

Nanotechnology in Ayurveda perspective

Swaroopa Chandorkar², Sharda Dagade-Gadale², Shobha Waghmode^{3*}

¹Department of Microbiology, Abasaheb Garware College, Pune 411004, INDIA

²Department of Chemistry, Y.M. College, Bharati Vidyapeeth, Pune-411038.

³Department of Chemistry, Abasaheb Garware College, Pune 411004, INDIA

Article History

Received: 10/05/2021

Accepted: 20/06/2021

*Corresponding E-mail:
shobhawaghmode@gmail.com

Abstract

Recently the global research is going towards nanoscale products and technology related to nanomaterials. Nanotechnology is the science and engineering involved in the design, synthesis, characterization and application of materials which are in nanometer scale. Although the nanotechnology is the technology of 21st century, its traces can be found in the old Indian medicinal culture. Ayurveda is a branch of medicine developed in *vedic* period and commonly practiced in Indian subcontinent. There are two main pillars stated in Ayurveda regarding treatment – one is physician and another is medicine. We can find the glimpse of nanotechnology mainly in the part explaining preparation of medicine particularly in non-herbal medicine preparation. In this review, we will try to uncover the relation between Ayurveda and nanotechnology. This review briefly explains about Ayurveda and nanotechnology. Any metal, mineral or gem when get converted into nano sized structure or nanoparticles, the physicochemical properties of that substance changes. Many concepts like one above given example are there in Ayurveda which were explained thousands of years back. This review is about such concepts and it mainly focus on synthesis of nanoparticles in ancient times and properties of nanoparticles beneficial in medicines.

Key words: Nanotechnology, Ayurveda, nanoparticles, herbal, *Bhasma*, drug, medicine

INTRODUCTION

Nanotechnology is the science and engineering involved in the design, synthesis, characterization and application of materials which are in nanometer scale, ranging from few to several hundred nanometers (Silva 2004). The word 'nano' means a billionth, so nanometer is a billionth (10⁻⁹) of a meter (Poole 2003). Nano-

engineered substrates are designed to exhibit very specific and controlled bulk chemical and physical properties as one can control their molecular synthesis and assembly. One should understand that nanotechnology is not a single emerging scientific discipline but rather a meeting of traditional sciences such as chemistry, physics, material science, and biology. So

collective expertise of all these fields is needed to develop this novel technology (Silva 2004). There are two main approaches of synthesis and assembly of nanomaterials - "Top down" and "Bottom up" approaches. Top down techniques begin with the macroscopic material or group of materials and incorporate smaller scale details into them. That means the methods in this approach seek to create smaller devices by using larger ones to direct their assembly. On the other hand, Bottom up approaches begin by designing and synthesizing custom-made molecules that have the ability to self-assemble or self-organize into higher order mesoscale and microscale structures. In simpler words these methods seek to arrange smaller components into more complex assemblies (Silva 2004). Nanotechnology has ability to create many new materials and devices with a wide range of applications. Like we can say in the field of medicine and biology; nanoengineered materials and devices designed to interact with the cells and tissues or carry out biologically specific functions can be link between technology and physiological systems and can be used in a novel clinical applications or treatment options.

Formulations of Ayurveda consists of substances of herbal, mineral/metal and animal origin which are processed pharmaceutically to have therapeutic effects (Chaudhary 2010). At the time of *Charaka* and *Sushruta* medicinal plants were primarily used for the preparation of remedial agents. In 8th century AD the Indian alchemist *Nagarjuna* first introduced the use of metals and minerals like - gold, silver, copper, mica, pyrites, mercury as medicinal agents. The branch of Ayurveda

dealing with herbo-mettalic preparation is known as *Rasashastra* (Pal 2015). *Rasashastra* and *Bhaishajya Kalpana* are ancient disciplines of pharmaceutics dealt with different raw materials (herbal, metal and mineral origin), different instruments, different procedures and different techniques required to utilize the nonliving things for benefits of living things. Especially metal and minerals present in the environment having useful and harmful impact on the living organism present on this universe (Gandhi 2014).

