Bulletin of Environment, Pharmacology and Life Sciences
Bull. Env. Pharmacol. Life Sci., Special Issue [1]2022 : 310-314

Online ISSN 2277-1808
Journal's URL:http://www.bepls.com
CODEN: BEPLAD

REVIEW ARTICLE **OPEN ACCESS**

Influence of Nanotechnology from Plant Products and Implementation in Pharmaceutical Industry

Lovy Singh Bist, Mrityunjay Mishra, Karneshwar Gholia, Amit Gupta
Department of Life Sciences (Biotechnology), Graphic Era Deemed to be University, Dehradun
Corresponding author's Email: dr.amitgupta.bt@geu.ac.in

ABSTRACT
Medicinal plants were explored all over the world and determined its immunobiological activity by several groups of researchers. The major criteria and focus of these studies are totally based on its uses and applications of active ingredients from plant products and then applied its application in pharmaceutical industry. Now a day, in developing countries, researchers again worked on these natural medicines derived from plant products because of synthetic drug which is highly expensive. In this regard, researchers more focused on nanotechnological approaches using medicinal plant products and may be able to enhance its biological activity. So, nanomedicine derived from plant products are the most intensely expanding borderline of Science and Technology, and is becoming popular day by day. Nanomedicine heralds the future of pharmaceutical industries and has emerged as an enormously promising technology. Nanotechnology finds application in the diagnostics, treatment and anticipation of diseases also it is estimated to have a significant effect on medicinal equipment's. The purpose of this review article is to provide a comprehensive overview of the various opportunities relating the use of nanotechnology in pharmaceuticals, to support the long list of therapeutic and diagnostic products of nanotechnology astonishing the market.
Key words: *Nanotechnology; pharmaceutical; application; market*

Received 20.02.2022 Revised 13.03.2022 Accepted 05.04.2022

INTRODUCTION

Medicinal plant products are widely used and applied all over the world because of its advancement in the field of phytopharmacological sciences. This science which enabled us in order to find out its composition along with its immunobiological properties of medicinal plant products. So, these activities are totally dependent on bioactive compounds i.e. flavonoids, tannins, terpenoids etc. The major drawback of these bioactive constituents having low absorption rate, high molecular size and unable to cross the cell lipid membranes. So, these are the major obstacles of these extracts for not using or applied clinically. In this regard, researchers proposed some combination of medicinal plant extracts/fraction with nanotechnology because of its formation of nanostructured systems. So, these nanostructured systems may be able to potentiate the activity of plant extract and also responsible for reducing the dose of extracts and showed less side effects [1, 2]. In other words, nanotechnology derived methods are able to deliver the active moiety on specific site or location.

The concept of nanotechnology runs deep to the bottom of things. There is unlimited possibilities and potential of the basic particles of matter which we call atoms and molecules. Nanotechnology is the term assigned to the areas of science and technology where the phenomenon occurs at microscopic levels, dimensions in the nanometric scale are made use of in the designing, production, characterization and application of materials, structures, systems and devices.Richard Feynman- an American Physicist delivered at Caltech, a lecture titled as "there's plenty room at the bottom "in 1959, he proved to be the inspiration for the field of nanotechnology. In 1974, Norio Taniguchi coined the term "nanotechnology."A more generalized description about nanotechnology was established by the National Nanotechnology Initiative, explaining concept of the manipulation of materials on an atomic or molecular scale, at least one dimension sized from 1 to 100 nanometers [3, 4]. The active and intentional modification of substances at molecular level has only been possible in the last quarter of a century, where different technologies have aided to the incidental evolution of nanotechnology. The basic concept of nanotechnology is to employ individual atoms and molecules to construct functional structures, changes in any substance or particles can be made to the level of manipulating atoms, molecules and chemical bonds [**5,6**].Recently machines called nanoassemblers have been invented, which are controlled and

commanded by a computer. These machines are of a size smaller than a nucleus and are made use into places that remain inaccessible to the hands and technology. Thus, it can be inferred that various forms of nanotechnology have a significant potential to make a huge impact on the society and it is most likely to be beneficial to individuals and organizations. Some nanomaterials include two dimensional nanotubes, nanowires and nanoparticles used in cosmetic and pharmaceutical coatings. Nanotechnology and its future implications are currently debated by scientist all over the world as it is believed that nanotechnology may be able to create many materials and devices with a wide range of applications, in fields such as in nanomedicines, nanoelectronics, biomaterials nanocapsules, dendrimers, nanorods, liposomes and energy production. Thus, it is right to say that nanotechnology influences almost every facet of day-to-day life and it is amongst the fastest emerging technologies of this era [5-7].

