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NANOTECHNOLOGY IN AYURVEDA IN RELATION TO RASASHASTRA

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ABSTRACT

Nanotechnology based on nanoscience is the technology of 21st century due its wide range of application in medicines, automobiles, computer etc. When we reduce the size of any material to nanoscale the changes in the properties of parent material are observed. Nanomedicine covers the area of diagnosis of diseases, cure and prevention of diseases in the healthcare system. Nano drug delivery systems can reduce the drug consumption and side effects by lowering the deposition of there active agent in the non targeted sites. *Rasashastra* is the branch of *Ayurveda* which deals with the use of metals, minerals or gems which are heavy, nonabsorbable and toxic substances in raw form. In *charaka Samhita* fine powder of metal is mentioned as '*Ayaskriti*'. In the era of *Rasacharya Nagarjuna* many new pharmaceutical techniques are developed in *rasashastra* like *shodhana, marana, bhavana, jarana, amritikaran, lohitikaran* etc. In the process of *'Marana'* of dhatus the metals, minerals or gems are converted into very very fine, absorbable, therapeutically effective and least toxic form called as "*Bhasma*". It is an attempt to understand and apply basics of nanotechnology in *Ayurvedic* pharmaceutics.

KEYWORDS: *Ayurveda, Rasashastra, Bhasma,* Nanotechnology.

INTRODUCTION

The term Nanotechnology is derived from Greek word 'nano' means dwarf. Nanotechnology deals with the understanding and control of matter at dimension between 1-100 nm. According to the EC recommendation, nanomaterials refers to a natural, incidental or manufactured material comprising particles either in an unbound state or an aggregate where in one or more external dimensions are in the size rage of 1-100nm for ≥ 50% of the

particles.[1] Bio inorganic nanoparticles or metal nanoparticles are used in medicine for diagnosis and treatment purpose.[2] In last 30 years material science has progressed widely with the applications of nanomaterials. Nanomaterials and structures owing to their small size as compared with larger bulk materials, making them suitable candidates for novel applications.[3] Nanotechnology has been the focus of considerable attention in the medicine due to the facility with which nanostructures interact with the body at the molecular scale.[4]

Ayurveda is the oldest system of Indian traditional medicine. *Rasashastra* a prominent branch of *Ayurveda* has documented about 80 inorganic substances out of which 35 are converted into *bhasma*. It is the powder form of an element which is obtained by processing the particular metal/mineral/gem with plant or/and animal product using various synthesis methods leading to formation of compounds with different physicochemical properties than parent material and thereby imparting therapeutic potential of the final product.[5-7] *Bhasma* is a mixture of micro and nanoparticles.[8-9] Metal *bhasmas* i.e, *Ayurvedic* nanomedicines and nanoparticles of gold, silver, iron & zinc are widely studied in past decade with promising results in cancer, diabetes, immunomodulation etc.[10-12]

AIMS AND OBJECTIVES

- To understand the concept of Nanomedicine
- To study different methods of preparing *bhasma*
- To study properties of various *bhasma* in *rasshastra*
- To study standardization of *bhasma*
- To study the correlation of current Nanotechnology and ancient *bhasma*

MATERIAL AND METHOD

1.1 Nanomedicine[13]

The field of nanomedicine is the science and technology of diagnosing, treating and preventing disease and traumatic injury, relieving pain and of preserving and improving human health using molecular tools and molecular knowledge of the human body.

