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BANANA FRUIT PEELS AS CAPPING AND REDUCING AGENTS TO CREATING CADMIUM OXIDE NANOPARTICLES AND EVALUATION ITS ACTIVITY AGAINST *E. COLI* AND *C. ALBICANS*

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Abstract

Cadmium oxide nanoparticles has been prepared by a plant technique as capping and reducing agents by using *Musa paradisiaca* (banana) fruit peels as natural and environmentally friendly materials instead of chemicals. Characterization was approved by Ultra-violet spectroscopy, Fourier Transform Infrared Spectroscopy, powder X-ray diffraction, and Scanning Electron Microscope techniques. The results have established that the prepared Cd-Nps nanoparticles are crystalline. The average particle size 25.59 nm. Cd-Nps appeared antimicrobial activity against clinical strains of bacteria (E. *coli*) and fungi (*Candida albicans*).
Keywords: Cd; NPs; banana; peels; nanoparticle; prepared.

Introduction

Today, the creating of nanoparticles has become a preferred field in nanoscience and the number of research in this field has increased due to the properties of materials dependent on their size. Green synthesis of nanoparticles represents an progress over other techniques since it is ecofriendly, simple and cost-effective (Hussain, 2018). The plant is a preferred application because the nanoparticals created by it are more stable and more diverse in dimension and form from that resulting when using other organism (Ramesh *et al*., 2014).

The cadmium nanoparticles have been prepared by physical, chemical and biological techniques such as microwave irradiation (Yang *et al*., 2005), by the sonochemical procedure (Arul Dhas and Gedanken, 1998) via Sonochemical and hydrothermal routes (Askarinejad and Morsali, 2009). Or by microbial synthesis (Bai *et al*., 2009; Hosseini and Sarvi, 2015). Cd-Nps synthesized through the green route as from the algae (*Chlamydomonas reinhardtii*) (Rao and Pennathur, 2017) or plant such as from Tea (Goud *et al*., 2016).

Cadmium nanoparticles have been broadly studied in recent times and find numerous biological applications as advanced disease diagnostics to biological imaging and molecular histopathology (Jin *et al*., 2011). Cadmium nanoparticles exhibit antibacterial activity above a wide range of bacterial species and in specific against *P. vulgaris* , *E.coli, E. hermannii* and *S. aureus* (Kaviyarasu *et al*., 2017), anti-viral, anti–tumor (Heidari, 2016) and anti-cancer properties (Heidari and Brown, 2015).

Peels are the main by-yields got through the handling of numerous fruit the studies confirm that these are worthy sources of carotenoids, polyphenols, and other bioactive compounds that own many useful effects on human health (Larrauri, 1999). Likely using of banana peel depend on its chemical ingredients. Banana peel is rich in essential amino acids, dietary fiber, polyunsaturated fatty acids, proteins, and potassium (Emaga *et al*., 2007). Banana peel is non-toxic, eco-friendly 'green material', have medicinal properties (Parmar and Kar, 2008). Banana peel extract was used in the synthesis of Gold and silver nanoparticles (Bankar *et al*., 2010; Ibrahim, 2015).

Materials and Methods

Preparation of the banana peels extract (BPE)

Musa paradisiaca (banana) peels is selected due to its ecofriendly nature and its rich antioxidant content for using as capping and reducing agents. Banana fruits were purchased from the local market. The peels washed with double distilled water and then in deionized water. It was cut into small pieces and 25 gm from their placed in a glass beaker containing 100 ml of deionized water then put on the hotplate at 60ºC for 10mins. Then it was filtered using an aseptic gauze, followed by using filter papers and use immediately.

CdO nanoparticle preparation

Cadmium oxide (CdO) was added at (0.04g) into 200 ml of DW, and the solution was placed on a stirrer-heat plate, 60°C, for 10 mins followed by adding few drops of the BPE until the color was changed into yellow-brown. Adding to the color change index, the laser radiation (with a capacity of 50mW and a wavelength of 650nm) has been directed to tubes containing the solution holding nanoparticles, the passage of light in a bundle indicates the formation of nanoparticles (Berne and Pecora,1981). The solution was dried in the oven at 60° C and then kept in opaque bottles for subsequent testing.

UV-vis, IR, spectroscopy

UV (Shimadzu UV-1650PC) and FTIR (Shimadzu FTIR–8400S) were executed at the College of Education, University of Al-Qadisiyah, Iraq.

