%) were present as minor elements. No carbon present in it indicates the absence of any natural organic Matter[21].

(5) FTIR (Fourier Transform Infrared) Study: - FTIR Spectroscopy, is an analytical technique used to identify organic, polymeric, and, in some cases, inorganic materials. A Research on *Abhraka bhasma* of 2 different methods after 35 and a 37 puta in which Fourier Transform Infrared (FTIR) study observed, various bonds of different functional groups indicate organo-metallic nature of sample shows O-H bond was prominent from *Shodhana* to *Amrutikarana* stages. In method 1 strongest sharp bond of O=C=O stretching bond was observed increasing from *Shodhana* to *Marana* whereas in method 2 decreasing from *Shodhana* to *Marana*. Si-O group sharp bond observed in both methods indicates elimination of Sulphur and Silicon[22]. Wele *et al* (2020)done research on Synthesis & Characterization of Krishna *Vajra Abhraka* in which FTIR study revealed organic functional group such as hydroxyl group, carbonate group and presence of carbon indicating bio-inorganic nature of the Bhasma[23].

(6) **EDS or EDAX (Energy Dispersive X-Ray Analysis):-** It is used to determine which chemical elements are present in a sample, and can be used to estimate their relative abundance. EDS also helps to measure multi-layer coating thickness of metallic coatings and analysis of various alloys. A Research on *Sahasraputi Abhraka Bhasma* (100Puta) in which EDS study shown higher percentage elements such as O (41%), Si (16%), K (13%) and Fe (13%) and the minor elements presence i.e. Al (6%), Mg (5%), Ca (4%) and Cl (1%)[24] Another Research Study on *Abhraka Bhasma* by 2 different methods after 35 and a 37 *Puta* in which EDX study shown that after *Shodhan* Si, Al increases while Fe, Mg and C decreases whereas after *Marana* Fe, Mg increases, Si, C decreases and after *Amrutikarana* Si, Fe, C increases, Al, Mg decrease which indicates detoxification of *Abhrak Bhasma*. Also presence of carbon suggests formation of organometallic compound[25].

Wele *et al* (2020) observed in EDAX study of *Krishna Vajra Abhrak* decrease tendency of

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harmful elements and increase useful elements such as Fe, Ca, and Na which highlights importance of Ayurvedic processing which is beneficial for its therapeutic use[26].

(7) TEM (Transmission electron microscopy):- It is an analytical technique used to visualize the smallest structures in matter. A Research Study on *Abhraka bhasma* of 2 different methods after 35 and a 37 puta. (Kantak *et al*, 2019) observed in TEM study the particles of different sizes and shapes ranging from 50 nm to 1 mm with change in the method of preparation. All the prepared products show agglomerated structures[27]. In TEM study of *Shatputi Abhraka bhasma*, morphology of Abhraka bhasma were in Polygonal shape and the Particles were present in agglomerates observed[28].

(8)BET (Brauner Emmet Teller):- It is mostly used for analyzing the fineness of cement and concrete, the adsorption capability of activated carbon, catalyst characterization, adsorption performance of gas purifiers, and for studying nanomaterials. Kantak *et al* (2019) observed in BET study high surface area of *Bhasma* along with higher porosity[29].

(9) DLS (Dynamic light scattering):- It is also known as photon correlation spectroscopy (PCS), is a very powerful tool for studying the diffusion behavior of macromolecules in solution. Kantak *et al*(2019) observed in DLS study bimodal distribution of particles of *Abhrak Bhasma* in Nano range(50-500 nm) in both Method 1 (50%) & Method 2 (90%)[30]. A Research on Abhraka Krishna Vajra Abhraka: Synthesis & Characterisation by Wele *et al* (2020) observed in DLS study, 98 percent particles are unimodal distribution[31].

(10) TGA (Thermo gravimetric analysis):- TGA is useful in determining purity and composition of materials, drying and ignition temperatures of materials and knowing the stability temperatures of compounds. Kantak *et al* (2019) witnessed presence of weight loss (0.2-0.3) at~100^{o}C in TGA study which was due to adsorbed moisture on the surface of *Abhrak bhasma*. indicates presence of moisture and decomposition of organic moieties[32].Tamhankar *et al*(2020) observed that when *Bhasma* heated at different temperatures and increases temperature gradually indicates melting, decomposition, and recrystallization and observed newer molecules formed with different molecular weights in TGA study [33].

