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Microbial Synthesis of Gold and Silver Nanoparticles and their Characterization

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ABSTRACT

We report the novel biological route for the synthesis of gold and silver nanoparticles using naturally grown mushroom species which is the facile, rapid cost effective and environmentally benign approach. The formation of nanoparticles was observed by change in colour of the reaction medium and then confirmed by using UV-visible spectroscopy. The SPR peak appeared at 530 nm for gold and for silver at 415 nm confirm the formation of the gold and silver nanoparticles respectively. PSA characterization was performed for size and distribution of the formed nanoparticles. The study identifies mushroom species as a potential candidate for biosynthesis of metal nanoparticles in large scale production.

Key words: Microbial synthesis, Gold and Silver nanoparticles, UV-visible spectroscopy, FTIR, PSA.

INTRODUCTION

Particles in the size range between 1 to 100 nm are identified as the nano-particles. Metal nanoparticles found many applications in various fields like medicine (Nakamura *et al*., 2019), agriculture (Anand and Madhulika, 2019), electronic (Wyatt *et al*., 2000), industries due to their unique antimicrobial (Qasim *et al*., 2018), optical (Huang *et al*. 2010), electrical properties (Diantoro *et al*., 2018). Gold, silver and copper nanoparticles exhibit the surface plasmon resonance in the visible range. Gold and silver have shown a great microbial activity for a wide range of microorganisms. Conventional physical and chemical methods were used for the synthesis of these nano-particles. But these methods involve the use and release of toxic chemicals during the synthesis process and causes the environmental pollution. Also, these methods are energy consuming and costly for the production of nano-particles. Biosynthesis of the nanoparticles involve the use of microorganisms, plants and templates which is the green approach. Fungi have shown their potential for the reduction of silver and gold ions form their nanoparticles (Birla *et al*., 2013; Jain, 2011). Mushrooms are the group of fungi which are widely used as a food and medicine in different parts of the world since long time (Manzoor-ul-haq, 2014). In the present study the mushroom extract was screened for its potential in the synthesis of the gold and silver nanoparticles and the formation was confirmed by UV-visible spectroscopy.

MATERIALS AND METHODS

Chemicals $HAuCl_4$ and $AgNO_3$ were used of analytical grade.

Collection of Mushroom Species

Mushrooms were collected in the agriculture region of Bhusawal in Jalgaon district. Mushrooms were collected in the rainy season when the conditions for their growth are favourable and easy availability. Photographs of the specimens were taken in their natural habitat on the shabby grass.

Preparation of extract

Fresh 10 gram of mushroom species were putted in 100 ml deionized water contained in Erlenmeyer flask. The flask was incubated in an orbital shaker at 110 rpm for 72 h at temperature 30 ^{0}C. The biomass was then filtered through Whatmann No. 1 filter paper and the filtrate was used for the synthesis of gold and silver nanoparticles.

Biosynthesis of Gold and Silver nanoparticles

For the synthesis of gold nanoparticles 1mM solution of $HAuCl_4$ was prepared. Equal amount of mushroom extract was challenged with 1mM Auric chloride and the flask was incubated in an orbital shaker at 110 rpm at temperature 30 ^{0}C for 12 h.

For the synthesis of silver nanoparticles equal amount of 1mM silver nitrate solution was added in mushroom extract contained in a flask. The flask was then incubated in an orbital shaker under the conditions that used for the synthesis of gold nanoparticles.

Characterization of Gold and Silver nanoparticles

The formation of the metal nanoparticles was detected visually from the change in colour of the reaction medium. UV-visible spectroscopy is used for the confirmation of the formation of the metal nanoparticles. The size of the prepared silver nanoparticles was determined using particle size analyser (Malvern Zetasizer ver. 6.34).

RESULT AND DISCUSSION

The preliminary indication for the synthesis of gold and silver nanoparticles is the change in colour of the reaction medium to pink and brown for gold and silver respectively from its original colour.

UV-visible spectroscopy

UV-visible spectroscopy is the characterization technique used to study the surface plasmon resonance exhibited by the metal nanoparticles. The UV-visible spectra of the prepared gold and silver nanoparticles are shown in fig. 4 and fig. 5 respectively. The SPR peak appeared at 530 nm in fig.4 confirm the formation of gold nanoparticles and the occurred at 415 nm in fig. 5 indicate the formation of silver nanoparticles. The single peak appeared in the UV-visible spectra indicates that the formed particles were spherical in shape [Desai R].

Figure 1. Photograph of mushroom species.

