



SYNTHESIS AND CHARACTERIZATION OF CDS NANOPARTICLES USING REISHI MUSHROOM

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ABSTRACT

Development of environmentally benign methods for the synthesis of nanoparticles is an evolving important branch of nanotechnology. The green synthesis of CdS nanoparticles has been regarded as the most promising technique for their prospective applications in biological system. Cadmium Sulfide nanoparticles were synthesized by using Reishi mushroom aqueous extract as a convenient, non-toxic and eco- friendly 'green' capping /reducing agent. The present study explains a simple, cost effective way of nanoparticle synthesis suitable for large scale production. Excitation of blueshift in UV-Vis spectroscopy reveals the formation of nanoparticles. TEM, XRD, SEM were used to study the morphology, distribution, crystallinity and size. Biological activity was studied using the bacterial strain *S. aureus* and *A. niger*.

Keywords: Cadmium Sulfide Nanoparticles, TEM, SEM, XRD, Antimicrobial Activity

I. INTRODUCTION

Nanotechnology and Nanoparticles based products and their applications are increased now a days due to the biological effectiveness. This relatively new field is focused on the creation and use of materials at the nanometre size scale for advanced biotechnology. Metal chalcogenides like sulfides, tellurides and selenides are of great importance because they are potential materials for optoelectronics applications. It is well known that Cadmium Sulfide belongs to the ii-vi group of semiconductor compounds and that it has been widely utilised in making heterojunction thin film solar cells[1-5]. CdS is one of the most studied materials with a band gap of 2.43 eV. There

are many methods for the formation of Cadmium Sulfide nanoparticles : Successive ionic layer adsorption and reaction (SILAR)[6-8], Sonochemistry method[9-10] , microwave radiation[11] ,sol- gel[12-13] , processing of polymer films containing cadmium atoms or ions with a vapor of hydrogen sulfide[14] and others. The synthesis and application of semiconductor nanoparticles like Cadmium Sulfide have gained interest due to their wide range of applications such as biosensors, photocatalysts, solar cells, diodes and quantum dots for targeted drug delivery and therapy. In spite of advantage of this method, there are very few literature reports available on the biosynthesis of cadmium sulfide nanoparticles using plant extracts.

Various physical, chemical and biological methods have been employed to synthesize nano materials. There has been many biological systems such as bacteria, fungi, actinomycetes, yeasts, viruses, and plants have been reported to synthesize various metal and metal oxide nanoparticles. The synthesis of metal nanoparticles using bio inspired, eco friendly greener methods is one of the most attractive aspects of current nanoscience and nanotechnology. In the present work, an attempt has been done to prepare Cadmium Sulfide nanoparticles using plant extract as capping/reducing agent.

Reishi mushrooms have continued to generate lot of interests particularly in its consumption of food, in cure of diseases, in biodegradation .There are many health promoting properties such as antioxidant, antimicrobial, anticancer, cholesterol lowering and immuno- stimulatory effects have been reported for some species of mushrooms. It is well known that mushrooms contain a very large variety of biomolecules with nutritional and medicinal properties. In view of its medicinal importance we have selected Reishi mushroom extract for the biosynthesis of cadmium sulfide nanoparticles in the present study.

II. MATERIALS AND METHOD

All chemicals were of analytical grade and purchased from Merck (India) and were used without further purification. The culture media were purchased from Hi- media (India). De ionized water was employed for preparing all the solutions and reagents.

2 MLH magnetic stirrer REMI, X-Ray Diffraction (XRD) Spectrometer -Make Pan analytical (Model No: X'PERT PRO), Scanning Electron Microscopy (SEM) JEOL -JSM (Model No:66iOLV), UV-Visible Spectrophotometer UV-Shimadzu (Model No: UV 2450 Double Beam), Energy Dispersive X-Ray Spectroscopy (EDS) (Oxford institute),Transmission Electron Microscopy(TEM).

III. EXPERIMENTAL

3.1 Preparation of Reishi Mushroom extract

10 g of fruiting bodies of Reishi mushroom were taken separately and rinsed twice in distilled water , dried on a tissue paper and cut in fine pieces, and powdered using a blender and finally boiled in 150 ml of sterile distilled water followed by 10 ml of methanol until its volume reduces to half . It was cooled down to the room temperature and then filtered using Whatmann No. 41 filter paper and stored for further investigation.



3.2 Biosynthesis of CdS nanoparticles

5 ml of mushroom extract was added into 50 ml Cadmium Chloride (0.1 M) solution. Sodium Sulfide (50ml, 0.1 M) dissolved in de-ionized water was added drop wise into the solution of Cadmium Chloride kept under magnetic stirring. The contents were later on placed on to a rotatory orbital shaker operating at 200 rpm, 30 °C for 12 hours in dark solution. The formation of the particle was monitored by sampling an aliquot (3 ml) of the mixture after 12 hours, followed by measurement of the UV-vis spectra using a spectrophotometer. In order to find the absorption maximum optical density of the content from wavelength, 250- 700 nm.