SYNTHESIS OF NANO-PARTICLES IN AYURVEDA

Ayurveda is a well-known and well establish science of ancient Indian heritage. The literal meaning of Ayurveda is "Science of Life". It is one of the oldest systems of medicine (Pal 2015). On the other hand, nanotechnology is the technology of 21st century (Danga 2020). It is considered as the biggest engineering innovation since the industrial revolution. This new technology promise to re-engineer the man-made world. Nanotechnology leads to the wave of novel revolutionary commercial products from machines to medicine (Sahu 2013). Though Ayurveda is very ancient and nanotechnology is recently developed; there is a relation between both. This review is trying to uncover the connection between Ayurveda and nanotechnology. The concept of nanotechnology was first discussed in 1959 by renowned physicist Richard Feynman, and the term 'Nanotechnology' was coined by Norio Taniguchi in 1974 (Sharma C. 2014). However, it is observed that the concepts of nanotechnology are included in thousand years old Ayurveda. In India, people commonly used nanotechnology in the form of *Kajal*

preparations from at least 2000 years ago. Ayurvedic *Bhasma* is the oldest form of nanotechnology. *Bhasma* is defined as powder form of substance obtained by calcination. In Ayurveda, they have described many pharmaceutical techniques (*Shodhana*, *Jarana*, *Marana*) by which metals and minerals are converted into very fine, absorbable, most effective and least or non-toxic form of medicines (*Bhasma*) (Danga 2020). Also, nanoparticles synthesized by nanotechnology has some properties like nano-size, bioavailability, specific target action, less toxicity which makes them a powerful tool in drug delivery system.

Chikitsa Chatushpad (Ayurveda) states that first important part in the treatment is the physician and the second most important part is medicine. It is considered as the main tool for treating the patients. There are two groups of Ayurvedic drugs - *Kashthaushadhies* (herbal preparations) and *Rasaushadhies* (herb-bio-mineral-metallic preparations). The innate qualities of *Rasaushadhies* like quick action, lesser dose, tastelessness, prolonged shelf life, better palatability have helped conquer the demand of patients as well as pharmaceutical proprietors (Chaudhari 2010). These properties along with some more physicochemical properties and good bioavailability can be achieved in metals and minerals by using different procedures like *Shodhana*, *Marana*, *Satvapatana*, *Kupipkava*, *Pottali* with their proper sequence (Gandhi 2014).

In all these methods, *Marana* (Incineration/Calcination) is more important from nanotechnology point of view. *Marana* brings many physicochemical changes in a metal or mineral like reduction in particle size to make it beneficial as a

therapeutic agent. *Shodhana* is the first step in the process of *Marana*. It is nothing but purification of the substance (metal/minerals). After removal of impure and toxic material from the substance, the next step is *Bhavana*. In this the purified material is triturated with specific herbal juices till doughy mass is obtained. Then the next step is *Chakrika Nirmana* also known as palletization, in which the doughy mass is converted into *Chakrika* (pellets) and kept for drying. Then these dry flat pellets were kept on earthen saucer and covered with another earthen saucer. The joint of both the saucers is closed with mud smeared cloth and allowed to dry. This specific arrangement is known as *Putra Yantra*. *Putra Yantra* is then subjected to *Putra*. *Putra* means a specific heating pattern for specific duration. It is an important step in the process of *Marana* and it depends upon the source of heat, direct/indirect application of heat, source of fuel and its dimensions. After this step, pellets are collected and examined for its consistency. Then the pellets are converted into fine powder. All the above steps are repeated till desired physicochemical and biological properties achieved to the material (Gandhi 2014). This is the traditional method for synthesis of nanoparticles. Now a days, nanoparticle synthesis is carried out by Radio Frequency (RF) plasma method, chemical methods, thermolysis, Pulsed laser method etc. In RF plasma method, nanoparticles synthesis utilizes plasma generated by radio frequency heating coils. Nanoparticles forms on the He atom entered in the system. Chemical methods are carried out by using different reducing agents. In thermolysis, nanoparticles can be made by decomposing solids at high temperature having metal

cations and metal organic compounds. This method is somewhat similar to traditional Ayurvedic method. Pulsed laser method is

used for synthesis of silver nanoparticles. Laser beams are used in this method to prepare nanoparticles (Poole 2003).

