Green Synthesis, Characterization and Antibacterial Activity of Cadmium Oxide Nanoparticles Using Calendula Officinali'S Plant

Irfan Ijaz, Ezaz Gilani, Ammara Nazir, Aysha Bukhari and Jahanzaib Ahmad Ansari

January 24, 2020

GREEN SYNTHESIS, CHARACTERIZATION and ANTIBACTERIAL ACTIVITY of CADMIUM OXIDE NANOPARTICLES USING CALENDULA OFFICINALI'S PLANT

Irfan Ijaz[1], Ezaz Gilani[1], Ammara Nazir[1,2], Aysha Bukhari[1] Jahanzaib Ahmad Ansar[i1]
1

[1] Minhaj University Lahore, [2] Punjab University Lahore

ABSTRACT: CdO nanoparticles are synthesize by using *CALENDULA OFFICINALIS* extract. Stable cadmium oxide nanoparticles were formed by treating aqueous solution of cadmium nitrate with extract of *CALENDULA OFFCINALIS*. The plant extract used as reducing and stabilizing agent. Phytochemicals plays the important role of capping agent in nanosynthesis. CdO nanoparticles are characterized by using different analytical techniques such as ultra-violet spectroscopy (UV), Infrared spectroscopy (IR) and Scanning electron microscope (SEM). The size of CdO nanoparticles were range from 73 to 94 nm shown by SEM images. .*CALENDULA OFFICINALIS* mediated CdO nanoparticles exhibited significant antibacterial activity against both bacteria gram negative bacteria and gram positive such as E,coli and staphylococcus.

Key Words: NPs, CdO, FTIR, UV-Vis, SEM

1. INTRODUCTION

Development of rapid, cost effective, simple, cost-effective and ecofriendly methods for the green synthesis of nanoparticles is worth in the field of nanotechnology. The advancement in the green synthesis of nanoparticles of different shape, controlled dispersity and size has many important [1]. Chemical and physical properties are strong effected by these factors and have many application in the field of electronic [2 ,3], sensing device [4, 5], optoelectronics [6, 7], recording media [8], medicine [9 ,10], bimolecular detection [11] and catalysis [12]. For the synthesis of nanoparticles, now several methods have been reported. Due to chemicals methods that are toxic, capital intensive and low productivity, and biological synthesis of nanoparticles has received significant interest [13]. There are several biological method for synthesis of nanoparticles has been suggested by using microorganisms (yeas, fungi, bacteria and actinomycetes), enzymes, plants and plant extract. But scientist is more interested in synthesis of nanoparticles by using plants because of its economical, rapid, eco-friendly protocol and it provide single step for the synthesis of nanoparticles [14]. Extracellular and intracellular synthesis are two categories of bio-synthesis of nanoparticles. The synthesis of nanoparticles by using environmentally benign material e.g plant flower and leaf extract, fungi and bacteria offer number of benefits of compatibility for pharmaceutical and biomedical applications as they do not use any toxic chemical in the synthesis procedure [15, 16]. The synthesis of cadmium nanoparticles is much more challenging than other noble metal due to instability of these nanoparticles in aqueous solution. The cost for synthesis of cadmium oxide nanoparticles is significantly less than silver and gold; thus, these are economically effective
Surface oxidation occurs as cadmium (Cd) nanoparticles are exposed to air and ultimately aggregation take place in short interval of time [17]. Oxides of nanomaterials are used as catalyst and starting material for preparing high developed ceramics [18]. As semiconductor cadmium oxide has application in sensor [19], solar cell [20], catalysts [21] and other optoelectronic devices ([22], [23],[24]).

In recent study rapid, simple, cost effective and biosynthetic method using calendula officinal's has been investigated for producing cadmium nanoparticles

2. EXPERIMENTAL DETAIL

2.1PREPARATION ofFLOWER EXTRACT

First of all, fresh petals of calendula officinalis were taken. Petals were washed with distil water to remove dust or other pollution deposited on the petals. The petals were dried under the shade. These dried petals were crushed into powder.