1.2 Importance of Nanomedicine[14]

- Target specificity
- Encapsulation efficiency
- Carry high concentration drugs
- Efficient drug release

- Ability to cross blood brain barrier
- Reduction in peripheral side effects of drugs by decreasing over all dose of drugs

1.3 Advantages of Nanomedicine[15]

- Convey most extreme measure of medication to the site of activity by passing all barriers.
- Reduce repeated dose administration
- Increased bioavailability
- Solubility enhancement
- Protection from toxicity
- Enhancement of pharmacological activity

1.4 Application of Nanotechnology in Biomedical field[15]

- Drug delivery
- Targeted therapy
- Gene delivery
- Detection and diagnosis
- Molecular imaging
- Biomarker mapping

2.1 *Bhasma*[16-17]

Rasashastra deals with the herbomineral preparations which includes various *bhasmas* i.e, an ash obtained through incineration of metals, minerals or gems after undergoing process of purification (*shodhana*), followed by the reaction phase which involves incorporation of some other mineral and herbal extracts *(bhavana*), then the pallets are made (*chakrika nirman*), incineration of material (*puta*).

2.2 Classification of *Bhasma*

- Metal based
- Mineral based
- Harbal

2.3 Preparation of *bhasma*

Bhasma can be prepared by two methods *Putpaka* method and *Kupipakwa* method.

2.4 *Shodhana* (Purification)

Shodhana is an addition and separation process. It involves the heating of the material at very high temperature (upto which the material becomes red hot) and suddenly quench in liquid (of acidic or basic pH) of normal temperature due to which molecular bonds in the material become loose and helps the breaking of particles into smaller and smaller size.

Effects of *Shodhana*

- Materials becomes free from visible and invisible impurities.
- Masses of minerals are converted into fine and brittle.
- Development of fineness and brittleness facilitates the bhavana process.
- Partial reduction takes place.
- Induction of organic therapeutic properties in the inorganic material.

2.5 *Bhavana* (Levegation)

It is the wet trituration process with addition of *maraca gana* drugs in the *shodhit* material. The quality of *bhasma* depends on the *maraka gana* added.[Table 1]

Bhasma	Maraka gana
Shreshtha (best quality)	Rasa, Hingula, Kajjali, Ras sindoor
Madhyama (better quality)	Herbal drugs of acidic and basic nature
Kanishtha (poor quality)	Gandhaka, Hartal, Manshila
Durguna (poorest quality)	Ariloha

Maraka gana drugs greatly help in the disintegration of metal & minerals. Mercury is supposed to make amalgamation with any metal and disintegrate their particles, hence mercury and its compounds are considered as best *maraka* drugs.

Effects of *Bhavana*

- Materials are mixed uniformly.
- Materials are divided into finer and finer.
- Surface area of material exposed which facilitates reaction during firing(puta).
- Develops softness, smoothness and stickiness which facilitates better binding of material.
- Enhances therapeutic properties of material.

2.6 *Chakrika nirman* (Pellatization)

Small disk of *bhavit* material should be made. Dry in sun or in dryer.

2.7 *Sharava samputikaran* (packing of disks)

Arrenge pellets in a earthen *sharava*. Covered it with another *sharava*. Joints of *sharva* should be sealed with cloth and mud in 7 layers. Again dry it in sun or dryer. Finally sealed *sharava* subjected to puta system of repeated heating till the material completely converted into *bhasma* with desired characteristics.

2.8 *Marana* (Incineration)

Incineration or calcination of the metals or minerals when subjected to heating of moderate to intense temperature. *Marana* is an association and dissociation process. Elements are converted into certain compounds. Parent compounds are converted into certain other compounds. Nature of compound formed depends upon the material used for *marana*. Metals are reduced to ash. It may be sulphide, oxide, chloride, sulphates etc. Macro forms of materials converted into micro forms. Heavy materials are converted into light one. The particle size of *bhavit* material deceases as the number of puta increases.

2.9 Amritikarana

It removes the remaining blemishes of *bhasma* and it enhances the therapeutic properties of *bhasma*

2.10 Lohitikarana

It develops desired red colour in case of *abhraka* and *loha bhasma*.