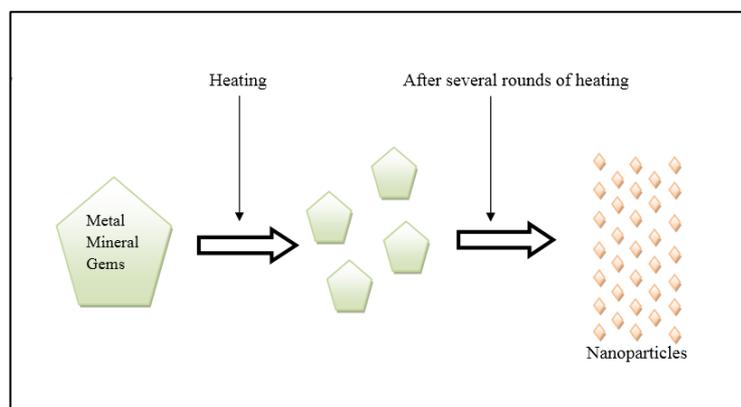


Figure 2: Schematic diagram showing ancient method of nanoparticles synthesis

It is really surprising that with limited knowledge, the scientist of ancient times continues burning and cooling of metals, minerals, gems to get rid of their toxic effects. However, the end result was remarkable. It was nothing but a nanotechnology. This procedure is shown in the figure 2. The nano size particles produced by this method were totally different from original particles in chemical composition and structure. It not only increased the surface area but the nano size also helped the drugs to reach the target site efficiently. These drugs had quick action and

required smaller dosage. There are many such drugs (Ayurvedic *Bhasmas*) like *Heerak Bhasma*, *Swarna-basant-malati Ras*, *Tamra Bhasma*, *Loha Bhasma*, *Rajat Bhasma* are available in the market used to treat many diseases. Physicochemical characterization of these *Bhasmas* are carried out by X-ray photoelectron spectroscopy (XPS), Inductively coupled plasma (ICP), Dynamic light scattering (DLS) and Transmission electron microscopy (TEM). Table 1 shows the formulation of some ayurvedic *Bhasmas* (Pal 2015).

Table 1: Ayurvedic *Bhasmas*

Name	Ingredients
<i>Heerak Bhasma</i>	Diamond
<i>Swarna Basant Malati ras</i>	Gold, piper-nigrum, white pear powder
<i>Tamra Bhasma</i>	Copper, mercury, sulfur
<i>Loha Bhasma</i>	Iron, cinnabar
<i>Rajat Bhasma</i>	Silver ash
<i>Kumar kalian ras</i>	Gold, iron, mica, copper pyrite, red sulfide of mercury
<i>Vaikrant Bhasma</i>	Manganese, sulfur

NANOPARTICLES IN MEDICINE

Nanotechnology is an emerging field in medicine that is expected to have significant therapeutic benefits. When it is about using particular medicine for treatment, one need to consider drug targeting or a drug delivery system. According to recent research nanotechnology plays very important role in drug delivery system. Nanoparticles has a self-targeting property due to their distinctively small size. Self-targeting means they can target a specific pathological area without the attachment of a specific ligand. These nanoparticles are either nanospheres or nano-capsules. They are able to absorb or encapsulate a drug, protecting it against enzymatic or chemical degradation. In the drug delivery system, there is another new concept known as nano-carrier. Nano-carrier is a nanomaterial used as transport module for another substance like a drug (Sharma C. 2014). Various novel drug delivery systems like liposomes, niosomes, nanospheres and phytosomes have the ability of delivering herbal drugs. Application of nanotechnology leads to increase in bioavailability and bioactivity of phytomedicine by reducing the size of the particles, surface modification, attaching or entrapping the phytomedicine with different polymers of micro or nanomaterials. Nanomaterials improves the pharmacokinetics profile and diffusion of drugs into various organs by crossing the barriers including the blood brain barrier (Gunasekaran 2014).

The application of nanotechnology for treatment, diagnosis, monitoring, and control of biological systems have been referred as nanomedicine (Ansari 2012). Nano-phytomedicine is the concept taken from Ayurveda. Nano-phytomedicines are

prepared from active phytoconstituents or standardized extracts. These medicines improve efficacy and bioavailability of administered drugs. Side effects and toxicity associated with these medicines are negligible. A nanosized herbal drug containing veteh root, seawort, cassia twig, liquorice root is found to be effective in pulmonary, bone, brain, liver and skin cancer. This formulation enters cancerous cells without damaging healthy cells. Nanoparticles are also effectively used in cosmetics. Many consumers have used nanoparticles in sunscreen lotion safely to protect from harmful UV rays and skin cancer (Sahu 2013).

