Nanoparticles

Therefore, nanoparticles could be the key factor for the future technologies. Scientific as well as public associations are paying their attention for nanoparticlestechnologyas a good investment source. Nanoparticles could be produced via physical, chemical or biological methods (Haider and Kang, 2015; Ebrahiminezhad et al., 2017).

Both chemical and physical methods use reducing agents such as sodium borohydride, sodium citrate and alcohols (Rai and Duran, 2011). However, using of microorganisms in synthesis of nanoparticles represents another great achievement because of the economic and ease production (Shelar and Chavan, 2014; Patel et al., 2015). Research revealed that biological methods is an inexpensive and eco-friendly way for synthesis of nanoparticles.

This method used biological agents including bacteria, fungi, yeast and plants (Mourato et al., 2011). Recently, emerging such microorganisms as eco-friendly nano-factories to manufacture inorganic nanoparticles was attractive (Lee et al., 2004; Lengke et al., 2007). Fungi were mentioned as excellent candidates for metal nanoparticle synthesis because they contain many of enzymes that induce the production (Sastry et al., 2003).

It was assumed that the mechanism involved in nanoparticles production by fungi was due to cell wall sugars that could reduce the metal ions (Mukherjee et al., 2002) and because they have the high cell wall binding capacity, metal uptake and secrete more amounts of proteins lead to the higher productivity of nanoparticles (Vahabi et al., 2011). Fungi have some advantages over the other microorganisms regarding the synthesis of NPs, because fungal mycelia are able to resist pressure, high temperature and easy storage in the laboratory (Kiran et al., 2016).

There are many of metals for biosynthesis (NPs) such as copper, zinc, iron, iron trichloride, lead carbonate, gold and silver (Siddiqi and Husen, 2016). In addition, silver NPs could be synthesized by fungi either intracellularly or extracellularly but the extracellular biosynthesis downstream process much easier and showed more activities against many pathogens (Ahmad et al., 2003). Among the active fungi that were reported to produce nanoparticles;

Rhizopous oryzae produced nanoparticles intracellularly of gold (Das et al., 2012), Verticillium sp extracellularly peodcued gold and silver nanoparticles (Soni and Prakash, 2014) in the size range of 20–51 nm. However, F. oxysporum produced nanoparticles of silver of 5–15 nm and 8-14 nm in diameter extracellularly (Ahmad et al., 2003; Senapati et al., 2005).

Many other fungi were approved for their productivity of nanoparticles of different metals either extracellularly or intracellularly including: Phoma sp. (Chen et al., 2003), the endophytic fungus Colletotrichum sp. (Shankar et al., 2003), Aspergillus fumigatus (Kuber and D'Souza, 2006) , Fusarium acuminatum (Ingle et al., 2008) , Trichoderma asperellum (Mukherjee et al., 2008), F. semitectum (Sawle et al., 2008), Phoma glomerate (Birla et al., 2009), F. solani (Ingle et al., 2009) , plant pathogenic fungi Aspergillus niger (Gade et al., 2008; Jaidev and Narasimha, 2010).

Aspergillus flavus (Vigneshwaran et al., 2007; Jain et al., 2011) , Paecilomyces lilacinus (Devi and Joshi, 2012), endophytic fungus Pencillium sp. (Singh et al., 2013), Aspergillus foetidus (Roy and Das, 2014), Rhizopus stolonifer (AbdelRahim et al., 2017), Penicillium Oxalicum (Bhattacharjee et al., 2017) and Trichoderma atroviride (Saravanakumar and Wang, 2018). Many recent reports have shown that production of nanoparticles by fungi are could be affected by various condition of temperature, biomass weight, time and pH (Balakumaran et al., 2016; Liang et al., 2017; Othman et al., 2017).

Husseiny et al. (2015) reported that most important factors that were affecting the biosynthesis of AgNPs were the temperature, pH, time, the concentration of AgNO3 and amount biomass. Narayanan and Sakthivel (2010) approved that incubation at 27 0C for 72 h with 7 pH and 10 g of the fungal biomass and 1mM concentration of AgNPs were considered the optimum conditions for production of AgNPs from AgNO3 by fungi.

Researches showed some variations in the characteristics of the biosynthesized AgNPs by different fungal species. These variations could be due to the source of fungal isolates or strains and types of medium (Devi and Joshi, 2012; Roy and Das, 2014). When Alam et al. (2017) compared the different types of media, they found Czapex dox broth was a good medium to produce enough mycelial biomass to synthesize AgNPs.

This because this medium contains essential carbon and nitrogen source along with other vital macro and micronutrients such as magnesium, sodium, calcium, potassium, iron and zinc which are vital for fungal growth. Nowadays, application of AgNPs confirmed their effectiveness in treatment of cancer, bone implant, anti-inflammatory and their biocidal activity against many bacteria and pathogens (Husseiny et al., 2015; Majeed et al., 2016).

The antibacterial properties of AgNPs are due to the oxidation and liberation of Ag+ ions into theenvironmentthat makes it an ideal biocidal agent (Sivakumar et al., 2015). It is expected that the large surface area to volume ratio as well as high fraction of the surface atoms of the nanoparticles increase their antimicrobial activity as compared with bulk silver metal (Joy and Johnson, 2015).

Moreover, the small size of the nanoparticles facilitates their penetration inside the cell. Additionally, excellent antibacterial properties exhibited by AgNPs are due to their well-developed surface which provides maximum contact with the environment (Mitiku and Yilma, 2017).

Recent research approved the antibacterial activity of the silver nanoparticles against many bacteria especially those having the capability to cause severe disease for the human such as Salmonella enterica, Enterococcus faecalis, Streptococcus, Proteus mirabilis, Staphylococcus aureus, Escherichia coli, Staphylococci and Pseudomonas sp (Devi and Joshi, 2012; Shelar and Chavan, 2014; Muhsin and Hachim, 2016; Madakka et al., 2018; Saravanakumar and Wang, 2018).

However, shape, dimension, and the exterior charge as well as the concentration of the AgNPs are important factors that affect the antimicrobial activity the nanoparticles against the tested bacteria (Madakka et al., 2018). Devi and Joshi (2012) approved the antibacterial activity of AgNPs comparing with erythromycin, methicillin, chloramphenicol and ciprofloxacin agents Staphylococcus aureus, Streptococcus pyogenes, Salmonella enterica and Enterococcus faecalis.

They showed that the diameter of inhibition zones obtained by the silver-nanoparticles, with 5-50 nm in diameter, were more than those obtained by the antibiotics. Shelar and Chavan, (2014) showed that Bacillus subtilis and Staphylococcus sp were inhibited by silver nanoparticles with diameter of 17-32 nm in very close pattern to the standard antibiotic streptomycin.

Muhsin and Hachim (2016) reported the best concentration of silver nanoparticles with diameter 8-90 nm that showed strong antibacterial activity against Escherichia coli, Proteus mirabilis, Pseudomonas aeruginosa, Salmonella typhi and Staphylococcus aureus streptomycin was 100 µl/ ml.

Based on the above-mentioned information, we assume that fungi as bio-factories for the biogenic synthesis of the silver nanoparticles are very interesting during eco-friendly and safe technology, also for future application as antimicrobial agents.