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Review Article

A REVIEW ON BIOSYNTHETIC NANOPARTICLES FROM NATURAL SOURCES AND THEIR IMPORTANCE FOR HUMAN HEALTH

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A B S T R A C T

Nanoparticles are synthesized by either synthetic or biosynthetic sources are synthesized from animals, bacteria, fungi, fungus, algae, and some of the sea animals by bioreduction, mechanical treatment, or chemical modifications. Bionanoparticles like nanochitin, liposomes are prepared by using biological methods with physical and chemical principles to produce nanoparticles (nano-sized) with particular functions. Natural nanoparticles are not harmful to human health, wild and domestic animals health as well as to nature, due to their high tensile strength, stiffness, high flexibility, thick, stabilizing nature, and good electrical thermal properties, these bio nanoparticles have numerous applications especially in biology, medicine, agriculture, tissue engineering, identification of pathogens, diagnosis of chronic diseases, paper industry, cosmetics, painting food industry and also in wastewater treatment. The main objective of the present study is represented to biosynthesis and applications of natural or bionanomaterials.

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INTRODUCTION

Naturally occurring nanoparticles (NNPs) are frequently present in the atmosphere, hydrosphere, lithosphere, and even in the biosphere, irrespective of human activities. Biosynthesis of nanoparticles employs the use of biological agents including microorganisms, animals, plants, and their byproducts. Nanoparticles are prepared by both synthetic and biosynthetic sources. Synthetic nanomaterials are synthesized by physical and chemical methods. Compared to bio nanoparticles, synthetic nanoparticles are damage to the environment, affect human health, and also harmful to animals. Bionanoparticles play an important role in different fields like medicine (Diagnosis of disease and identification of pathogens), biology, environment (removal of pollutants), and agriculture. Bionanomaterials are synthesized by bioreduction methods were reducing sugar, enzymes, and phenolic compounds, and this process is controlled by several parameters like concentration (composition of the source of raw material mixture), pH, and nature of raw material for the preparation of bionanomaterials (Sahayaraj, 2012). Based on the composition, nanoparticles are classified into three classes namely organic nanoparticles (more degradable), Inorganic nanoparticles (less degradable) and hybrid nanoparticles (Table-1) and the main aim of the present review was indicates that, the synthesis and applications of biosynthetic or natural nanomaterials for human and animal welfare.

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Biosynthetic Chitin Nanofibrils

Chitin nanofibrils are natural polymers, extracted from fishery and crustaceans waste materials of natural origin. These are made up of α- polysaccharides of N- acetyl-D-glucosamine with a mean dimension of 5*7* 240 nanometers (nm). Chitin nano fibrillar bio-nano particles are characterized by remarkable properties such as strength, stiffness, degradability, sustainability, and thermostability. Chitin nanofibrils have a lot of biomedical applications like in cosmetics, textiles, wastewater treatment (Mantovani *et al*., 2010; Morganti *et al*., 2017 A & B), stem cell therapy, hair follicle enlargement, skin moisturizing, skin regeneration and also used in advanced medication and food packaging (Morganti *et al*., 2011 A & B).

Biosynthetic Nanocellulose

Cellulose is a biopolymer found naturally in animals, bacteria, algae, and plant cells such as wood and cotton. It is the most abundant polymer in nature is the main constituent in the cell wall of trees and plants (cotton -90%, bast fibers -70-80%, and in wood -40-50%) (Han *et al*., 1996; Varshney and Naithani, 2011). It is also be found in animals, bacteria, algae, and some of the sea organisms. By different mechanical treatments or chemical changes on cellulose pulp, nanometer-sized cellulose such as cellulose nanofibrils, and cellulose nanocrystals are formed and it can be termed as nanocrystals, whiskers, rods, nanofibers, or nanofibrils. Nanocellulose has a high tensile strength, stiffness, high flexibility, good electrical and thermal properties (Deepa *et al*., 2011). Nanocellulose is commonly used as filler or reinforcement in biocomposites and it is mainly used in food industries (as additives, thicker or stabilizer) (Strom *et al*., 2013), due to its absorption nature, is used in medical and hygiene products (Tissues, diapers) and also nanocellulose is used in films, cosmetics, painting, paper, paperboard and packing industries (Westman and Hasani, 2012).

and Barik, 2010). Eukaryotic organisms like fungi may be used to produce silver and gold nanoparticles by extracellular synthesis (Ahmad *et al*., 2005). Biosynthesis of silver nanoparticle sizes varies from 100-400 nm and may reduce the toxicity to domestic animals and humans.