X-Ray diffraction (XRD)

XRD (Bestic Germany Aluminium) through using CuKα radiation (λ = 1.54 Å) at 40 kV and 40 mA was done on the dry materials at the Service Lab, College of Education/Ibn Al-Haithem, University of Baghdad, Baghdad, Iraq.

Scanning electron microscopy

The scanning electron microscope (SEM) (SEM HV:30.00KV VEGA\\TESCAN/ Czechy) performed in the nanotechnology and advanced materials research center / University of Technology , Iraq. Clean and sterilized glass slides were immersed in the solutions and Leave to dry on a heat plate at 50°C. This step was repeated four times and then the slides were left to dry in the oven at 100 ° C for 24 (Holi, A.M. and Al-Jubory, 2019).

Antimicrobial activities

The antibacterial activities of the Cd-Nps (25%, 50, and 100% concentration) were tested against *Escherichia coli* and *Candida albicans* (obtained from the Labs of Maternity and Children Teaching Hospital .The diagnosis of clinical strain has been confirmed in laboratories of the College of Biotechnology, University of Al-Qadisiyah). The cultivated bacteria and yeast, at three days age with 1X 10^8 CFU were planted into the Muller Hinton agar media, then we have made wells in the media by a cork borer, and put 0.1 ml from each concentration of Cd-Nps in each well separately after that the plates were incubated at 37 C for 48 hours then the inhibition zones were measured. All the experiments were performed in triplicate under aseptic conditions (Abdel Raouf *et al*., 2017).

Results and Discussion

CdO nanoparticles

In the current work, we have created CdO- Nps. The cadmium oxide solution Prepared by banana peels altered to a Yellowish-brown color from 10 minutes forward at room temperature, point to the founding of cadmium oxide nanoparticles. As well as the passage of light in a bundle (Fig. 1) indicates the formation of nanoparticles, as the collision of light with the particles leads to reflection and the smaller the size of the particles the greater the density of the beam Reflected (Berne and Pecora, 1981). The prepared materials CdO was characterized via UV-Visible, FTIR, X-Ray Diffraction and FESEM.

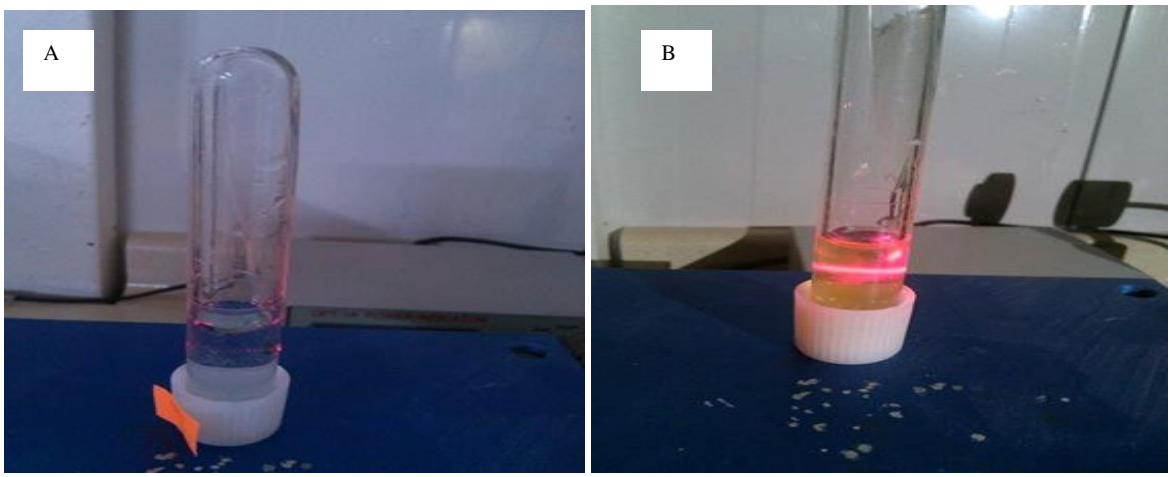

Fig. 1: Direct laser light on A: CdO solution B: CdO-Nps

UV-Visible absorption

The UV-Visible absorption spectrum of Cd-Nps is exhibit in Fig. 2. The spectrum was document in transmission mode and the samples were ready by making a scattering in deionized water. The crystallite size rises the shoulder shifts to lesser wavelengths and lastly dissolve in bulk solids. Related results for the UV-vis spectra of the nanocrystalline Cd was reported by previous researchers (Motte *et al*., 1992; Hoyer *et al*., 1995; Nair *et al*., 2002). A sharp absorbance of the Cd-Nps is saw at 282.5 nm, which point to an almost uniform size of the nanoparticles. Our result is in agreement with those of previous studies (Salehi *et al*., 2014).

