Review Article

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NANOTECHNOLOGY IN HERBAL MEDICINES AND COSMETICS

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ABSTRACT
Nanophytomedicines are prepared from active phytoconstituents or standardized extracts. The world market for nanomedicine is estimated to reach $130.9 billion by the fiscal year 2016. Liposome nanoparticle (NP) with entrapped doxorubicin has been reported to be 300 fold more effective because of better pharmacokinetic ability in treatment of Kaposi sarcoma. NP of paclitaxel is used in the treatment of breast cancer. It has increased water solubility, reduced toxicity and improved therapeutic index. Nanotized herbal drug containing active principles of veteh root, seawort, cassia twig and liquorice root is found to be effective in pulmonary, liver, bone, brain and skin cancer. The *in-vivo* pharmacokinetic parameters of polymeric nanoparticles containing curcumin reveal at least 9 fold increase in oral bioavailability when compared to curcumin administered with piperine as absorption enhancer. The green nanotechnology utilizes plant based phytochemicals in the overall synthesis and architecture of NP. Cumin and gum arabic are used for synthesis of gold NP that has reduced toxicity to living organism and environment. Bhasma used in Ayurveda is ancient but ultra modern nanomedicine prepared from metal. Swarna bhasma has particle size of 56 nm. NP in cosmetics has been used safely and effectively. NP ingredients like Zno and TiO_2 have properties that provide greater degree of protection from sun. Liposome containing *Aloe vera* extract in size range less than 200 nm diameter has shown higher rate of cell proliferation and increased synthesis of collagenase in *in vitro* test using human skin fibroblast and epidermal keratinocytes.
Keywords: Nanotechnology, Nanoparticle, Nanophytomedicine, Green nanotechnology

INTRODUCTION

The advent of nanotechnology is considered to be the biggest engineering innovation since the industrial revolution. Proponents of this new technology promise to re-engineer the man-made world, molecule by molecule, sparking a wave of novel revolutionary commercial products from machines to medicine[1]. The origin of nanotechnology is often attributed to a concept advanced by Richard P. Feynman. The word nano derived from the greek noun "nano" meaning "dwarf". A nanometer is one billionth of meter or length of 10 hydrogen atom placed side by side or 1/80000 of thickness of human hair. The particle size of nanoparticles (NP) in medicine ranges from 5 nm - 250 nm. These are produced by various chemical or physical processes and having specific properties[2].

The world market for products using nanotechnology is estimated to reach US$1trillion by 2015. Chinese and Indian government are also investigating and committing to nanotechnology. In 2006 Indian and Australian governments contributed 20 million dollars to start Australia-India Science Research Funding Programme. According to the report published by BCC Research, the market value of the worldwide nanomedicine industry was $63.8 billion and $72.8 billion in 2010 and 2011, respectively. The market is estimated to grow at a CAGR of 12.5% to reach $130.9 billion by the fiscal year 2016. The market for anti-cancer products was valued at $28 billion in the fiscal year 2011 when compared to the 2010 value of $25.2 billion. It is anticipated to reach $46.7 billion by the fiscal year 2016 for a CAGR of 10.8% during the period 2011-2016

Tools in Nanotechnology

Cantilever

Cantilever is a tiny bar anchored to one end can be engineered to bind to molecule associated with cancer. These molecule bind to alter DNA protein that present in cancer cell[3].

Nanopores

Nanopores allow DNA to pass through one strand at a time hence DNA sequencing can be made more efficiently. Thus shape, electrical property of each base on strand can be monitored. As these properties are unique for each of four bases that make up genetic code. The passage of DNA through a nanopore can be used to decipher the encoded information including error in code associated with cancer.

Fullerene

A fullerene is any molecule composed entirely of carbon, in the form of a hollow sphere, ellipsoid, or tube. Spherical fullerenes are also called buckyballs, and cylindrical ones are called carbon nanotubes or buckytubes. Fullerenes are similar in structure to graphite, which is composed of stacked graphene sheets of linked hexagonal rings; but they may also contain pentagonal (or sometimes heptagonal) rings.

Nanotubes

These are smaller than nanopores. Nanotubes are about half of the diameter of molecule DNA. It helps to exactly pin point location of changes in mutated region associated with cancer. These are first tagged with bulky molecule. Using nanotube tip on a record player the physical shape of DNA can be traced.

Dendrimers

These are tree like macromolecules with branching reach out from central core. These branched macromolecules are constructed around a simple core unit. Dendrimers have a high degree of molecular uniformity, narrow molecular weight distribution, specific size and shape characteristics, and a highly functionalized terminal surface. The manufacturing process is a series of repetitive steps starting with a central initiator core. Each subsequent growth step represents a new "generation" of polymer with a larger molecular diameter, twice the number of reactive surface sites, and approximately double the molecular weight of the preceding generation[3, 4].

Classification of nanoparicles

- Labile Nanoparticles: Liposomes , micelles, polymers, nanoemulsions etc[3].
- Insoluble Nanoparticles: TiO_2, SiO_2, fullerens, quantum dots, carbon lattices, nanotubes etc[3].
- One dimensional nanomaterial: Nanowire and nanotube[4]
- Two dimensional nanomaterial: Self assembled monolayer film[4]

Nanophyotomedicine – Nanotechnology in Herbal Drugs

Nanophytomedicines are prepared from active phytoconstituents or standardized extracts. Use of Nanophytomedicine improves efficacy and bioavailability of administered drugs. They also decrease the side effects and toxicity of administered drugs.

