Nanoparticle from biological source: their role in medicine and drug delivery

Showkat Ahmad Mir[1], Preeti Acharya[2] and Binata Nayak[*]
Ph.D. Research Scholar[1], Junior Research Fellow[2], Associate Professor[*]

[1,] School of Life Sciences, Sambalpur University
At/po- JyotiVihar, Burla; Dist- Sambalpur
Odisha, India. Pin- 768019

[*] Author for correspondence: School of Life Sciences, Sambalpur University

At/po- JyotiVihar, Burla; Dist- Sambalpur
Odisha, India. Pin- 768019

Abstract: The field of nanotechnology principally surrounds and holds within biology, physics, chemistry, polymer science and material science. They synthesize typically nano sized particles having the diameter 10^{-9} meter. A nanoparticle has very interesting properties in different fields such as medicine, nutrition, energy and has remarkably advantages in pharmacological industries to act against bacterial and viral diseases, therapeutics for cancer and tumours. However the biological synthesis of nanoparticles from microorganism are cost effective and they show instant synthesis from algae, fungi, plant, bacteria, seaweeds, diatoms etc and effectively control various diseases with almost no harmful effects.

Index Terms - Nanoparticle, Algae, Biological pathways, cancer, Drug delivery.

I. INTRODUCTION

In the present scenario living organisms both plants and animals become resistant to different drugs which has made by pharma companies earlier but now a day's research finding show a new way to make resistant drugs into anti resistant by targeting with nanoparticles which is a cost effective technology. However the size of nanoparticle is approximately 10-100 nm Nanotechnology is one of the most emerging and rapidly growing field. In this technology synthesis of nanoparticles of different metals by the help of biological organism is a burning field. These nanoparticles show good results like antibacterial, antifungal, and antitumor activities. This technology is mostly involved in manufacturing of new materials at the nanoscale level thus the word nano indicates that the size is one billionth of a meter.

Now a day's green nanotechnology and systematic synthetic strategies have gained interest for the synthesis of silver nanoparticle. Current synthesis of nanoparticles by green technology is the wide field of research. The nanoparticle is mutually dependent to consumers health and industrial products, so it is compulsory to expand techniques that implement a green path for the synthesis of nanoparticles, because to dispense more environmental sound synthesis of nanoparticle. In present date nanosilver technology is used in various manufacturing processes and their end products. However nanosilver is used in liquid forms such as colloidal (coatings and sprays), or within a shampoos (liquid), and can also embedded in solid polymer or suspended in soaps.

1.1 Metallic nanoparticles:

In present era synthesis of metallic nanoparticles is an intersection between nanotechnology and bio nanotechnology has began over 150 years back and received a considerable attention to develop environmental friendly technologies in material science.

1.1.1 Gold Nanoparticles:

Fusarium oxysporum Fungus is used to synthesize gold nanoparticles (AuNp) and actinomycetes and *Thermosporum sp*, has also been reported to synthesize gold nanoparticles extracellulary [Ahmad, Sastry *et al* 2003, Mukherjee *et al* 2003]. However intracellular synthesis of AuNp has been reported by using another species of fungus (*Verticillium*) [Mukherjiee *et al* 2001]. Filamentous *Cyanobacteria* has been introduced to synthesize AuNp or nanocluster of different shapes, from Au(I) thiosulfate and Au (III)chloride and analyze its formation mechanism (Lengke *et al* 2006). A New method is used in green chemistry to synthesis gold nanoparticles AuNp, in which AuNp are dissolved in Nacl solution from the bulk of gold substrate by using a chistosan without any stabilizer and reductant [Namazi, Fard 2011]. Citrus fruit grape juice are used as synthesis of AuNp, in this technique HAucl4 acts as a precursor and reducing agent, the size of these gold nanoparticles are in the range of 15-80 nm [Taranwski, Ulbricht, 2011].

1.1.2 Silver Nanoparticle:

Synthesis of metallic nanoparticles using algae as a source and can be performed in three major steps (1) culturing the algae and to prepare the algal extract in aqueous or in organic solvent by boiling or heating for certain period of time, (2) To prepare the molar solution of ionic metallic compounds and, (3) Pour the algal extract on molar solution of ionic metallic compounds either by heating and stirring or without stirring for certain duration under controllable conditions[Thakkar *et al* 2010,].