3.3 Characterization of CdS nanoparticles

3.3.1 UV-Visible spectra analysis

The colour of the solution was observed by naked eye in order to check the formation of CdS nanoparticles. The bio-reduction of the reaction mixture of pure CdS ions during exposure to the extract of Reishi Mushroom was easily followed by observing the UV-Vis spectrum at different intervals taking 1ml of sample compared with 1ml of distilled water as a blank. The absorbance of the resulting solutions was monitored UV-Vis spectrophotometrically in the range 250-700 nm.

3.3.2 TEM

The formation of CdS nanoparticles was confirmed by using transmission electron microscopy (TEM). For this 5 µl of the sample solution was put on to lacy carbon coated 3mm diameter copper grids.

3.3.3 XRD

The phase identification and crystalline structures of the nanoparticles were characterized by X-ray powder diffraction.

3.3.4 SEM

The Morphological features of synthesized nanoparticles were examined by scanning electron microscopy (SEM) JEOL-JSM (Model NO:- 66iOLV).

3.3.5 EDAX measurements

EDAX is an analytical technique used for elemental analysis or chemical characterization of a sample.

IV. RESULTS AND DISCUSSION

4.1 UV-Visible spectral studies

The visual study of CdS NP production from the Reishi Mushroom plant extract was confirmed by UV-2450 Shimadzu Double Beam spectrophotometer by recording the absorbance from 250-700 nm. The color change from pale yellow to dark yellow is observed and a typical absorption peak obtained at 255.5 nm as shown in Fig.1

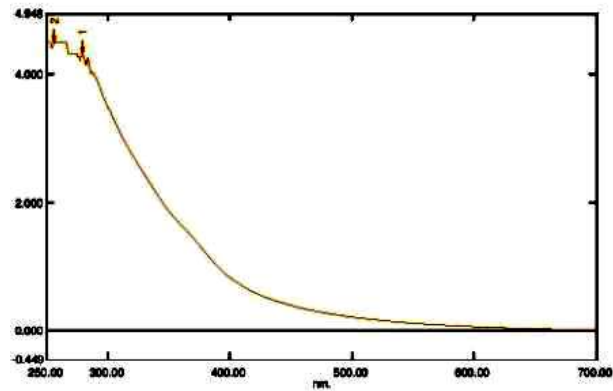


Figure.1

4.2 X-Ray Diffraction (XRD) Spectrometer

The phase identification and crystalline structures of the nanoparticles were characterized by X-ray powder diffraction. The particle size or grain size of the particles was determined using Scherrer formula. The Fig. 2 shows the XRD pattern of CdS nanoparticles obtained using Reishi Mushroom extract. The diffraction peaks appeared at 12.15, 26.81, 32.91, 33.46, 36.71, 43.93, and 48.08, the average crystallite size according to scherrer formula calculated using the highest peak of the 26.81 is found to be 21.00784 nm.

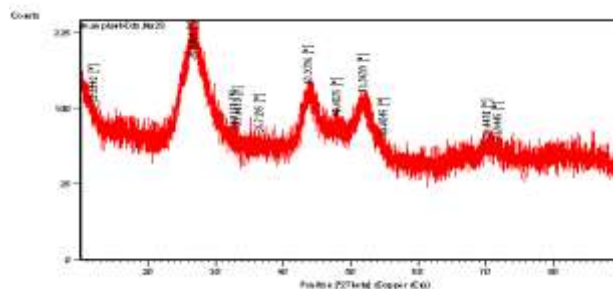


Figure.2

4.3 Scanning Electron Microscope (SEM)

SEM measurement was carried out by using JEOL-JSM - 66iOLV SEM machine. Thin films of the sample were prepared on a carbon coated copper grid by just dropping a very small amount of the sample on the grid, extra solution was removed using a blotting paper and then the film on the SEM grid were allowed to dry by putting a mercury lamp for 5 min. From the Fig.3 it is clear that the particles are crystalline in nature.

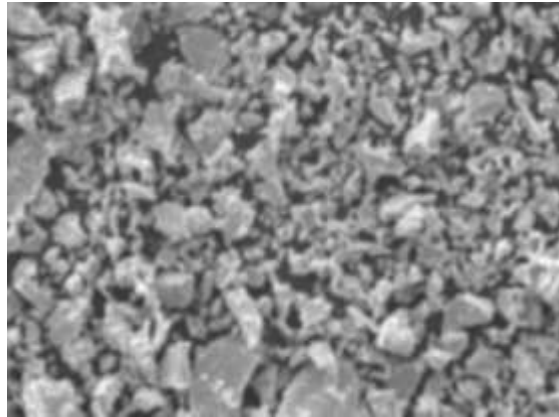


Figure.3

4.4 Energy Dispersive X-Ray Spectroscopy (EDS)

Further analysis of the CdS particles by Energy Dispersive Spectroscopy confirmed that the presence of signal characteristics of elemental Cd and S. Other peaks in this Fig.4 corresponds to carbon, Sulphur were due to sputter coating of glass substrate on the EDS stage and were not considered in elemental analysis of Cd and S.