To prepare the 10 % petals extract of calendula officinalis, 20 gram of petals were add in 200 mL of distil water. This mixture was transfer into water bath for 1 hour. The temperature of water bath was 60-100^{0}C. The mixture had volatile compound. In order to avoid escaping of volatile compound the conical flask was covered with aluminum foil.

After 1 hour flask was removed from the water bath and cooled at room temperature. Extract was filtered by using whatman filter paper twice so no solid residual left.

The 10 % extract of petals of calendula officinalis was preserved for further work.

2.1.1. SYNTHESIS of CdO NANOPARTICLES

30 ml of 10% extract was taken into 100 mL of beaker. The beaker was placed onto the hot plate. 0.01 M cadmium nitrate solution was taken into the burette. The cadmium nitrate solution was added into the petal extract drop wise with continuous stirring. The change of color confirms the synthesis of nanoparticles formations. The color changed from yellow to dark green. This nano-solution was preserve for characterizations

2.2. CHARACTERIZATION of CdO NANOPARTCLES

2.2.1. UV-Vis ABSORBANCE SPECTROSCOPY.

The optical absorption of cadmium oxide was measured by usingUV-Vis Spectrophotometer**.** The UV spectrum was measured at room temperature. The UV spectrum was measured by using quartz cuvette. The path length of cuvette is 1cm. Electromagnetic radiation such as commonly serve as a wave phenomenon that is characterized by wavelength and frequency. The wavelength is the distance between adjacent trough and crust.

2.2.2. FOURIER TRANSFORMS INFRARED SPECTROSCOPY.

FTIR were carried out to detect the possible biomolecules and phytochemicals that are useful for the Cd ion reduction and capping of CdO nanoparticles green synthesized by using calendula officinal's petals extract. JASCO 4100 was used to record the FTIR spectrum within the range of 4000cm to 400cm

2.2.3. SCANNING ELECTRON MICROSCOPE (SEM).

Using SEM technique, size, shape and morphology of CdO nanoparticles is examined. The SEM (VEGA3 TESCAN) was applied at an accelerating of 8.0kV.

2.2.4. ANTIBACTERIAL ACTIVITY of GREEN SYNTHESIZED CADMIUM OXIDE NANOPARTICLES.

Disc diffusion method was used to to test the antibacterial activity of green synthesized cadmium oxide nanoparticles. Disc diffusion method was used againsttwo bacteria gram- negative bacteria (E,coli) and gram positive (staphylococcus). The nutrient agar plates were, prepared and inculcated for 24hrs. Cadmium oxide nanoparticles solution was poured into the each plate which contain bacterial cultures.

3. Result and discussion

The CdO nanoparticles is synthesized by the reduction of cadmium ion and flower extract at room temperature. During this reaction, green synthesis of cadmium oxide nanoparticles reduced by Calendula officinal's made color of flower extract change. The UV-Vis spectrophotometer was used to record this color change. The absorption spectra of cadmium oxide (CdO) nanoparticles formed by using calendula officinal's had an absorbance peak at near 300nm (figure 1)[25].