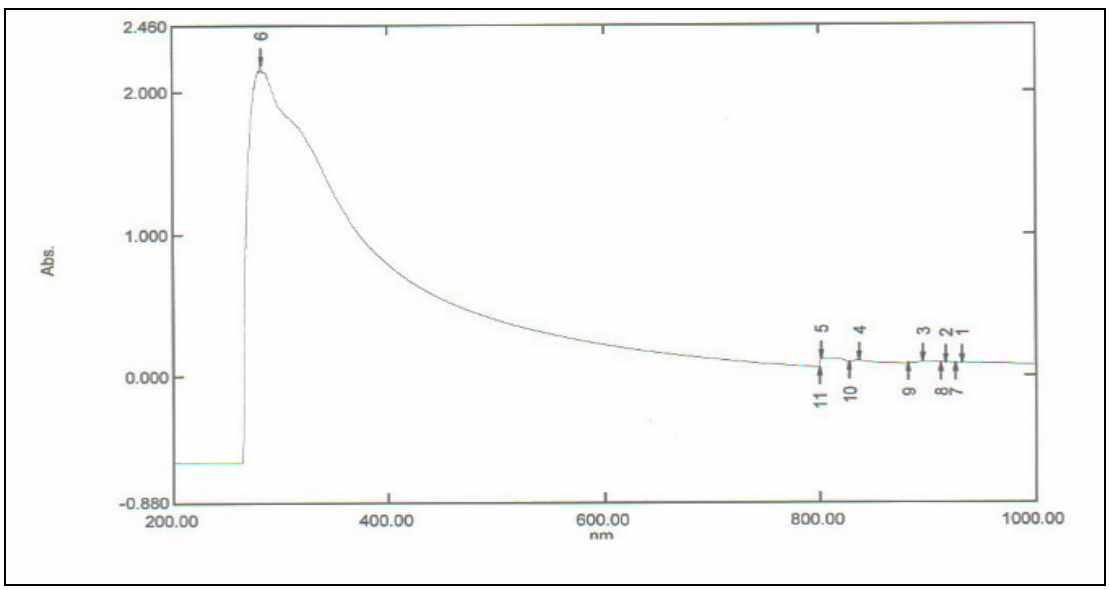

Fig. 2: Ultraviolet-visible spectrum of the Cd-Nps prepared with banana peels

FT-IR study

Figure 3 shows IR spectrum of CdO nanoparticles .there are O-H stretching (3394.4 cm^{-1}) and vibration (1589.23 cm^{-1}) bands in addition to CdO band (524cm^{-1})