NANOPHARMACEUTICALS

The drawbacks of conventional form of drug dosage are rapidly being replaced by pharmaceutical nanotechnology. The conventional forms suffered many drawbacks like damage to healthy cells, poor patent complains, bioavailability, etc. If we consider the current scenarios, then at present the whole pharmaceutical industry is facing a huge pressure to be able to efficiently provide great quality pharmaceuticals to the patients while retaining the profitability [6-8].

Nanopharmaceuticals or pharmaceutical nanotechnology is therefore emerging as a better alternative area and is nowadays regarded as the technology of the present. The nanopharmaceuticals have a great potential to tackle the disappointment caused by the old-style therapeutics which deals with not being greatly efficient in the site-specific targeting of drugs and leading to toxic systemic side effects and therefore, bringing up more and more patient compliances.

The nanopharmaceuticals may be considered as an emergent field where the drug delivery or the delivery system of the drug is carried out at nanoscale level. This has proved to be a better way of providing the right dosage of a drug. The nanopharmaceuticals cover all the areas based on pharmaceuticals that apply to the formulation, development and delivery. A huge sum of money has already been invested in the development of the nanomedicines, but as of now most part of them is shelved until they start giving redundant results. It is thereby expected that nanotechnology will facilitate to redesign some of the older pharmaceuticals and several may even find their path to the market [6-9].

Pharmaceutical Nano System

The application of nanotechnology into the pharmaceuticals has greatly helped in the formulations of more advanced drug delivery system. The nanopharmaceutics is the hope of the healthcare and has enormous promise. The pharmaceutical nanotechnology helps to fight against several diseases by the antigen associated with the disease and also by detecting the microorganisms and viruses causing the disease. Nanomaterials bring a unique shape and functionalities which help in developing nanomaterials and nanosystems that aid in developing and delivering of the drugs [10-12].Some of them are listed as follows:

- ✓ *Polymeric nanoparticles***:** These are biocompatible and biodegradable and provide complete drug protection. These have a size range between 100-1000 nm. The polymeric nanomaterials are used as carriers for the sustained and controlled delivery of drugs.
- ✓ *Polymeric micelles***:** These have a high diagnostic value and are used for the active and passive targeted drug delivery. There sizer range varies between 10-100 nm.
- ✓ *Metallic nanoparticles:* These have a very small size which results in more surface area and so they have a greater bioavailability and are more stable which is the most favored characteristic of a drug. These are made use of in the sensitive diagnostic assays, thermal ablation and radiotherapy enhancement. These are the colloids of gold and silver and have a size range lesser than 100 nm.
- ✓ *Dendrimers:* These are highly branched and monodispersed polymeric systems. These are employed in the controlled delivery of drugs and for the targeted delivery of drugs to the macrophages and liver. The dendrimers are produced by the method of controlled polymerization have a size lesser than 10 nm.
- ✓ *Liposomes:* These are phospholipid vesicles and are deployed for the active and passive delivery of gene, protein and peptides. Their size range varies between 50-100 nm and they have a very good biocompatibility and entrapment efficiency.

APPLICATION OF NANOTECHNOLOGY IN PHARMACEUTICALS

Development of nano-enabled products*:* - The development of product involves the discovery and development of new drugs for the treatment of diseases and hence, it is an area of continuation and research. Some properties such as solubility, permeability, degree of ionization, stability in biological

fluids, lipophilicity and protein binding properties are taken into consideration when a new molecule of drug is synthesized. Some properties of the drugs can be improved and enhanced by the development of drug delivery system on the basis of Lipid and Polymer based nanoparticles [12-15].

- *Lipid Nanoparticles:* - These are medically advanced non-viral gene delivery system which ensures safe and effective delivery of nucleic acid preventing the use of genetic medicines. Size of these particles ranges between 50 – 1000 nm. There use in oncology has improved the treatment of cancer by enhancing the antitumor activity of several chemotherapeutic agents.
- *Polymeric Nanoparticles:* -Particles which lies in the size range from 1 – 1000 nm. They are biodegradable in nature. These particles include polylactic acid, polyglutamic acid, chitosan, polylactic-glycolic acid. These nanoparticles have various applications in different fields, for example, in drug delivery biosensors, nanocomposites etc.
- *Nanocrystalline metal coating*is mainly applied and used on orthopedic prostheses to enhance hardness and provide a high degree of resistance to corrosion and wear.
- Nanotechnology is also used in coating implantable medical devices that do not interfere with Magnetic Resonance Imaging (MRI). This helps the patients to receive high quality MRI imaging.