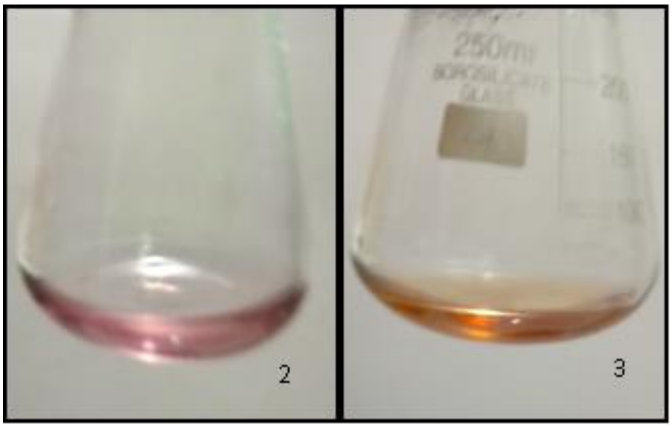

Figure 2. Mushroom extract. Figure 3. Flask 2 showing gold NPs and flask 3 showing silver NPs.

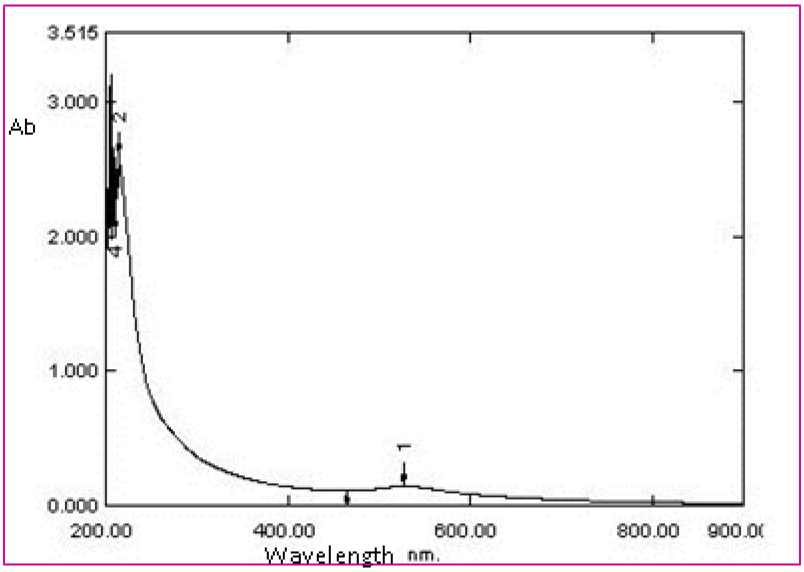

Figure 4. UV-visible spectra of Gold NPs

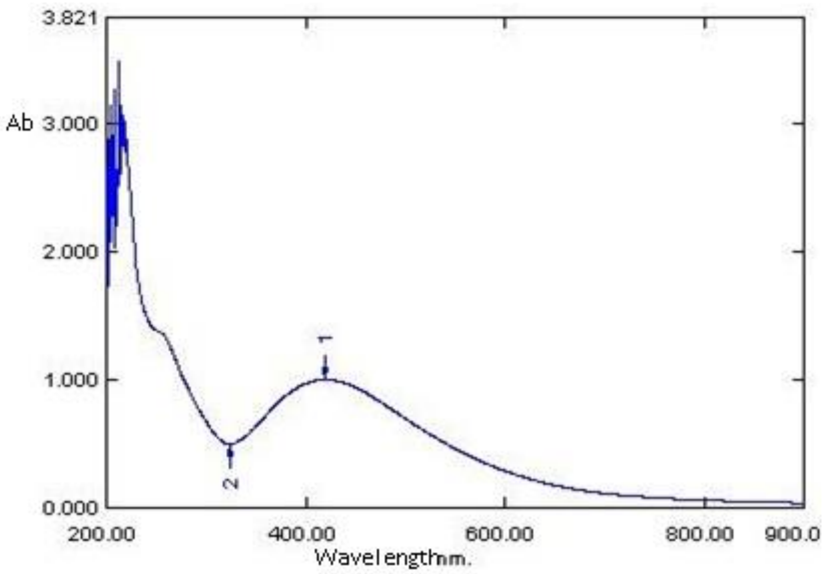

Figure 5. UV-visible spectra of silver NPs.