The combination of nanotechnology with traditional herbal medicine provides a very useful tool in designing future herbal medicines with improved bioavailability profile and less toxicity (Sahu 2013). Ayurvedic herbal medicines and Ayurvedic *Bhasma* holds strong relevance in the emerging era of nanomedicine. It can serve as a template for the development of future nanomedicine (Sharma R. 2015).

CONCLUSION

There is a very strong connection between Ayurveda and nanotechnology. Though nanotechnology is a recent science, the roots and the concepts of nanotechnology are found in thousands of years old Ayurveda. Ayurveda describes the physicochemical properties of metal, minerals and gems changes when they are converted into nano-sized particles. Ancient Indian scientists not only showed how these nanoparticles (*Rasaushadhies*) are useful but also explained how one can prepare them. Those pharmaceutical techniques mentioned in Ayurveda can be known as ancient methods

of nanoparticles synthesis. Properties of nanoparticles such as nano-size, specific target action, bioavailability, less toxicity are beneficial in the field of medicine.

There are many uses of nanoparticles or nanomaterial synthesized by nanotechnology in the field of nanomedicine. Nanoparticles are used as an effective tool in the drug delivery system and drug targeting. Nano-phytomedicines, herbal nano sized anticancer medicines, nanocurcumine, Ayurvedic *Bhasma* are some applications of nanotechnology combined with Ayurveda. Combination of Ayurveda and nanotechnology will lead to many applications to come in future era.

REFERENCES

1. Pal S., The Ayurvedic *Bhasma*: The Ancient Science of Nanomedicine, Recent Patents on Nanomedicine, 5, 12-18, (2015).
2. Danga SK and Chaudhary P., Nanotechnology - Revolutionary phase in prospective of Ayurvedic medicine, Journal of Ayurveda and Integrated Medical Sciences, 5, 2456-3110, (2020).
3. Sahu A., Nanotechnology in herbal medicines and cosmetics, Int. J. Res. Ayurveda Pharm., 4(3), (2013).
4. Sharma C. and Singh C., Nano Carriers of Novel Drug Delivery System for "Ayurveda Herbal Remedies" Need of Hour- A Bird's Eye View, Am. J. PharmaTech Res., 4(2), 2259-3387, (2014).
5. Chaudhary A. and Singh N., Herbo mineral formulations (*Rasaushadhies*) of Ayurveda an amazing of Ayurvedic pharmaceuticals, Ancient Science of Life, 30(1), 18-26, (2010).
6. Gandhi P., Chaudhary A., Prajapati P., Marana-As a Bio-nanotechnology of Ayurveda, STM journals, 1(2), 12-18, (2014).
7. Silva G., Introduction to Nanotechnology and Its Applications to Medicine, Elsevier, 61:216-20, (2004).
8. Poole C. and Owens F., Introduction to Nanotechnology, Wiley-Interscience, (2003).
9. Gunasekaran T. et al., Nanotechnology: an effective tool for enhancing bioavailability and bioactivity of phytomedicine, Asian Pac J Trop Biomed, 4(Suppl 1): S1-S7, (2014).
10. Ansari S. et al., Influence of nanotechnology on herbal drugs: A Review, J. Adv. Pharm. Tech. Res., 3(3), (2012).
11. Sharma R. and Prajapati P., Nanotechnology in medicine: Leads from Ayurveda, Researchgate, (2015).
12. Kalyankar V. K., Dagade P. M, Dagade S.P and Waghmode S. A. Biosynthesis of Silver nanoparticles using isolated superoxide dismutase enzyme from novel source *Papaverum somniferum* L. Vol. 19 (3) March (2015) Res. J. Chem. Environ.
13. Omkar Pawar, Neelima Deshpande, Sharada Dagade, Preeti Nigam-Joshie, Shobha Waghmode. Green synthesis of silver nanoparticles from purple acid phosphatase apo-enzyme isolated from a new source *Limonia acidissima*. **J.of Expt.Nanoscience**.doi.org/10.1080/17458080.2015.1025300, Published online: 27 Mar 2015.
14. Preeti Nigam, Shobha Waghmode, Michelle Louis, Shishanka Wangnoo, Pooja Chavan and Dhiman Sarkar. Graphene quantum dots conjugated albumin nanoparticles for targeted drug delivery and imaging of pancreatic cancer. **J. Mater. Chem. B**, 2014, 2, 3190-3195, DOI: 10.1039/C4TB00015C.
- 15.