Nano based drug delivery system: - Nanotechnology is playing an important role to bridge the gap of biological and physical sciences by applying nanostructures and nanophases in the field of nanomedicine and nano based drug delivery system. This technique uses curative agents at nanoscale level to develop nanomedicines. These nanoparticles are small sized nanospheres as they are made up of materials designed at atomic or molecular level. This enables them to move freely in human body as compared to bigger materials. These nanostructures are utilized as delivery agents by attaching therapeutic drugs and deliver them to target tissues [**11-15**]. As nanostructures are highly biocompatible and biodegradable, they are useful when tagged with drugs having poor solubility and less absorption ability, making them efficiently cure the diseased tissue. The nano-dimensional materials are mainly used in medical biology include nanorobots, nano sensors and lipid systems like lysosomes, micelles etc.

- *Treatment of Alzheimer's Disease (AD*), neurodegenerative disease having high rate of prevalence and reported especially seen in elderly population in all over the world. The most common drugs were used especially for this disease are oral medications(conventional). Because of its side effects were reported in human gastrointestinal tract and totally lacks its activity in brain. So, these drugs and dosage regiments hinder patient compliance and lead to treatment discontinuation. Nanotechnology based drug delivery systems administered by different routes can be considered as promising tools to improve patient compliance and achieve better therapeutic outcomes. Active and passive immunization against AD is the most widely studied alternative AD therapies because conventional oral drug therapy is not yielding satisfactory results.
- *Cardiovascular Applications*- Cardiovascular or heart related diseases claim many lives globally, most of which can be prevented. With the increase in diets which contains high saturated fat, salt and sugar. People are living a sedentary lifestyle causing problems such as obesity which leads to the increase in cardiovascular diseases. Studies show that cardiovascular diseases are the major cause of worldwide deaths claiming 17 million lives in 2015 and this figure is projected to increase to 23 million in 2030. For cardiac related diseases such as hypertension, atherosclerosis and myocardial infraction, nanomedicines are being made through which nanoparticles are administrated into the targeted vessels, due to their properties, nanomaterials can provide novel opportunities in cardiovascular tissue engineering.

Prevention of drugs: -Nanotechnology helps in the prevention of drugs in many ways: -

- ✓ Prevent drugs from getting tarnished in gastrointestinal region.
- ✓ Improves bioavailability by enhancing aqueous solubility.
- ✓ Increases the resistance time in the body.
- ✓ Helps the delivery of water - soluble drugs to their target location.
- ✓ Reduces the chances of side effects to a greater extent.

As discusses earlier, Nanomaterials or nanometals are present in machines for sensitive detection and safer imaging of diseased tissues. For example, super paramagnetic iron oxide nanoparticles are used in machines such as MRI for the detection of cancer.

Reduction of adverse effects: - Nano drugs depict specific uptake mechanism of absorptive endocytosis, so they are easily and directly absorbed by the cells as compared to large particles. This direct interaction helps to treat the diseased cells efficiently and reduces the threat of side effects.

Useful in diagnosis, detection, imaging: -The emerging concept of 'Theranostic' i.e., therapy and diagnosis is highly useful for the treatment of problems such as cancer. The theranostic nano particles are proven to be helpful in the diagnosis of diseases, reporting the location of specific disease, identifying the

stage of disease, and providing information about the response of the treatment. Nano particles can also carry therapeutic agents for tumor. For example, Chitosan, a biopolymer is used for the encapsulation or coating of various types of nano particles producing different types of particles having multiple functions in the detection and diagnosis of various diseases.

Case Study: Use of Nano technology in the treatment of Cancer

Nano drug delivery system has become highly effective in treating cancer. Nano compounds named 'Phytochemicals' that are present in plants are exploited for their anticancer properties [**6-9**]. These are limited due to their low water solubility and poor bioavailability. But researches have proved that they become more soluble when delivered by the nano carriers like micelles, dendrimers, liposomes, nanoparticles etc. and exhibited a remarkable effect on the cancer cells as compared to their free form. More interestingly, the half-maximized dose of the phytochemical was reduced significantly when it was delivered by the nano carriers. This improves cancer chemotherapy by reducing undesired effects and invigorating site-specific drug delivery.