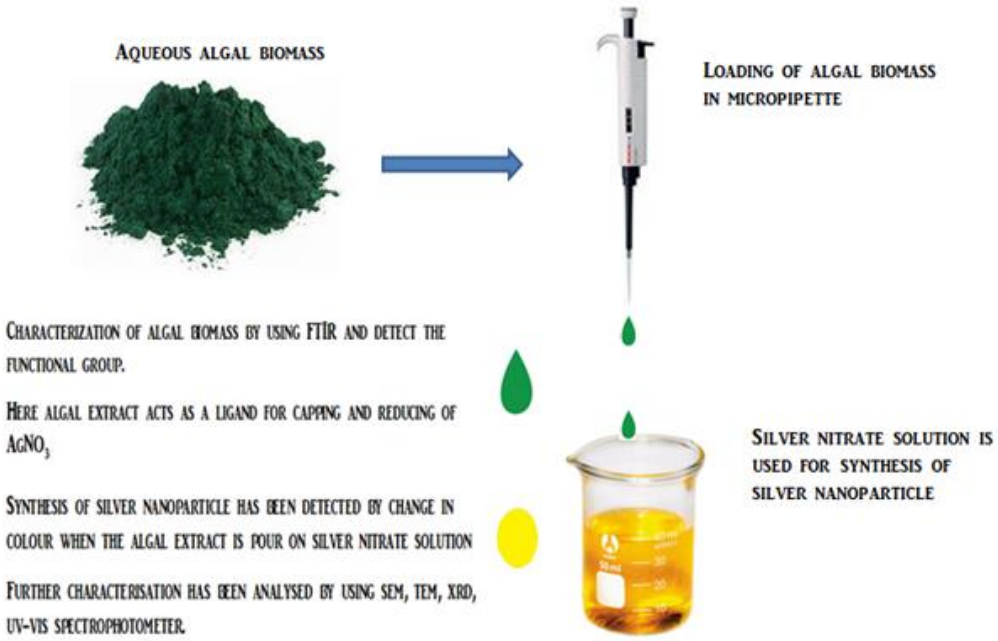
1.2.1 Properties of metallic nanoparticles:

Silver nanoparticles displays distinctive properties like electronic, catalytic, optical, and other physical and chemical properties [Sun 2013]. Silver nanoparticles have been applied in many fields including photonics, micro-electronics, photo catalysis, lithography, and surface-enhanced Raman spectroscopy. [Bhui *et al* 2009]. Several types of chemical and physical technologies such as chemical reduction [Khan et al 2011,Dong 2009] electrochemical reduction, [Roldan *et al* 2005, Zhang *et al* 2002], photochemical reduction, [Huang *et al* 1996, Park 2011] and heat evaporation [Smetana *et al* 2005, Pyatenko *et al* 2007] have been developed for the synthesis of silver nanoparticles. In present date the green-synthesis of silver nanoparticles has become a apparent or prominent science. e.g., using extracts of plant, fungi, algae for reducing silver nitrite to obtain nanoparticles with antimicrobial activities has emerged as a cost-effective and eco-friendly approach. [Krishnaraj *et al* 2010, Zargar 2011]. Normally nanoparticles are more reactive but why? It is because of high ratio of the surface area to the volume a feature vital to catalytic reactivity, thermal conductivity, antimicrobial activity, chemical steadiness, and non-linear optical performance [Kamal *et al*, 2010].

1.2.2 **Synthesis of nanoparticles:**

The fabrication of silver nanoparticles has been widely studied, and their stability and dispersion are crucial. Stabilizers such as surfactants, micelles, ligands, and polymers have been widely utilized in the literature. [Ahmed *et al* 2006, Zou *et al* 2006]. Recently, incorporating metal nanoparticles into polymers

has been proposed. Immobilizing metal nanoparticles on matrix polymers called nanometal polymer hybrids efficiently prevents nanoparticles' aggregation. [Prozorova *et al* 2014]. In addition, the biocompatibility can thus be improved. [Capadona *et al* 2007] Polymers can act as matrix materials to help metal nanoparticles' growth control and stabilization. [Laudenslager *et al* 2008]. Fabricated uniform polystyrene spheres coated with silver nanoparticles by simultaneous photo-induced polymerization and reduction. [Wang *et al* 2012]