If we observe the different stages of *bhasma* preparation it can be noted that at every stage effort is made to bring down the particle size finer and finer. Now a days many *bhasmas* are available in market [Table 2]

Bhasma	Company
Abhraka bhasma	Baidyanath, Unjha, zandu, Dabur, Patanjali, Dhootpapeshwar, Jagriti, Curoveda etc.
Suvarna bhasma	Baidyanath, Dabur, Patanjali, Dhootpapeshwar, Unjha, Zandu etc
Loha bhasma	Baidyanath, Dhootpapeshwar, Dabur, Patanjali, Dhanvantari etc
Tamra bhasma	Baidyanath, Dhootpapeshwar, Guapha,Patanjali etc
Rajat bhasma	Dabur, Unjha, Patanjali, Baidyanath, Dhootpapeshwar etc
Makshik bhasma	Baidyanath, Patanjali, Dhootpapeshwar, Jagriti, Basic Ayurveda, Dabur etc
Madoor bhasma	Baidyanath, Patanjali, Dhootpapeshwar, Divya Chaitanya, Unjha etc
Nag bhasma	Baidyanath, Dhootpapeshwar, Garga, Gopal ayu bhavan etc
Vang bhasma	Baidyanath, Dhootpapeshwar, Dabur, Patanjali etc
Yashad bhasma	Baidyanath, Green wealth, Dhootpapeshwar, Rasashram etc

Mukta bhasma	Patanjali, Dhootpapeshwar, Dabur, Zandu, Baidyanath, Unjha etc
Praval bhasma	Baidyanath, Dhootpapeshwar, Jagriti, gopal ayu bhavan, kottakal etc
Godanti bhasma	Baidyanath, Patanjali, Dhootpapeshwar etc
Kasis bhasma	Patanjali, Baidyanath, Jagriti, Bhardwaj etc
Vaikrant bhasma	Baidyanath, Sadhana, VHCA etc
Hirak bhasma	Unjha, Dabur,Dhanvantari, Baidyanath etc
Akik bhasma	Baidyanath, Unjha, Basic Ayurveda etc
Spatika bhasma	Baidyanath, Jagriti, Basic Ayurveda,Patanjali etc
Kapardik bhasma	Baidyanath, Dhootpapeshwar, Gopal ayu bhavan, VHCA etc
Tankan bhasma	Baidyanath, Patanjali etc
Shankh bhasma	Baidyanath, Patanjali, Dabur, Unjha etc

2.11 Parameters for Standardization and quality control of *bhasma*

A) Ancient Parameters [Table 3]

Physical	Chemical
Varna (colour)	Gatrasatva (tasteless)
Varitara (float)	Nirdhuma (absence of fumes)
Unama	Apunarbhava (irreversibility)
Rekhapurna (furrow filling)	Nirutha (irretrievable)
Anjana sannibha (softness)	Amla pariksha (sour test)
Nischandra (lusterless)	Aksharatva (absence of alkaline taste)
Sukshmatva (fineness)	

B) Modern Parameters

Physicochemical Analysis

- Colour
- Loss on drying
- Total ash
- Acid insoluble ash
- Water soluble ash
- Solubility
- Particle size
- Essay of elements
- Foreign material
- Microbial content

Some of the principal methods for the characterization of the nanomaterials, operation principle, physicochemical parameters analyzed, and respective limitations[18] [Table 4]