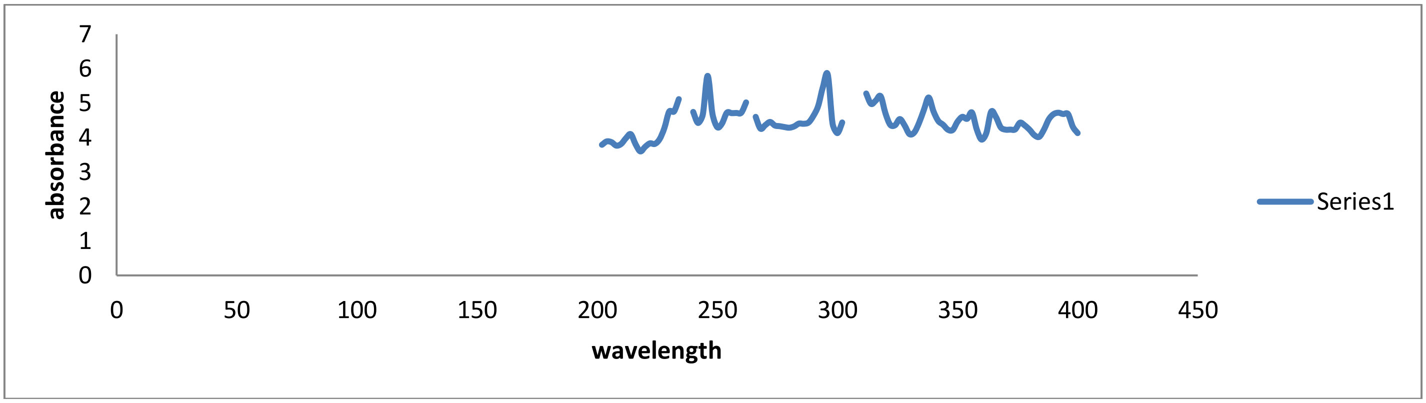

Figure 1: UV-Vis absorption spectra for CdO nanoparticles.

FTIR were carried out to detect the possible biomolecules and phytochemicals that are useful for the Cd ion reduction and simple, rapid and green protocol for synthesis of CdO nanoparticles at without utilizing physical and chemicals step. The absorption peak at around 1600cm^{-1} confirmed the binding of C-F . The peak observed at 2100 cm^{-1}confirmed alkynes. The peaks observed at 3300 cm^{-1} confirmed the amine stretching. The peak at 3700 cm^{-1} confirmed alcoholic functional group. The variations in the peaks positions show the presence of some metabolite such as polyphenols, alkaloids, flavonoids and terpenoids which are abundantly present in flower extract and play vital important role in the synthesis of cadmium oxide (CdO) nanoparticles.

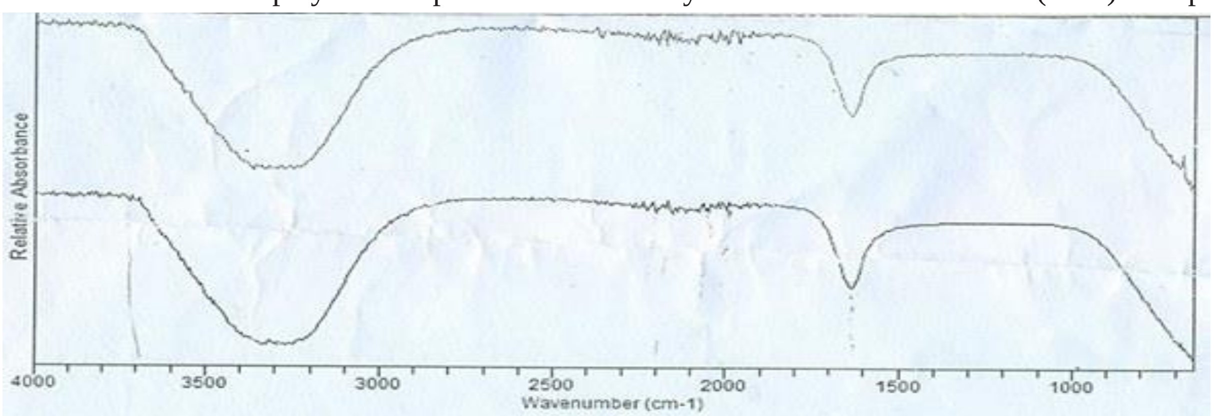

Figure 2. FTIR spectra of CdO nanoparticles synthesized using flower extract of calendula officinal's

Green synthesis of cadmium oxide nanoparticles and morphology by SEM analysis confirmed the average size of particles was 91nm. The shape were irregular.

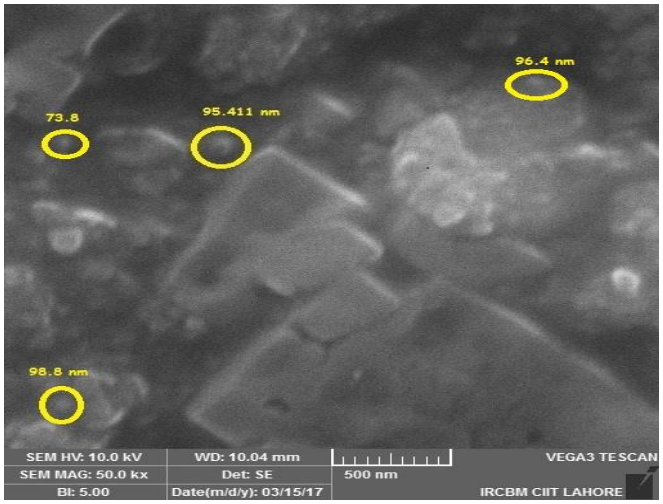

Figure 3. SEM images of cadmium oxide nanoparticles synthesized using calendula officinali's

