Research Article

Free radical scavenging activity of plant-mediated zinc oxide nanoparticles

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ABSTRACT

Aim: This study aims to synthesize and study the free radical scavenging activity of plant-mediated zinc oxide nanoparticles (ZnO NPs). **Introduction:** ZnO NPs have received much attention recently as it has many properties such as its extensive antimicrobial activity, eco-friendliness, and simplicity. ZnO especially has special attention due to its excellent antibacterial nature. In addition to these properties, ZnO NPs were also found to be less toxic in *in vitro* test. ZnO NPs characterization is done ultraviolet-visible techniques. ZnO NPs exhibited high antioxidant activity against DPPH free radicals scavenger. **Materials and Methods:** Collection and preparation of plant extracts, synthesis of ZnO NPs, characterization of ZnO NPs, and preparation of NPs powder were used. **Results:** The plant extract is in dark green color and the ZnO NPs are seen in light yellowish in color. The graph reached its peak at a wavelength of 380 nm. **Conclusion:** This research shows that ZnO NPs show excellent biocompatibility and less toxicity. Hence, the NPs are expected to be utilized in the future in various industries for wide purposes.

KEY WORDS: Antioxidant, Characterization, Nanoparticles, Spectrophotometer, Zinc oxide

INTRODUCTION

Nanoparticles (NPs) have been getting a lot of recognition lately. They can be described as microscopic particle <100 nm. NPs possess many desirable properties and have been linked to numerous applications in various industries such as in medicine, physics, optics, and electronics. Zinc acts as one of the abundant metals and can be represented in the six classes of enzymes, namely, lyases, transferases, oxidoreductases, hydrolases, isomerases, and ligases.[1] Zinc oxide (ZnO) NPs have received much attention recently as it has many properties such as its extensive antimicrobial activity, eco-friendliness, and simplicity[2,3] and also among the nanometal oxide particles which have been considered due to its low cost, simplicity, eco-friendliness, and wide-ranging pharmaceutical effect. ZnO especially has special attention due to its excellent antibacterial nature.[3,4] In addition to these properties, ZnO NPs were also found to be less toxic in *in vitro* test.[5]

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ZnO NPs have been reported in various technical industries such as solar cell,[6] conductive electrode,[7] sensor,[8] lasing,[9] and bioimaging[10] mainly due to their high stability, less toxicity, low-cost synthesis, and wide bandgap semiconductor.

ZnO NPs have been used in the deposition of polyethylene terephthalate (PET) which has wide applications in food packaging, textiles, and agricultural production. Cheng *et al*. studied the surface morphology, structure, and properties such as antimicrobial activity and ultraviolet (UV) protection of the ZnO NPs and implemented it in the coating of the PET film and established its potential in producing UV protective and antimicrobial PET films for many applications.[11]

Another kind of fluorescent particles that have gained a significant interest is the quantum dots (QDs). They are known to exhibit exceptional luminescence as well as electronic properties. ZnO QDs/NPs, in particular, have been used in the application of transistors and UV detection. They have been used in nano optoelectronic devices such as photodetectors, light-emitting diodes, and solar cells.[12,13]

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The production of metal and semiconductor NPs is a growing area in the research fields widely due to the potential applications in novel technologies. Over the years, inorganic materials including metal and metal oxides have the ability to withstand harsh process conditions and are regarded safe.[14] The many inorganic NPs such as silver, gold, copper, copper oxide, titanium oxide, and ZnO are synthesized using green methods. ZnO NPs are of profound interest since they are relatively inexpensive, semiconducting properties, etc., and hence used in the formulation of health-care products.[15]

In the study conducted by Elumalaim *et al*. – green synthesized ZnO NPs were found to be more potent than bare ZnO. Although there are several methods available for the synthesis of ZnO NPs such as wet chemical, sonochemical methods, chemical microemulsion, and vapor phase process, biosynthesis has been conventional. The biosynthesis of the ZnO NPs is desirable for biomedical applications such as cosmetics, drug carriers, and fillings since they are believed to be non-toxic, biosafe, and biocompatible.[16,17]

Thus, the main of this research work is to study about the free radical scavenging activity of plant-mediated ZnO NPs.

MATERIALS AND METHODS

Preparation of Plant Extract

Plant extracts were collected from Chennai. The collected plant extract was washed 3–4 times using distilled water, then dried it in shade for 7–14 days. The well-dried plant extract was made into powder using mortar and pestle. The collected powder was stored airtight container. One gram of plant powder was dissolved in distilled water and boiled for 5–10 min at 60–70°C. The solution was filtered using Whatman No. 1 filter paper. The filtered extract was collected and stored in 4°C for further use.

Synthesis of NPs

One millimolar of ZnO dissolved in 90 or 80 ml of double-distilled water.

The plant extract added with the metal solution and was made into 100 ml solution. The color change was observed visually and photographs were recorded. The solution is kept in magnetic stirrer or orbital shaker for NPs synthesis.

Characterization of NPs

The synthesized NPs solution is preliminary characterized using UV-visible spectroscopy; 3 ml of the solution is taken in cuvette and scanned in double beam in UV-visible spectrophotometer from 300 nm to 700 nm wavelength. The results were recorded for the graphical analysis.

Preparation of NPs Powder

The NPs solution is centrifuged using Lark refrigerated centrifuge. The ZnO NPs solution is centrifuged at 8000 rpm for 10 min and the pellet is collected and washed with distilled water twice. The final purified pellet is collected and dried at 100–150°C for 24 h. Finally, the NPs powder is collected and stored in airtight Eppendorf tube.