Anticancer therapy

The benefit of using nanotechniques in anticancer therapy is target delivery of anticancer drugs with fewer side effects. Liposomes with entrapped doxorubicin were reported to be 300 fold more effective because of better pharmacokinetic ability in treatment of Kaposi sarcoma. Nanoparticles surface modified with cationic chitosan were efficient for drug delivery both *in vitro* and *in vivo*. Abraxane is approved for the treatment of breast cancer. Abraxane is a nano-formulation of paclitaxel conjugated to nanobead protein structure. The nanobead protein conjugated formulation increases water solubility allowing for elimination of the toxicity associated with the solvent vehicle (cremophor) and improved therapeutic index. Nanotized herbal drug containing active principles of veteh root, seawort , cassia twig and liquorice root is found to be effective in pulmonary, liver, bone, brain and skin cancer. This nanoformulation enter cancerous cell without damaging healthy cell[5-8].

Nanocurcumine

Curcumine is fat soluble molecule which has poor water solubility, greatly limiting its bioavailability. Curcumine also metabolised quickly further reducing its bioavailability. These problems have lead to search for a super-curcumin that deliver all of benefits in a more usable and bioavailable form. This problem is solved by tiny particle of curcumine encapsulated in oil cavity surrounded by membrane. Encapsulation in these tiny particles allows lipid soluble curcumine to be better absorber and also slow the release into blood stream, enhancing and improving bioavailability. *In vitro* and animal study has suggested that curcumine may have antitumour, antioxidant, antiarthritic and anti inflammatory activity. *In vivo* pharmacokinetic studies reveal that curcumine entrapped nanoparticle demonstrate at least 9 fold increase in oral bioavailability when compared to curcumine administered with piperine as absorption enhancer[9].

Green nanotechnology (Cumin- mediated gold nanoparticle)

Several of the currently used nanoparticle production process utilize toxic chemical either in the form of reducing agent to reduce various metal salt to their corresponding nanoparticle or as stabilizing agents to stop NP from agglomeration. For example hydrazine and sodium borohydride that are currently used in reduction reaction of gold to produce gold and various metallic Nanophytomedicine. Both of them are highly toxic to living organism and environment. The utility of plant based phytochemicals in the overall synthesis and architecture of Nanophytomedicine. Connection between plant science and nanotechnology provide inherently green approach to Nanotechnology referred as green nanotechnology. The powerful antioxidant characteristics of various phytochemicals within cumin contain functional group such as carboxyl, amino, thiol and hydroxyl including cuminaldehyde, alpha and beta pinene, cuminin alcohol, p-cymine and beta terpene within cumin will provide synergistic chemical reduction power for reduction of gold salt to their corresponding gold Nanophytomedicine. Experimental study shows that none of the individual constituent are potentially reducing and stabilising gold Nanophytomedicine, whereas cocktail of the entire chemical along with gum arabic are responsible for synthesis of gold Nanophytomedicine in aqueous medium[10].

Ayurvedic Bhasma - a nano preparation

Bhasma used in Ayurveda for treatment of various disease for the past several centuries, is the oldest form of nanotechnology. Bhasma is ancient but ultra modern nanomedicine prepared from metal after many scientific process to raw material into the therapeutically active form. This is done through classical process by repeated incineration and grinding with some herbal juice and other specified drug. Due to its small size basic character gets changed. It is mainly due to change in electrical, thermal, inorganic, optical, chemical and biological behavior. Swarna Bhasma is a therapeutic form of gold metal of nano size particle. When evaluated by various tool and techniques like AFM (atomic force microscope), SEM (scaning electron microscope), it was found that the size of particle was 56 nm. Analysis by FT-IR and XRD shows that pure Au in zero valency state[11].

Natotechnology in Cosmetics

NP in personal care product sits on top of the skin care formulation. Nanoparticle in sunscreen has been used safely and effectively by consumer for decade to protect

from harmful UV rays and skin cancer. Nanophytomedicine ingredients like ZnO and TiO_2 have properties that provide greater degree of protection from sun.

Aloe vera extract in nanoparticle

Aloe vera extract that is formulated in cream or gel widely use for skin care mostly in dermatitis, psoriasis, dryness, scaling, flaking, eczema, sunscreen lotion and anti aging preparations. According to recent study scientist in Japan claims that *Aloe vera* extract is unable to cross stratum cornium. Penetration of such hydrophilic compound into skin is highly suppressed by water impermeable barrier of stratum cornium which is composed of protein rich nonviable cells and intercellular lipid domain. One potential solution is increasing dose administered to skin but it could lead to inflammation. They have investigated liposome containing *Aloe vera* from soybean lecithin that could enhance penetration. After preparing *Aloe vera* containing liposome, having diameter less than 200 nm, in vitro test using human skin fibroblast and epidermal keratinocytes has been performed. According to study cell proliferation rate has been significantly higher with the liposomal *Aloe vera* than non-encapsulated. In addition collagenase synthesis has increased by 23% with liposomal extract compared with 4% non encapsulated extract[12].

CONCLUSION

The combination of nanotechnology with traditional herbal medicine may provide a very useful tool in designing future herbal medicine with improved bioavailability profile and less toxicity. The connection between plant sciences and nanotechnology has the potential to develop an attractive symbiosis between green revolution and nanotechnology with realistic prospects for minimizing the application and generation of toxic chemicals that destroy living organisms and our environment. High priority must be given to investing resources in determining how best to manage nanotechnology safely and ethically.

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