The antibacterial activity of green synthesized cadmium oxide nanoparticles (CdONPs) against two bacteria gram- negative bacteria (E, coli) and gram positive (staphylococcus) were investigated. These bacterial strain were poured into plates that consist of agar nutrient and by using glass spreader, spread evenly over the plate and "well" was made by using disc diffusion method. Cadmium oxide nanoparticles (CdONPs) were poured into the each plate and measured the zone of inhabitation illustrated in table No 1.

Figure 4. Antibacterial activity of cadmium oxide nanoparticles and Zone of inhabitation

Table 1. Antibacterial activity of cadmium oxide nanoparticles and Zone of inhabitation

Microorganisms	Zone of inhabitation	
	Reference	**CdO nano-solution**
E.Coli	**7mm**	**20 mm**
Staphylococcus	**8 mm**	**15 mm**

4. CONCLUSION

CdO nanoparticles were synthesized by using calendula officinalis. The nanoparticles were characterized by using different techniques such as UV-vis spectroscopy, FTIR spectroscopy and SEM. The Similarly the UV absorption obtain at 300 nm which confirm the synthesis of CdO nanoparticles. Photochemical plays the role of capping agent in nanosynthesis. SEM. The size of CdO nanoparticles were range from 73 to 94 nm shown by SEM images. CdO synthesized nanoparticles were showed a significant antibacterial activity. Thus calendula officinalis mediated CdO nanoparticles can be used in antibiotic drugs.

REFERENCES

[1] P. Mukherjee, A. Ahmad, D. Mandal et al., "Fungus-mediated synthesis of silver nanoparticles and their immobilization in the mycelial matrix: a novel biological approach to nanoparticlesynthesis," *Nano Letters*, vol. 1, no. 10, pp. 515–519, 2001.