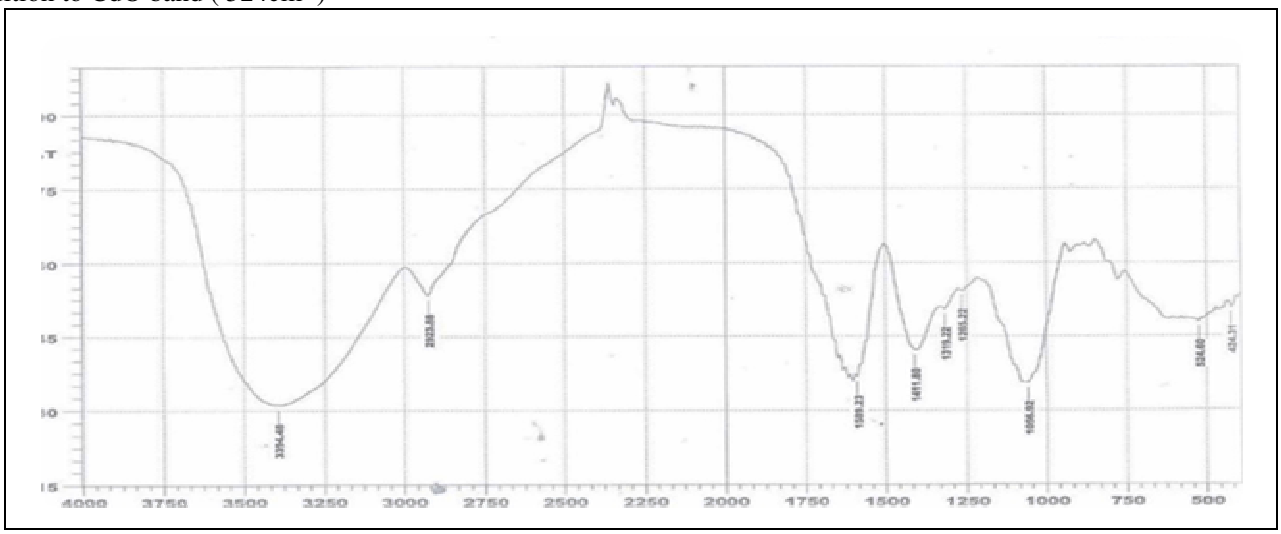

Fig. 3: FTIR Transmission spectra of pure CdO nanoparticls

X-ray diffraction analysis

X-ray diffraction analysis (XRD) pattern of CdS sample is reveal in Fig. 4. It exhibits the strongest peaks at 2θº values of 28.3089, 40.4885 and 50.1282º. Increase in sharpness of XRD peaks indicates that particles are in crystalline nature. The estimated average grain size of the sample is 25.59 nm from the FWHM of the most extreme peaks to 2θº.The size of the Nps was calculated using the Scherrer's equation: $D = K\lambda / \beta \cos(\Theta)$

D: crystallite size.β:full width at half maximum of diffraction line in radians λ: X–ray target wavelength. K: shape factor ≈ 0.94.Θ: Diffraction angle for diffraction line.

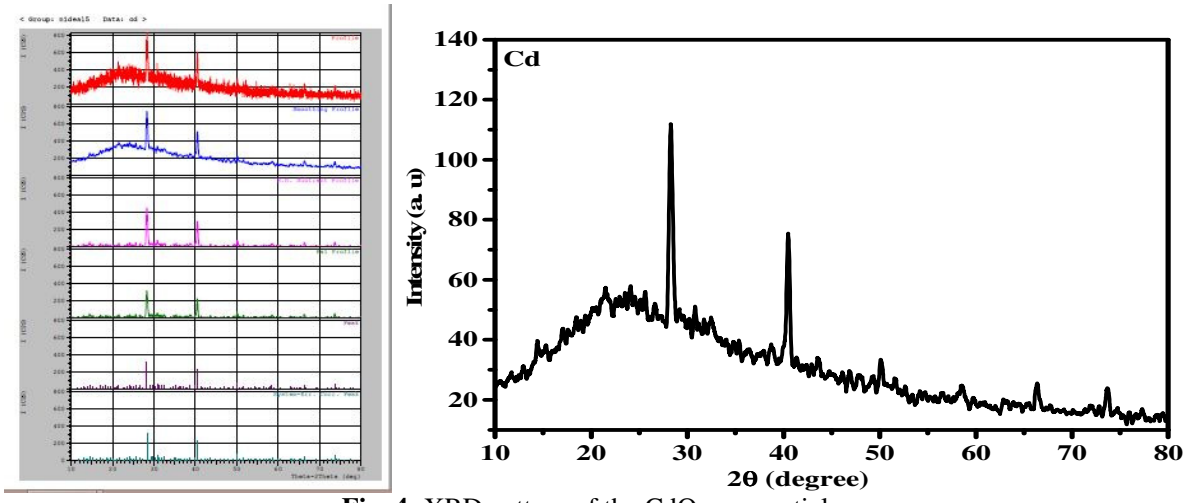

Fig. 4: XRD pattern of the CdO nanoparticles

Electron microscope analysis

The image of created Cadmium Oxide nanoparticles is seen in Figure 5. The image shows the CdO nanoparticles created by the banana peels extract. The shapes were spherical and irregular. This image is taken with the scanning electron microscopy (SEM)