Table 1 Classification of nanopaticles based on their composition

S.NO	Organic nanoparticles (More degradable)	Inorganic nanoparticles (Less degradable)	Hybrid
1	**Polymeric nanoparticles** **Ex:** Chitosan Alginic acid Pullulan Casein Gum Carrageanan Xanthan gum Albumin Zein β- lactoglobulin	**1. Metal nanoparticles** **Ex:** Silver nanoparticles Iron nanoparticles Titanium dioxide CdSe **2. Non- Metal nanoparticles** Ex: Silicon dioxide Zinc oxides Magnesium oxide Selenium oxide Copper oxide Sulfur oxide Aluminum oxide	**1.Inorganic - inorganic** **2.Organic - Inorganic** **3.Organic - organic**
2	**Lipid based nanoparticles**		
3	**Solid lipid nanoparticles**		
4	**Carbon based nanoparticals** **Ex:** Carbon nanotubes Graphene oxide Graphene quantum		
5	**Liposomes** EX: Lipoplex Ceramid		

Table 2 Different types of biosynthetic nanoparticles from different sources and their applications

S.No	Name and source of the Bionanoparticle	Characteristics	Method of synthesis	Applications	References
1	Chitin nanoparticles	Hihgh, biodegardability, Low toxicity, Permeation enhancer, Film forming nature	Gelation	Cosmetics, textiles, waste, water treatment, Anti bacterial, biomedical, Pharmaceutical, food and environmental industry, Anti-aging.	Park and Kim, 2010; Zheng *et al*., 2012
2	Nano Cellulose (Plants, bacteria, algae, marine, animals, cell wall of trees & plants	Stiffness, high tensile, reinforcement effect, thickner, stability, high flexibility, good electrical	Mechanical treatment & chemical modification	Paper, paper board, packing industry, food industry (food additives) cosmetics, films, painting, tissues and diapers industries, filler in biocomposites.	Strom *et al*., 2013; Westman and Hasani, 2012; Deepa *et al*., 2010
3	Ferrous nanoparticle (Bacteria, fungus, yeast, algae)	Biocompatibility and non-toxic	Green synthesis and natural synthesis,	Cosmetics, tissue engineering, cancer treatment, anti-microbial, anti-bacterial, gene therapy	Dobson, 2006; Daniel *et al*., 2013
4	Gold nanoparticles (Bacteria, fungus, Yeast, Plant)	Physical stability, magnetic, catalytic properties	Physical (Ultra violet Irradiation), plasma synthesis, chemical (citrate synthesis), & sonochemical	Medicine, catalysis, sensors	Shedkulkar *et al*., 2014.
5	Siver nanoparticles (Bacteria, fungi, algae, yeast)	Nontoxic in nature,	Extracellular modifications, physical and chemical methods	DNA sequencing, anti-bacterial, anti-microbial, medical devices, sunscreen lotions and to cure plant diseases, food packing &coating	Furon *et al*., 2004; Duran *et al*., 2007
6	Znic oxide nanoparticles (*Aeromonas hydrophila* bacteria), plants, orange juice, *Aloe Vera*	Eco-friendly, zeta potential at surface,	Green synthesis, physical and chemical method.	Food additives, anti-microbial	Iravani *et al*., 2014 Occhiuto *et al*.,2009
7	Liposome (Animals and human phospholipids)	Very low or no toxic, liquid state at room temperature, inert, biocompatible and biodegradable	Heat treatment, sonication, (mozafari method)	Anti-microbial agents, bioactive compound	Fathi *et al*., 2012; Yu *et al*., 2018