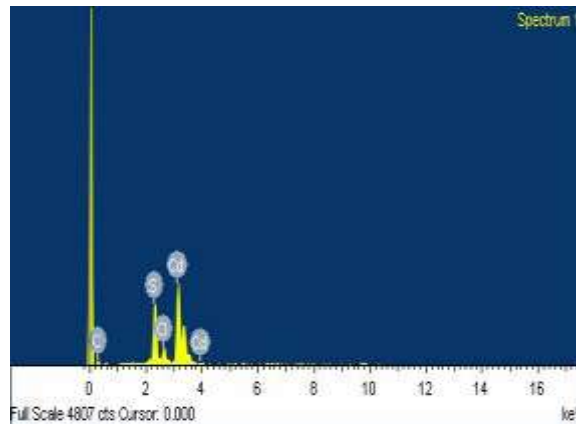


Figure.4

4.5 Transmission Electron Microscopy (TEM)

TEM analysis is the most reliable method for determining the size of the nano materials. TEM provides the insights into the morphology, stabilization and the size of the CdS nanoparticles. TEM measurement was carried out to determine the size and morphology of CdS nanoparticles extracellular synthesized from Reishi Mushroom extract. It is clear from the TEM image (Fig.5) that the particle shape is spherical, and the bar marker represents in the figure is 10nm.

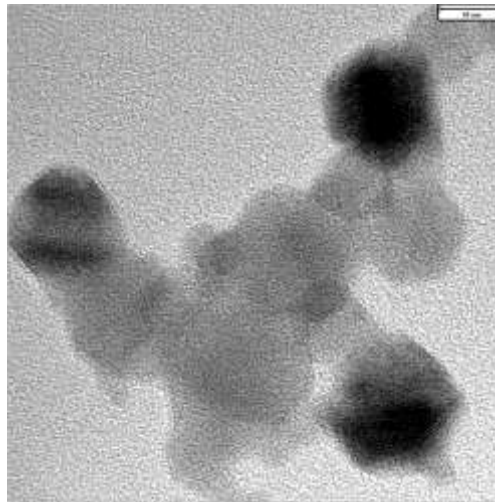


Figure.5

4.6 Microbial Activity

4.6.1 Anti-bacterial Activity

Anti-bacterial activity of the given extracts were performed by using cup plate method; Against a test organism *Staphylococcus aureus*. Nutrient agar medium was sterilized by moist heat sterilization using an autoclave (121 °C: 15-20 lb for 20 min's). 60 sterile petri plates were used for the assay to get triplicate values. Molten agar medium was inoculated with microbial suspension and poured in to the plates (temperature of the medium for inoculation is 35-40 °C). After solidification of the medium, cups were made aseptically using a stainless borer. 50 µl of sample of the extracts and an antibiotic solution of 50 µl were placed in the cups and the plates were kept in refrigerator for diffusion for a period of one hour. The plates were then kept in the incubator for one day at 37 °C. The inhibition zone diameters were then recorded and the diameters were compared against those obtained for the standard antibiotic.(Amikacin - 10 µg/ml prepared in sterile water). The images of the extract and anti microbial activity in Figs .6&7 respectively.



Figure.6



Figure.7

4.6.2 Anti-Fungal Activity

Anti -fungal activity of the given extract were performed by using cup plate method , Against a test organism *Aspergillus niger*. Potato dextrose agar medium was sterilized by moist heat sterilization using an autoclave [121 ° C; 15-20 lb for 20 min's]. 60 sterile petri plates were used for the assay to get triplicate values. Molten agar medium was inoculated with microbial suspension and poured in to the plates(temperature of the medium for inoculation is 35-40° C.) After solidification of the medium, cups were made aseptically using a stainless borer. 50µl of the sample of the extracts and an antibiotic solution of 50µl were placed in the cups and the plates were kept in refrigerator for diffusion for a period of one hour. The plates were then kept at room temperature for 3 days. The inhibition zone diameters were then recorded and the diameters were compared against those obtained for the standard antibiotic (Fluconazole- 20 µg ml dissolved in methanol) as shown in Fig.8.

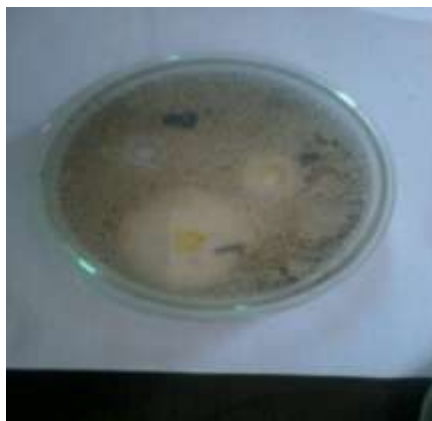


Figure.8

V. CONCLUSION

In the present study the Reishi Mushroom extract was used for the first time for the biosynthesis of CdS NPS and characterized using XRD, FTIR, SEM, TEM. The biological applications such as microbial activity (*Staphylococcus aureus*, *Aspergillus niger*) were studied which reveals that it has excellent anti microbial activity. But the exact extracellular mechanism of CdS formation with the use of plant extract still remains unclear and requires further detailed investigation .

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