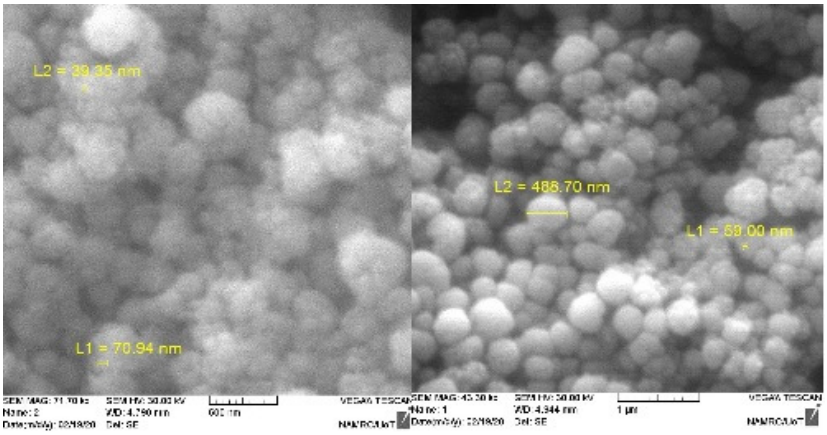

Fig. 5: SEM images of CdO

Antimicrobial activity

The antimicrobial effectiveness of Cd-Nps was assayed by calculating the inhibition zone against *E. coli* and *C. albicans*. The dimensions of the inhibition zones of growth are exhibit in Table 1. The results point to that Cd-Nps created from banana peels extract exhibited effectual antimicrobial activity against bacteria and fungi. From table 1, we note that the cadmium oxide solution did not affect of inhibition bacteria under study, but the suspension of nanoparticles of cadmium oxide was inhibited bacterial growth and the inhibition range increased with increasing the concentration. We also note that the banana peel extract alone had a slight effect compared to the presence of the nanoparticle. As for the candida yeast, it was not inhibited by a cadmium oxide solution or banana peel extract without the presence of nanoparticles. The results for the green synthesized Cd-Nps were comparable to that of gentamicin and fluconazole. Cadmium nanoparticles antimicrobial activities were reported by previous studies over a broad range of bacterial and fungi species (Chandran *et al*., 2014; Kaviyarasu *et al*., 2017). Cadmium Oxide nanoparticles concentration leads to the promotion of antibacterial characteristics and the lowering growth rate of bacteria. The presence of nanoparticles encourage cellular destruction (Salehi *et al*., 2014).

Table 1: The inhibition zone diameter (mm) in mutable concentrations of Cadmium Oxide nanoparticles on *E. coli* and *C. albicans.*

Microorganism	Inhibition zone diameter (mm)					
	CdO	Concentration of CdO-Nps %			BPE	G or F
		25	50	100		
E.coli	0.0	14	16	20.5	12.5	23.5
C. albicans	0.0	16.5	19.5	23.5	0.0	25.5

E: Banana peel extract, G: Gentamycin ,F :Fluconazole

References

Abdel-Raouf, N.; Al-Enazi, N.M. and Ibraheem, I.B. (2017). Green biosynthesis of gold nanoparticles using *Galaxaura elongata* and characterization of their antibacterial activity. Arabian Journal of Chemistry, 10 : S3029-S3039.

Arul, D.N. and Gedanken, A. (1998). A sonochemical approach to the surface synthesis of cadmium sulfide nanoparticles on submicron silica. Applied physics letters, 72(20): 2514-2516.

Askarinejad, A. and Morsali, A. (2009). Synthesis of cadmium (II) hydroxide, cadmium (II) carbonate and cadmium (II) oxide nanoparticles; investigation of intermediate products. Chemical Engineering Journal, 150 (2-3): 569-571.

Bai, H.J.; Zhang, Z.M.; Guo, Y. and Yang, G.E. (2009). Biosynthesis of cadmium sulfide nanoparticles by photosynthetic bacteria *Rhodopseudomonas palustris*. Colloids and surfaces B: Biointerfaces, 70(1): 142-146.

Bankar, A.; Joshi, B.; Kumar, A.R. and Zinjarde, S. (2010). Banana peel extract mediated synthesis of gold nanoparticles. Colloids and Surfaces B: Biointerfaces, 80(1): 45-50.

Berne, B. and Pecora, R. (1981). Dynamic Light Scattering: With Applications to Chemistry, Biology and Physics. John Wiley & Sons, New York.

Chandran, P.; Kumari, P. and Khan, S.S. (2014). Photocatalytic activation of CdS NPs under visible light for environmental cleanup and disinfection. Solar Energy, 105: 542-547.

Emaga, T.H.; Andrianaivo, R.H.; Wathelet, B.; Tchango, J.T. and Paquot, M. (2007). Effects of the stage of maturation and varieties on the chemical composition of banana and plantain peels. Food chemistry, 103(2): 590-600.