Diagrammatic representation of synthesis of silver nanoparticle from algae

1.2.3 Synthesis of silver nanoparticles and their antimicrobial and antifungal activities:

One-step synthesis of silver nanoparticles exhibiting multiple antimicrobial activities with size range of 10–60 nm by reduction of silver nitrate ($AgNO_3$) using aqueous dextran solution as both reducing and capping agent [Bankura *et al* 2012]. Recently, several strategies for silver nanoparticles polymer hybrids were proposed. To make strategies and find a green synthesis process for silver nanoparticles' by extracting polysaccharides from ` silver nanoparticles, the silver nanoparticles are fixed with microspheres of methacrylic acid copolymer and shows delightful results against bacteria present in water i.e. used in water sterilization and cannot be washed away due to its stabilities [Gangadharan *et al* 2010]. In addition, some hybrid materials with embedded silver nanoparticles were used against *Candida sp, Escherichia coli, Pseudomonas sp, Aspergillus, niger* or *Penicillium sp* and others [Harshvardan *et al* 2010, Yang *et al* 2013, Lin *et al* 2012]. As compared to larger particles nanoparticles attain a position of many sided materials exhibiting new or advanced characteristic [Mohanpuria *et al* 2008]. These nanoparticles are important for playing roles in medical diagnostics, drug delivery systems, anti-sense and gene therapy applications, and tissue engineering [Kubik *et al*, 2005]. Silver ions and silver based compounds are known bactericides and have geared research interests towards nanoparticles as antibacterial agents [Crabtree *et al*

2003,]. The silver nanoparticles show efficient antibacterial activity due to the large surface area that comes in contact with the microbial cells and therefore, has a higher percentage of interaction than larger particles of the same parent material [Morones *et al* 2005]. The bactericidal mechanism involves the formation of free radicals that induce membrane damage as elucidated by [Kim *et al* 2007].

1.2.4 Synthesis of nanoparticles by different techniques:

In order to provide a more environmentally sound synthesis of nanoparticles, various biological routes are considered including the use of plant extracts [Shankar 2004], enzymes [Schneidewind 2012], bacteria [Saifuddin *et al*, 2009], fungi [Balaji *et al*, 2011], and algae [Martinez-Castanon *et al* 2008]. Amongst biological systems used, microalgae attract special attention since they have the ability to bio remediate toxic metals, subsequently converting them to more amenable forms. Microalgae have been shown to produce nanoparticles not only of silver but also of other metal ions such as gold, cadmium, and platinum [Brayner *et al* 2007, Parial *et al* 2012].

1.2.5 Emergence of new green nanotechnology for the synthesis silver nanoparticles:

Recently green nanotechnology has been emerged in synthesis of sound and safe nanoparticles. To explore the new way for synthesis of metallic nanoparticle by using algae i.e., *chlorella vulgaris* and Diatoms *Chaetoceros calcitrans*, etc the algal extract is used for synthesis of AgNPs [Karthikeyan *et al* 2015]. AgNPs have potential antimicrobial activity against human pathogens *Staphylococcus aureus, Staphyococcus epidedymis, Escherichia coli,* and *Pseudomonas aerugionsa* [Sudha *et al* 2013].

1.2.6 Pathway for Intracellular and extracellular synthesis of nanoparticles:

Nanoparticle biosynthesis arises through intracellular and extracellular pathways by a variety of microorganisms [Kannan 2011]. Generally, synthesis of nanoparticles is considered to be a result of exposure to toxic substances by secreting extracellular substances to capture the material or mediated through electrostatic interactions [Hallmann *et al,* 1997]. Alternatively, nanoparticles can be formed enzymatically either with extracellular or intracellular enzymes [Ahmad *et al,* 2003]. In the extracellular pathway, the reduction of Ag+ ions occurs through reductase enzymes and electron shuttle quinones [Duran *et al,* 2005]. However, intracellular formation of nanoparticles imparts the nutrient and substance exchange processes [Mahdieh *et al,* 2012]. Intracellularly, the ions are reduced by electrons produced by the organisms to avoid damage in the presence of enzymes such as NADH dependent reductases [Kumar *et al,* 2007]. This suggests that the metabolic status and a growth phase of an organism determine its ability to synthesize nanoparticles [Gericke *et al,* 2006]

1.2.7 Nanoparticles and their use in drug delivery:

However the applications of silver nanoparticles attain a peak and risen up day by day because of it is a major tool for diagnosis and treatment of cancer. It has a delightful targeting drug delivery vesicles and probes for advance cancer screening [wie *et al* 2012]. However silver nanoparticles shows possible cell toxicity against different cancer cells such as cervical cancer HeLa, breast cancer MCF-7 cells, colon cancer HT29 cells, and lung cancer A549 cells [sriram *et al* 2010, jeyaraj *et al* 2013]. A great problem regarding to many and currently used tumour probes and the compounds run towards tumour will be hinder by the very poor permeability of tumour to blood borne compounds. This problem is especially well known with solid tumours because of high intestinal pressure, blood vessels become punctured and the lymphatic