(11) UV-Vis-IR (Ultraviolet-visible-infrared Spectroscopy):- UV-Vis and UV-Vis-NIR instruments measure the light absorbed, transmitted, or reflected by the sample across a certain wavelength range. Tamhankar *et al*(2020)[34] revealed changes in *Shataputi Abhrak Bhasma* at various stages by Ultraviolet-visible-infrared Spectroscopy where order of reflectance observed that 20 puta of *Abhraka bhasma* passes most part of spectrum in the sunlight reflected comparable to 50 & 100 puta which highlights importance of *Nishchandratwa* of *Abhrak Bhasma* with successive puta.

OBSERVATION AND DISCUSSION: -

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Abhrak Bhasma Pariksha like *Nischandratva, Sindurabh Varnata,Susukshmatwa, Unnama Rekhapurnatva , Nirdhumatvam, Apunarbhavatva, Niruttha* has been described in detail as per *Rasashashtra* classics. Hundreds to thousands of incinerations are performed during the preparation of Abhrak bhasma for various therapeutic uses and *Rasayan karma*.The modifications made to physico-chemical processes are emphasized by the significance of their various modern analytical techniques which has been carried out for this purpose. According to an XRF study, Abhraka contains more iron than other elements, particularly when it is in its raw state. However, silica content lowers when Abhraka undergoes the processes of *Shodhana, DhanyAbhraka nirmana,* and *Marana.* This indicates importance of Marana process & *Bhasma pariksha* which is specific to Abhraka Bhasma such as *Nischandratva*. Particle size distribution of Abhraka is irregular, ranging from spherical to oblongated, according to a FEG-SEM study. O, Fe, and Si are the three main elements found in EDS. A TEM study reveals that the size and form of the particles vary from 50 nm to 1 mm. increased surface area correlates with increased porosity, according to BET study, while a bimodal and unimodal particle distribution is shown in DLS study. Repeated incineration & lavigation process helps to form a nanosize particles of Abhraka Bhasma which is supported by SEM& TEM study. According to a TGA examination, weight loss is caused by moisture and the disintegration of organic materials. Repeated lavigation process followed by subsquent incineration process helps Abhrak has the elemental content of the sample and the conditions of its preparation determine the X-ray diffraction line's intensity in X-ray diffraction (XRD). Abhraka shown the crystalline substance as a prominent diffraction peak. A significant quantity of Fe is seen in the monoclinic structure of KMg3(Si3Al) O10(OH) form various compound formation according to XRD. Changes in the form of *Bhasma* & its Composition can be revealed with XRD study. Organic compounds with distinct functional groups of the O-H band, O=C=O stretching band, Si-O group sharp band, and C-Br band are shown by FTIR analysis. FTIR analyzes the functional group that detects a compound's absorption of light in the electromagnetic spectrum, but it only interacts with the spectrum in relation to a polar molecular band present functional group in Bhasma indicate presence of various *Bhavana dravya*.The porosity of the particles in the BET analysis indicates their strength, permeability, and whether or not porous used in molecules dissolve in organic solvents. Higher surface area & porosity indicates high rate of absorption Bhasma. In DLS, the particle specially in shatputi & *Shatraputi Abhraka Bhasma* size distribution and colloidal data demonstrate that the solar spectrum is reflected at a discrete 330 nm peak, with low levels of reflected light at 100 Puta. All these analytical tests highlight the importance of various stages of Bhasma preparation and its scientific importance

so it is very important to match both i.e. Classical as well as modern analytical parameters

CONCLUSION:-

Various classical & modern analytical parameters of *Abhraka Bhasma* are important tool to maintain the quality of *Bhasma*. Modern analytical techniques support the classical *Bhasma pariksha* which signifies its use for *Bhasma pariksha*. These techniques helps to characterize Bhasma further both in its physical and chemical form. So, use of various sophisticated analytical techniques in *Bhasma pariksha* is the need in order to standardize Bhasma formulation.

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