Biosynthetic Silver Nanoparticles

Synthetic silver nanoparticles are prepared by physical and chemical methods by using different types of chemical agents and may affect the human and animal health. But syntheses of silver nanoparticles from biological organisms like bacteria, fungi, actinomycetes, algae, plants, and yeast (Rai *et al*., 2008; Thakkar, 2010; Margarita, 2011) and from weeds like Ipomoea aquatica (Cubic or spherical) and Ludwigia adscendens (Roy

Silver nanoparticles are basically applied in the field of biological science such as antimicrobial, antibacterial, sequencing of DNA, in medical devices, like surgical masks (Furno *et al*., 2004), in sunscreen lotions (Duran *et al*., 2007), in textile fabrics (Kong and Jang, 2008), and also to control plant diseases (Kim *et al*., 2008).

Biosynthetic Ferrous Nanoparticles from Microorganisms

Ferrous nanoparticles (FeNps) are small-sized, spherical shaped synthesized from bacteria (Actino bacter sp) in the presence of oxygen (aerobic) condition (Bharde *et al*., 2006) and from fungus-like *Aspergillus, Verticillium, Fusarium oxysporum* (Kaul *et al*., 2012). A biosynthetic ferrous nanoparticle is extensively used in cosmetics, diagnosis of cancer disease, drug delivery, gene therapy, antibiotics (Yu *et al*., 2018; Laurent *et al*., 2011) and also used in biomedical applications such as anti-inflammatory, antibacterial, anti-neoplastic, antioxidant and Fenton catalyst (Dobson, 2006; Daniel *et al*., 2013).

Biosynthetic Gold Nanoparticles

Biosynthesis of gold nanoparticles are manufactured in the form of clusters, rods, tubes, powder, and films by physical (UV-Irradiation), chemical (Citrate synthetase), Physicochemical (sonochemical), and biological methods (Plasma synthesis) from different types of microorganisms such as bacteria (*bacillus sp, Rhodopseudomona sp, Cyanobacteria, Anabaena sp, Plectonema sp*), single-cell protein of *Spirulina* (Govinraju, 2008), fungi (*Fusarium sp, Verticillium sp*) (Mukherjee *et al*., 2001; Mandal and Bolander, 2006; Kumar *et al*., 2007), yeast, Actinomycetes, plants, and animals. Gold nanoparticles are naturally developed for various applications such as in industries, biotechnology, electrical pharmaceutical, and medical and also in the agriculture sector for human welfare (Shedkulkar *et al*., 2014) due to their physical stability, magnetic and catalytic properties.

Biosynthetic Zinc Oxide

Nano zinc oxide is synthesized by using reproducible bacterium like *Aeromonas hydrophila* (Iravani, 2014), plants (milky latex of *Calotropis procera*, *Aloe vera*, and orange juice (Jha *et al*., 2011). Studies related to Divya *et al*., 2013, zinc oxide nanoparticles are used as antimicrobial agents, cause damage to bacterial membrane and help to lysis the bacteria and also is used as food additives.

Liposomes

Liposomes are lipid-based formulations which is a major component of biological membranes and sizes between 1-1000nm. Nano liposomes are an excellent tool for the treatment of numerous diseases like gastric and esophageal cancer such as colorectal cancer, nervous system cancer (glioblastoma multiform), memory improvement (Luo *et al*., 2016; Daree *et al*., 2016), and in liver protection (Sonali *et al*., 2016). Liposomes are helpful to carry active molecules to the specific target site and due to its small size, biocompatibility and biodegradable nature, are used in cosmetics, food ingredient or food additives, pharmaceuticals (Panahi *et al*., 2017)

CONCLUSION

The present review represent that biosynthetic nanoparticles are very small (1-100nm), low toxicity, biocompatible, inert and are used in different recent advances like biomedical, food industry, paper, tissue paper and packaging industry, agriculture, cosmetics, tissue engineering and diagnosis of different types of diseases related to kidney, liver and cancer. Natural synthetic nanoparticles are also used as antimicrobial, antiviral, antibacterial, antifungal and anti-aging agents.

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