Method	Operation Principle	Physicochemical parameters analysed	Limitations
Transmission Electron Microscopy	An electron beam interacts and passes through the sample and the scattered electrons are focused to create an image	Particle size, Size distribution, shape, agglomeration, aggregation, Crystal structure.	Operation in high vacuum, Only applied for solid samples, Time consuming, expensive, Complex sample preparation.
Scanning electron Microscopy	An electron beam interacts with the sample but the beam pass over the surface and due to the secondary electrons ejected from the surface by inelastic scattering occurs the creation of the image	Particle size, Size distribution, shape, agglomeration, aggregation, Crystal structure.	Operation in high vacuum, Time consuming, expensive, Solid and conductive materials, Complex sample preparation.
Atomic Force Microscopy	A scanning probe moves over the surface of the sample and detect the surface topography by the forces measured from the interaction between both surfaces	Particle size, Size distribution, shape, agglomeration, aggregation, surface properties	Sample must adhere to a substrate or be dispersed on it, time consuming
Particle Tracking Analysis	The sample is placed in the dark background and then it is illuminated by an intense laser light. The scattered light and the movement of particles under Brownian motion is measured through a sensitive camera on the optical microscope.	Particle size, Size distribution, agglomeration, aggregation	The sample must be a suspension, Less sensitive if the particles distances are small
Field Flow Fractionation	The separation of the particles occurs according to the differences in their mobility induced by a laminar flow field and after an interaction with a second perpendicularly field force	Particle size distribution	Complex algorithm to extract size distribution, Particles in agglomerates or aggregates are not determined
Differential Electrical Mobility Analysis	The particle samples pass through an electric field and according to their electrical mobility(charge) separation occurs	Particle size, Size distribution	Only aerosol samples, samples need to be charged
Dynamic Light Scattering	The hydrodynamic diameter is determined through the measurement of the fluctuations of the scattered light caused by the particles Brownian motion	Particle size, Size distribution	Only applied for suspensions, Bad resolution for polydisperse samples

	in the suspension by Stokes-Einstein equation		
X-ray Diffraction	A X-ray beam passes through the sample and interacts with the repeated planes of atoms. Atoms organized in a crystalline structure will diffract the beam. Through Bragg´s law the distance between the planes of atoms is calculated	Particle size, shape, structure for crystalline materials	Only applied for crystalline materials
Brunauer Emmet Teller	This technique is based on the physical adsorption of an inert gas (N_2 or Ar) at the surface of the particles at low temperature. By the number of adsorbed molecules on the surface, the surface area is calculated	Specific surface area, Porosity	Only applied for dry samples

Various Bhasmas with their particle size and uses[19-37][Table 5]

Bhasma	**Nanoparticle**	**size**	**Use**
Tamra bhasma	Copper oxide	100 nm	Anemia,jaundice,abdominal disorders ,etc
Abhraka bhasma	mica	19-88nm	Respiratory disorders,diabeties,anemia,etc
Loha bhasma	Iron oxide	100-500nm	Anemia,jaundice,etc
Suvarna bhasma	Calcinated gold	28-35nm	Improves immunity,general weakness,anemia,etc
Rajat bhasma	Calcinated silver	2-7nm	Irritable bowel syndrome,acidity,etc
Nag bhasma	Lead sulphide	60nm	Urinary incontinence,diabeties,spleen disorders,etc
Vang bhasma	Tin dioxide	80-100nm	Genitourinary disorders,diabeties,etc
Yashad bhasma	Zinc oxide	100-400nm	Diabeties,anemia,othalmic disorders,etc
Mukta bhasma	Calcite	156nm	Acitity,blood pressure,acne,headache,etc
Samgandhak kajjali	Mercuric sulphide	156nm	Improves immunity,antibacterial,etc
Trivang bhasma	Lead, Zinc& Tin oxide	500nm	Skin disorders,diabeties,etc
Shankh bhasma	Calcium oxide	600nm	Calcium deficiency,acidity,etc
Praval bhasma	Calcium oxide	1015µm	Calcium deficiency,acidity,etc

DISCUSSION AND CONCLUSION

By these studies we can conclude *Bhasmas* are the best examples of Nanotechnology and Nanomedicine practiced during ancient period. Ancient knowledge of process of *bhasmikaran* may cover the current scientific validation of Nanotechnology. We can consider *bhasma* as nanomedicine and are free from toxicity in therapeutic doses. The drugs developed by this method were not only more effective but had also quick action, required in smaller

dosage, more palatable and had longer shelf life.Continuous burning and cooling of metals/minerals/gems changes the physical and chemical properties of the parent materials.Nano sized particles were totally different from original particles in chemical composition and structure.It not only increases the surface area but the nano size also helps the drug to reach the targeted site efficiently. It is the need of moment to extend the use of *bhasma* as nanomedicines in various aspects like detection and diagnosis of the diseases to make them more effective in serving the society.

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