DISADVANTAGES OF NANOTECHNOLOGY IN PHARMACEUTICALS

Even though there are a lot of benefits of Nanotechnology in medicine [**4-6**], still there are some disadvantages too:

- Nanotechnology is highly expensive and hence the products of nanotechnology, like nanomedicine are also expensive. Therefore, such medicine can't be afforded by middle class or poor people. Hence, there is a great need to work on this technology to lower the cost of manufacturing and research to lower the cost of such medicine and make it easily affordable for all people as this medicine can be highly effective on some diseases, like cancer.
- It also has some unusual health effects. Nanoparticles may react with the non-targeted organs/area of human body as they are very small and cannot be controlled 100%, which makes it unspecific and this may cause unpredictable reactions.
- It's toxicity and low solubility is also a major problem as these can be a serious threat to human health.
- It also causes some privacy threat as nanoparticles are so small that they can be misused for some unethical benefit, which is totally illegal. For example – one can hide Nano-transmitter in someone's medicine to track their location without their consent. And, since the size of these nano-transmitter is so small, it can be easily hided in someone's medicine with other nanoparticles.
- In some recent studies it is also mentioned that nano particles cause lung injuries as it triggers the cell programmed death,but the reason is still unknown.

REFERENCES

1. Bharali DJ, Siddiqui IA, Adhami VM, Chamcheu JC, Aldahmash AM, Mukhtar H, Mousa SA. (2011). Nanoparticle Delivery of Natural Products in the Prevention and Treatment of Cancers: Current Status and Future Prospects. Cancers; 3: 4024-4045.
2. Surangi H, Thilakarathna, Rupasinghe HPV. (2013). Flavonoid Bioavailability and Attempts for Bioavailability Enhancement, Nutrients ; 5: 3367-3387.
3. Bouwmeester H, Dekkers S, Noordam MY, Hagens WI, Bulder AS, Heer C *Et al.* (2009). Review of health safety aspects of nanotechnologies in food production. Reg Toxicol Pharmacol; 53, 52–62.
4. Bradley EL, Castle L, Chaudhry Q. (2011). Applications of nanomaterials in food packaging with a consideration of opportunities for developing countries. Trends Food Sci Technol 22: 603–610.
5. Qui Y, Park K. (2001). Environment sensitive-hydrogels for drug delivery. Adv Drug Devl Rev; 53: 321–339.
6. Cheng Q, Li C, Pavlinek V, Saha P, Wang H. (2006). Surface-modified antibacterial TiO2/Ag+ nanoparticles: preparation and properties. Appl Surface Sci ; 252: 4154–4160.
7. Couch LM, Wien M, Brown JL, Davidson P. (2016). Food nanotechnology: proposed uses, safety concerns and regulations. Agro. Food IndHitech 2016; 27: 36–39.
8. Dasgupta N, Ranjan S, Mundekkad D, Ramalingam C, Shanker R, Kumar A. (2015). Nanotechnology in agrofood: from field to plate. Food Res Int ; 69: 381–400.
9. Ezhilarasi PN, Karthik P, Chhanwal N, Anandharamakrishnan C. (2013). Nanoencapsulation techniques for food bioactive components: a review. Food Bioprocess Technol ; 6: 628–647.
10. Helmke BP, Minerick AR. (2006). Designing a nano-interface in a microfluidic chip to probe living cells: challenges and perspectives. Proc Nat Acad Sci USA; 103: 6419–6424.
11. Inbaraj BS, Chen BH. (2015). Nanomaterial-based sensors for detection of foodborne bacterial pathogens and toxins as well as pork adulteration in meat products. J. Food Drug Anal ; 24: 15–28.
12. Jianrong C, Yuqing M, Nongyue H, Xiaohua W, Sijiao L. (2004). Nanotechnology and biosensors. BiotechnolAdv 22: 505–518.

13. Farokhzad OC, Karp JM, Langer R. (2006). Nanoparticle-aptamer bioconjugates for cancer targeting. Expert Opin Drug Deliv ;3:311–324.
14. Farokhzad OC, Cheng J, Teply BA *et al*. (2006). Nanoparticle-aptamer bioconjugates result in significant tumour reduction in vivo. Proc Natl Acad Sci USA;103(6):6315–6320.
15. Ferrari M. (2005). Cancer Nanotechnology: Opportunities and Challenges. Nature Rev Cancer; 5:161–171.
16. Grodzinski P, Silver M, Molnar LK. (2006). Nanotechnology for Cancer Diagnostics: Promises and Challenges. Expert Rev. Mol. Diagn. ;6(3):307–318.
17. Lupton M. (2014). Where to draw the line – regulation of therapeutic applications of nanotechnology. Asian J WTO Int. Health Law Policy; 9: 197–216.

CITATION OF THIS ARTICLE

L S Bist, M Mishra, K Gholia, A Gupta.Influence of Nanotechnology from Plant Products and Implementation in Pharmaceutical Industry. Bull. Env.Pharmacol. Life Sci., Spl Issue [1] 2022 : 310-314