RESULTS AND DISCUSSION

Biosynthesis of ZnO NPs

ZnO NPs were synthesized from Phyllanthus extract by green synthesis method, which is more reliable and less toxic when compared with other methods. The formation of light yellow color indicated the synthesis of ZnO NPs.

Visual Observation

The plant extract is in dark green color and the ZnO NPs are seen in light yellowish in color Figure 1.

UV-visible Spectroscopy

The optical absorption spectra of ZnO NPs were recorded using UV-visible spectroscopy. Figure 2 shows the UV-visible absorption spectrum of ZnO NPs. The absorption spectrum was recorded for the sample in the range of 250–390 nm. The spectrum showed the absorbance peak at 380 nm corresponding to the characteristic band of ZnO NPs.

There is a slight variation when there is a change in concentration in the standard solution. The free radical scavenging activity of the ZnO NPs increases with increase in standard solution concentration [Figure 3 and 4].

DISCUSSION

In recent years, there is a wide range of opportunities and improvement in facilities that have helped in paving the way for science and technology, especially nanotechnology. ZnO NPs have been known to show many positive properties that can be put into good use in many industries such as optics, medicine, and electronics to name a few. There has been increased demand for natural substances which can be used for depigmenting, anti-wrinkle, and other cosmeceutical purposes.[18]

The role of ZnO NPs in cosmetic, medicine, and various other industries has taken a big leap in this century. Biosynthesized ZnO NPs from Phyllanthus by green approach are confirmed visually and through UV-visible spectrophotometer, indicating that the

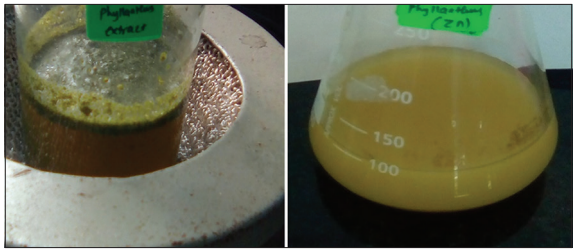

Figure 1: Visual observation of zinc oxide nanoparticles

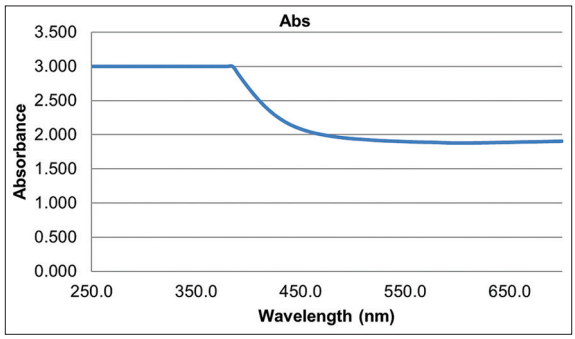

Figure 2: Ultraviolet-visible spectroscopy

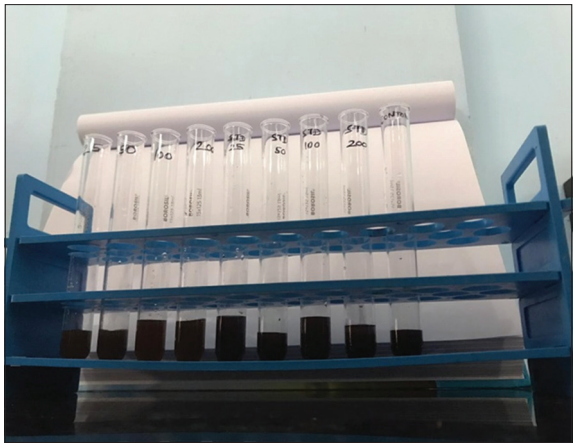

Figure 3: Antioxidant activity

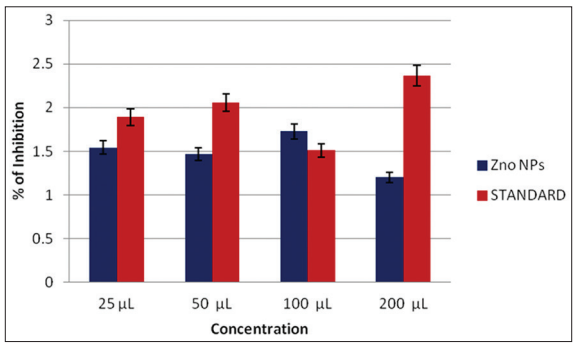

Figure 4: Antioxidant activity

synthesis of ZnO NPs is successful. Salleh *et al*.[19] reported that the stem of *Piper officinarum* exhibited both antityrosinase and antioxidant activities. The results of the study clearly indicate that the synthesized ZnO NP possesses antioxidant activity with respect to mechanisms of both free radical scavenging and reducing activities. It is also observed that as concentration of sample increases, the absorbance also increases. Higher absorbance for the reaction mixture indicates greater reducing power.[20] According to Basavegowda *et al*., who reported that the palladium NPs exhibited potent antityrosinase and antioxidant activities.

CONCLUSION

Our study revealed that the ZnO NP synthesized from Phyllanthus extract by green approach exerted potential antioxidant activities. Therefore, the ZnO NPs might be used as antioxidant for pharmaceutical products and also drug care system.

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