Goud, B.S.; Suresh, Y.; Annapurna, S.; Singh, A.K. and Bhikshamaiah, G. (2016). Green Synthesis and Characterization of Cadmium Sulphide Nanoparticles. Materials Today: Proceedings, 3(10): 4003-4008.

Heidari, A. and Brown, C. (2015). Study of composition and morphology of cadmium oxide (CdO) nanoparticles for eliminating cancer cells. Journal of Nanomedicine Research, 2(5): 20.

Heidari, A. (2016). Biotranslational medical and biospectroscopic studies of cadmium oxide (cdo) nanoparticles–dna/rna straight and cycle chain complexes as potent anti–viral, anti–tumor and anti–microbial drugs: a clinical approach. Transl Biomed, 7(2): 76.

Holi, A.M. and Al-Jubory, S.Y.O. (2019). Zinc Oxide Nanoparticles and Nanorods as Antimicrobial Agents: Particle Size Influence. Nano Biomed. Eng, 11(4): 375-380.

Hosseini, M.R. and Sarvi, M.N. (2015). Recent achievements in the microbial synthesis of semiconductor metal sulfide nanoparticles. Materials Science in Semiconductor Processing, 40: 293-301.

Hoyer, P.; Baba, N. and Masuda, H. (1995). Small quantum-sized CdS particles assembled to form a regularly nanostructured porous film. Applied physics letters, 66(20): 2700-2702.

Hussain, C.M. (2018). Handbook of nanomaterials for industrial applications. Elsevier.

Ibrahim, H.M. (2015). Green synthesis and characterization of silver nanoparticles using banana peel extract and their antimicrobial activity against representative microorganisms. Journal of Radiation Research and Applied Sciences, 8(3): 265-275.

Jin, S.; Hu, Y.; Gu, Z.; Liu, L. and Wu, H.C. (2011). Application of quantum dots in biological imaging. Journal of Nanomaterials, 2011.

Kaviyarasu, K.; Kanimozhi, K.; Matinise, N.; Magdalane, C.M.; Mola, G.T.; Kennedy, J. and Maaza, M. (2017). Antiproliferative effects on human lung cell lines A549 activity of cadmium selenide nanoparticles extracted from cytotoxic effects: investigation of bio-electronic application. Materials Science and Engineering: C, 76: 1012-1025.

Larrauri, J.A. (1999). New approaches in the preparation of high dietary fibre powders from fruit by-products. Trends in Food Science & Technology, 10(1): 3-8.

Motte, L.; Petit, C.; Boulanger, L.; Lixon, P. and Pileni, M.P. (1992). Synthesis of cadmium sulfide in situ in cadmium bis (2-ethylhexyl) sulfosuccinate reverse micelle: polydispersity and photochemical reaction. Langmuir, 8(4): 1049-1053.

Nair, P.S.; Radhakrishnan, T.; Revaprasadu, N.; Kolawole, G. and O'Brien, P. (2002). Cadmium 24-ethylxanthate: A novel single-source precursor for the preparation of CdS nanoparticles. Journal of Materials Chemistry, 12(9): 2722-2725.

Parmar, H.S. and Kar, A. (2008). Medicinal values of fruit peels from *Citrus sinensis, Punica granatum* and *Musa paradisiaca* with respect to alterations in tissue lipid peroxidation and serum concentration of glucose, insulin, and thyroid hormones. Journal of Medicinal Food, 11(2): 376-381.

Ramesh, P.; Rajendran, A.; Meenakshisundaram, M. (2014). Green synthesis of zinc oxide nanoparticles using flower extract *Cassia auriculata*. J NS NT 1 (1): 41–45.

Rao, M.D. and Pennathur, G. (2017). Green synthesis and characterization of cadmium sulphide nanoparticles from *Chlamydomonas reinhardtii* and their application as photocatalysts. Materials Research Bulletin, 85: 64-73.

Salehi, B.; Mehrabian, S. and Ahmadi, M. (2014). Investigation of antibacterial effect of Cadmium Oxide nanoparticles on *Staphylococcus aureus* bacteria. Journal of nanobiotechnology, 12(1): 26.

Yang, H.; Huang, C.; Li, X.; Shi, R. and Zhang, K. (2005). Luminescent and photocatalytic properties of cadmium sulfide nanoparticles synthesized via microwave irradiation. Materials chemistry and physics, 90(1): 155-158.