[2] N. A. Melosh, A. Boukai, F. Diana et al., “Ultrahigh-density nanowire lattices and circuits,” *Science*, vol. 300, no. 5616, pp. 112–115, 2003.
[3] D. H. Gracias, J. Tien, T. L. Breen, C. Hsu, and G. M. Whitesides,“Forming electrical networks in three dimensions by selfassembly,” *Science*, vol. 289, no. 5482, pp. 1170–1172, 2000.
[4] J. Wang, “Nanoparticle-based electrochemical DNA detection,”*Analytica Chimica Acta*, vol. 500, no. 1-2, pp. 247–257, 2003.
[5] M. Han, X. Gao, J. Z. Su, and S. Nie, “Quantum-dot-taggedmicrobeads for multiplexed optical coding of biomolecules,” *Nature Biotechnology*, vol. 19, pp. 631–635, 2005.
[6] R. Jin, Y. Cao, C. A. Mirkin, K. L. Kelly, G. C. Schatz, and J.G. Zheng, “Photoinduced conversion of silver nanospheres to nanoprisms,” *Science*, vol. 294, no. 5548, pp. 1901–1903, 2001.
[7] G. C. Schatz, A. A. Lazarides, K. L. Kelly, and T. R. Jensen,“Optical properties of metal nanoparticles and nanoparticle aggregates important in biosensors,” *Journal of Molecular Structure*, vol. 529, pp. 59–63, 2000.
[8] E. Mayes, A. Bewick, D. Gleeson et al., “Biologically derivednanomagnets in self-organized patterned media,” *IEEE Transactions on Magnetics*, vol. 39, no. 2, pp. 624–627, 2003.
[9] J. A. Rojas-Chapana and M. Giersig, “Multi-walled carbonnanotubes and metallic nanoparticles and their application in biomedicine,” *Journal of Nanoscience and Nanotechnology*, vol.6, no. 2, pp. 316–321, 2006.
[10] J. L. Li, L. Wang, X. Y. Liu et al., “In vitro cancer cell imagingand therapy using transferrin-conjugated gold nanoparticles,” *Cancer Letters*, vol. 274, no. 2, pp. 319–326, 2009.
[11] N.L.RosiandC.A.Mirkin,“Nanostructuresinbiodiagnostics,”*Chemical Reviews*, vol. 104, no. 4, pp. 1547–1562, 2005.
[12] Y. C. Kim, N. C. Park, J. S. Shin, S. R. Lee, Y. J. Lee, and D.J. Moon, “Partial oxidation of ethylene to ethylene oxide overnanosized Ag/alpha-Al2O3 catalysts,” *Catalysis Today*, vol. 87,no. 10, pp. 153–162, 2003.
[13] A. Ahmad, P. Mukherjee, S. Senapati et al., ″Extracellularbiosynthesis of silver nanoparticles using the fungus *Fusarium oxysporum*,″*Colloids and Surfaces B*, vol. 28, no. 4, pp. 313−318,2003.
[14] K. N. Thakkar, S. S. Mhatre, and R. Y. Parikh, ″Biologicalsynthesis of metallic nanoparticles,″*Nanomedicine*, vol. 6, no. 2, pp. 257−262, 2010.
[15] J. Karimi Andeani, S. H. Kazemi, S. Mohsenzadeh, and A. Safavi″Biosynthesis of gold nanoparticles using dried owers extract of *Achillea wilhelmsii* plant,″*Digest Journal of Nanomaterials andBiostructures*, vol. 6, no. 3, pp. 1011−1017, 2011.
[16] P. Mohanpuria, N. K. Rana, and S. K. Yadav, ″Biosynthesis ofnanoparticles: technological concepts and future applications,″ *Journal of Nanoparticle Research*, vol. 10, no. 3, pp. 507−517,2008.
[17] K. Manickathai, S. Kasi Viswanathan, and M. Alagar, ″Synthesisand characterization of CdO and CdS nanoparticles,″*IndianJournal of Pure and Applied Physics*, vol. 46, no. 8, pp. 561−564,2008.
[18] .J. Y.Park, Y. J. Lee, K. W. Jun, J. O. Aeg, and D. J. Yim, ″Chemicalsynthesis and characterization of highly oil dispersed MgO nanoparticles,″*Journal of Industrial and Engineering Chemistry*,vol. 12, no. 6, pp. 882−887, 2006.
[19] D. G. Shchukin, D. V. Sviridov, and A. I. Kulak, ″Integratingphotoelectrochemical semiconductor sensor for sulphide ion determination,″*Sensors and Actuators B*, vol. 76, no. 1-3, pp.556−559, 2001
[20] R. S. Mane, H. M. Pathan, C. D. Lokhande, and S. H. Han, ″Anefective use of nanocrystalline CdO thin films in dye-sensitizedsolar cells,″*Solar Energy*, vol. 80, no. 2, pp. 185−190, 2006.
[21] K. M. Abd El-Salaam and E. A. Hassan, ″Active surface centresin a heterogeneous CdO catalyst for ethanol decomposition,″*Surface Technology*, vol. 16, no. 2, pp. 121−128, 1982.
[22] W. Dong and C. chu, ″Optical properties of surface-modifiedCdO nanoparticles,″*Optical Materials*, vol. 22, no. 3, pp. 227−233, 2003.
[23] C. H. Bhosale, A. V. Kambale, and A. V. Kokate, ″Structural,optical and electrical properties of chemically sprayed CdO thin films,″*Solid-State Materials for Advanced Technology*, vol. 122, no. 1, pp. 67−71, 2005.
[24] M. Ghosh and C. N. R. Rao, ″Solvothermal synthesis of CdOand CuO nanocrystals,″*Chemical Physics Letters*, vol. 393, no. 4−6, pp. 493−497, 2004.

[25] Karimi Andeani, J., Mohsenzadeh, S. (2012). Phytosynthesis of cadmium oxide nanoparticles from Achillea wilhelmsii flowers. *Journal of Chemistry*, *2013*.