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An overview: Biosynthesized nanoparticles with their potential applications

Khan NT[1]*, Jameel J, Jameel N and Rheman SUA

Department of Biotechnology, Balochistan University of Information Technology Engineering and Management Sciences, Pakistan

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***Corresponding author:** Nida Tabassum Khan, Department of Biotechnology, Faculty of Life Sciences and Informatics, Balochistan University of Information Technology Engineering and Management Sciences, Pakistan, Tel: 3368164903; Email: nidatabassumkhan@yahoo.com

Abstract

Synthetic techniques being employed for the assembly of metallic nanoparticles are quiet costly with hazardous effect on the environment. Such process is not only expensive but consumes a toxic chemical that poses health threats. Therefore biosynthetic approach was adopted to design nanoparticles with unique properties for potential scientific applications.

Keywords: Metallic nanoparticles; Biosynthetic; BUITEMS; Extracellular

Introduction

Nanotechnology

"Nano" means very small or dwarf [1].Taniguchi coined the term "Nanotechnology" which implies to the modification, reduction and fabrication of materials at nano scale with distinctive properties such as good strength, cost effective, lighter, eco friendly, definite and specific etc [2,3]. Even though nanotechnology is at its early stages, but is growing fast, opening numerous prospects for the scientific minds to use this enhanced technology for human welfare [4-6].

Nanoparticles

Nanoparticles are nano-sized objects whose size is measured in nanometers (nm) ranging from 0.1nm-100nm [7] exhibiting distinct morphological characteristics which is quite different from their bulk form.

Biosynthetic methods for nanoparticles synthesis

Although atomizer technologies, photochemical reduction, laserablation,ultrasonicfields,lithography,ultravioletirradiation techniques have been commonly used for the production of nanomaterials but such synthetic techniques are quiet costly and involves poisonous compounds that are not environmental friendly. Therefore biological production of nanoparticles is a prime candidate method because it is a green chemistry method that combines microbial technology with nanotechnology [8]. Nanoparticles can be either produced extracellularly (outside the cell) or intracellularly (inside the cell) depending on the site where they are assembled. Nevertheless the precise mechanism is not well understood [9].

Applications of different metallic nanoparticles

Various studies reported that metallic nanoparticles have widespread applications specifically in nano medicine where they are employed in drug and gene delivery systems [10,11] in reaction kinetic studies [12],in biomedical engineering [13],in tumor annihilation [14], in bio labeling [15,16] and bio detection [17] and in MRI contrast enhancement [18] etc.

The following are some examples of different applications of nanoparticles:

o Nanoparticle based drug delivery system was developed using Alginate nanoparticles for tuberculosis. Effect of this drug was investigated against mice infected withtuberculosis, which showed complete bacterial inhibition from spleen ,liver and lungs [19]

o Titania andAlumina nanoparticlespossess the capabilities such as migration, proliferation and adhesion therefore effectively function in the repair and regeneration of bones [20,21]. For example nanopolymers, nanocearmics, nanometals and nanocomposites [22].

o Zirconium nanoparticle possesses unique physico-chemical properties therefore used in the formation of hard abrasive surfaces and high temperature resistant coatings for micro- cutting tools and engine components [23].

o CdSe quantum dots make them suitable to be used as luminescent probes [24].

o Europium (III)-chelate nanoparticles of size (~107nm) was covalently linked tomonoclonal anti-hexon antibodies to develop an effective sandwich ELISA method for identification of adenoviruses [25,26]

o Fe_3O_4 (magnetite) and Fe_2O_3 (maghemite) nanoparticles were used in trained drug delivery system [27]

o Samarium nanoparticles were used in the clinical diagnostics and treatment of cancerous tumors' [28]

o Gold nanoparticles of various morphology possess the potential to destroy malignant cells thus employed in cancer therapy [29,30] and also serves as efficient carriers molecules for gene and drug delivery systems [31]

o Gold nanoparticles also functions as selective photo thermal agentsto assist purification of water [32].

o It was also stated that gold nanoparticles could inhibit the functional activity of factors secreted bychronic lymphocytic leukemia (CLL) cells that causes the abnormal production of white blood cells thus resulting in cancerand triggers cell death [33-35].In another study, naked gold nanoparticles could inhibit VEGF-induced proliferation therefore these nanoparticles were used to treat ovarian cancer and metastasis by inhibiting endothelial growth factor (VEGF) [36,37].

o Antimony oxide (Sb_2O_3) nanoparticles can be used as effective catalyst and also used in the manufacture offunctional fillers [38].

o Magnetite nanomaterials were used in water purification procedures [39,40].

o Nanosilver not only possess wound healing property but promotes early formation of neodermis therefore used in wound dressings [41,42].

o Non-spherical gold nanoparticles were found to be suitable to be used in optical and biomedical labelling [29]

o Platinum nanocrystals were employed in the production of fuel cells in chemical industries [43]

o Silver nanoparticles can be employed in areas like electronics, nanowires, and electric circuits [44]

o Silver nanoparticles possess antimicrobial properties therefore nanocrystalline silver is used to coat cathetersto prevent nosocomial infections related to catheters infections. Consequently, silver nanoparticles function as antimicrobial agent with no systemic toxicity [45].

o Recently nanoparticles have been used in the removal of viruses by nanofiltration [46]. For example removal of non-envelopedBovine enterovirus and Bovine parvovirus with the help of 50- and 20-nm-sized nanofilters [26,47]

o Thiol-stabilized nanoparticles were employed as "bio-catalyst" [48] as well as in microbial and molecular detection by fluorescence labeling [49]

o Incorporation of titanium nanoparticles in cosmetics and sunscreen, In addition these nanoparticles have practical applications in manufacturing components for automobiles, aircraft, ships, etc [50].

o Metal nanoparticles can also be employed in biosensing technology because of localized Surface Plasmon Resonance (LSPR [51,52].For example gold and silver nanoparticle yields high absorbtion coefficients and scattering properties within the UV/visible wavelength range [53,54].

o Future applications of nanoparticles involve high speed data communication, transport and detection of digital information for security of home land and computing components [54]

Conclusion

Current applications of biosynthesized nanoparticles includes areas like sensors, biolabelling and imaging of living cells and tissues etc. In addition their properties can be easily modulated according to their size, shape and composition producing nanoparticles of effective properties that can be employed in various sectors replacing the need for chemically synthesized nanoparticles.

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