vessels function poorly [Jain 1991]. The drugs normally used do not penetrate into the three to five cell diameters from blood vessels that leave the specific, recognized site with drug or exposed to small quanity of drug which may facilitate the development of resistance [Hambley, Hait 2009]. Peptides that bind to receptors of breast cancer cell Her2 are pinpoints used in deliver the compounds to tumour by the activity of receptors, also folic acid is used to target the tumour by folate receptor [Gee *et al* 2008, Ratnam 2007]. Gold nanoparticles are used in drug delivery by active targeting, passive targeting or combination of both methods. Passive targeting employ the enhanced permeability and retention (EPR) effect feature of many diseased sites [Maeda *et al* 2000]. Active targeting can be successfully bring out by gathering AuNp with various tumour targeting agents like small molecules folic acid peptides and antibodies. Maximal accumulation of AuNp in effected cells, organs, tumour is essential to successfully bring perfect drug delivery. However it has also been studied that by passive targeting the accumulation of AuNp at tumour cells, the shape and size is dependent to targeting to HeLa cells [Chithrini *et al 2006*].

1.3.1 Characterization of Silver and Gold Nanoparticles:

The characterization of different nanoparticles can be carry out by using different instrumentation such as UV-Vis Spectroscopy, Fourier Transform Infra Red Spectroscopy (FTIR), Powder X-ray Diffractometry (XRD),X-ray Photoelectron spectroscopy(XPS), Atomic Force Spectroscopy (AFM), Dynamic Light Scattering (DLS), Transmission Electron Microscopy(TEM), Scanning Electron Microscopy (SEM), [Suresh *et al,* 2010].

However the above said techniques are used to find out various properties of nanoparticles such as their geometry, shape, size, crystallinity, and surface area. By SEM, TEM, and AFM the shape size and morphology can be analysed with accuracy. Also the height and volume of different nanoparticles can be measured in three dimensional images by using AFM. However the crystalline structure of nanoparticles can perform by using X-ray Diffraction, UV-Vis Spectroscopy is a major efficient technique to confirm the formation of nanoparticles by showing Plasmon resonance. Besides these the major instrument used to detect the functional groups in different micro organisms as a reducing and capping agent is Fourier transform Infrared Spectroscopy (FTIR),

FIG:1. Metallic nanoparticle database analyses are dividing according to countries all over the world

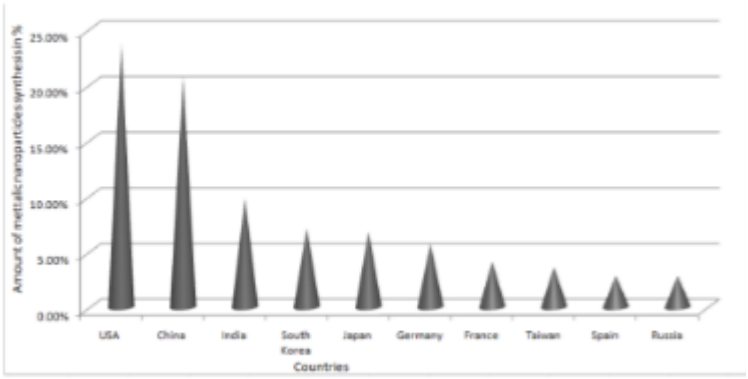
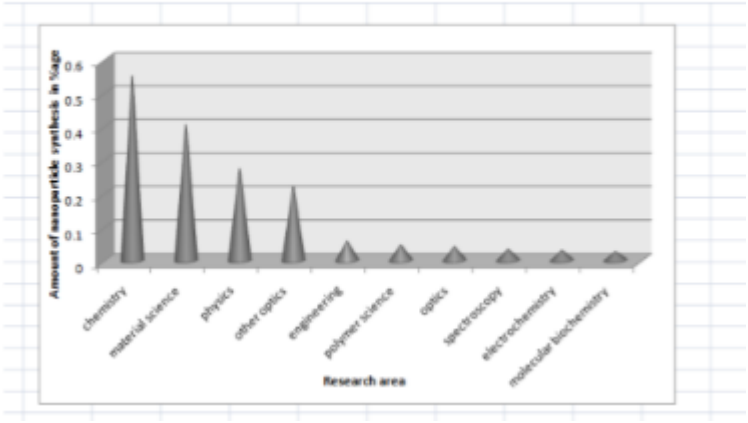


FIG: 2. Metallic nanoparticles data base analyses are dividing according to research area.



II. Conclusion:

To synthesis metallic nanoparticles by using different techniques and strategies, i.e. plant extract, fungi, bacteria, algae extract and diatoms is cost effective and eco friendly. However the synthesis of nanoparticles has great importance in day today life and has high antimicrobial, antifungal, anticancer activities. Besides the antimicrobial, antifungal activities it is also used in targeting to tumours by loading the drug compounds with nanoparticle and target to specific site receptors of tumour cells and cancer through blood vessels.

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