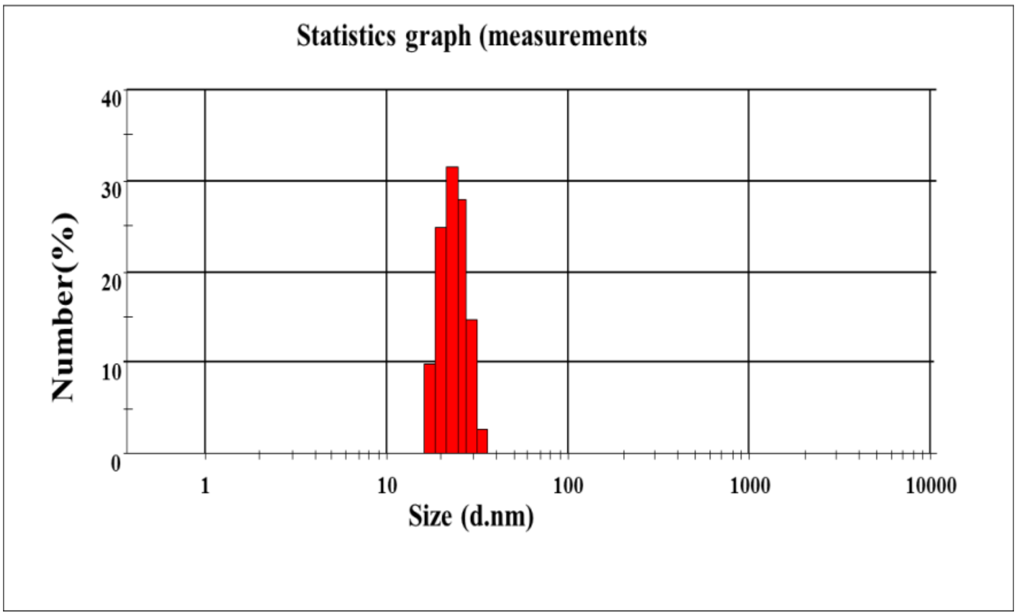

Figure 6. PSA histogram for gold nanoparticles.

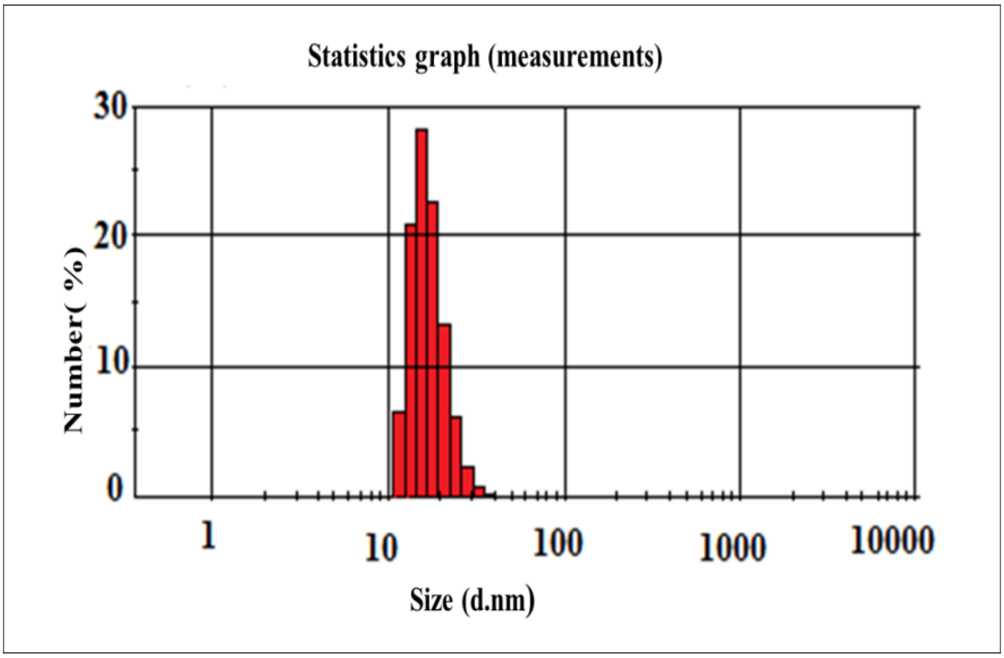

Figure 7. PSA histogram for silver nanoparticles.

CONCLUSION

Mushroom species found in the agriculture have shown their potential for the reduction of gold and silver ions and form their nanoparticles. The formed nanoparticles were spherical in shape and in the size range 10 nm to 50 nm. The method is best suited for large scale production in industries.

Conflicts of interest: The authors stated that no conflicts of interest.

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