Effect of Nano Particles on Antibacterial Activity of Aloe Vera

Dr.Entessar H. Ali
Applied Sciences of Department, University of Technology / Baghda
Khawla S. khashan
Applied Sciences of Department, University of Technology / Baghdad
Iman I. Jabber
Applied Sciences of Department, University of Technology / Baghdad

Received on: 30/9/2012 & Accepted on: 15/8/2013

ABSTRACT

In this work, synthesis of CdS nanoparticles with *Aloe vera (L.*) extract and its activity on bacterial pathogens was investigated. CdS nanoparticles were synthesized by using chemical methods. Physical properties like: X- ray diffraction (XRD), Atomic force microscopy (AFM) and UV-VIS transmission spectroscopy were employed to characterize the crystalline structure, size and transmission spectra of nanoparticles. X-ray diffraction analysis confirms the formation of cubical and hexagonal structures of CdS nanoparticle. The AFM show the formation of aggregate of nanoparticle with particle size ranging 7 – 20 (nm). The antibacterial activity of *Aloe vera*-conjugated CdS nanoparticles showed effective inhibitory activity against the pathogens.

Keywords: Aloe Vera, Nan particles, Antibacterial Activity, Chemical Method.

تأثير الجسيمات النانوية على النشاط المضاد للبكتيريا من الصبار

الخلاصة

في هذا العمل تم التأكيد من الفعاليه الحيويه لجسيمات CdS النانويه واستخدام الصبار *Aloe vera* على مسببات الأمراض البكتيرية .لقد تم تصنيع جسيمات CdS النانوية عبر الطريقة الكيميائية. استخدمت الخصائص الفيزياوية مثل حيود الاشعه السينية XRD و مجهر القوة الذرية AFMوالتحليل الطيفي UV-VIS لتحديد التركيب البلوري و الحجم وطيف النفاذيه للجسيمات النانوية .يبين تحليل الاشعه السينيه تكوين تراكيب مكعبه وسداسيه للجسيمات النانويه من CdS ويظهرAFM تشكيل مجاميع لجسيمات متناهية الصغر مع حجم الجسيمات تتراوح 7 - 20نانوميتر. أظهرت النشاط المضاد للبكتيريا من الصبارمترافق مع جسيمات النانوية CdS فعالية النشاط المثبطة ضد مسببات الأمراض.

INTRODUCTION

With the development of nanotechnology since 1974, controllable synthesis of nanoparticles has attracted much attention due to their potential applications in many areas [1]. Especially, they have been extensively exploited for use in biomedical areas, such as targeted drug delivery [2], imaging [3], sensing [4] and antimicrobial [5]. Among these nanoparticles, CdS NPs are particular interest due to its strong and wide-spectrum antimicrobial activities [6-9], which might act as a novel bactericide to solve the serious antibiotic resistance problem.

https://doi.org/10.30684/etj.32.1B.8
2412-0758/University of Technology-Iraq, Baghdad, Iraq

CdS NPs can be successfully synthesized by traditionally chemical and physical methods. However, these methods strongly depend on severe reaction conditions, for example, aggressive agents, harmful solvent system to environment and ecology, higher temperature and higher pressure, and so on.

Aloe vera (L.) Burm.f. (Aloe barbadensis Miller) is perennial succulent xerophytes, which develops water storage tissue in the leaves to survive in dry areas of low or erratic rainfall. The innermost part of the leaf is a clear, soft, moist and slippery tissue that consists of large thin-walled parenchyma cells in which water is held in the form of viscous mucilage [1]. *Aloe vera* has been used for many centuries for its curative and therapeutic properties and although over 75 active ingredients from the inner gel have been identified, therapeutic effects have not been correlated well with each individual component [2]. Many of the medicinal effects of *Aloe* leaf extracts have been attributed to the polysaccharides found in the inner leaf parenchymatous tissue [3,4], but it is believed that these biological activities should be assigned to a synergistic action of the compounds contained therein rather than a single chemical substance [5]. *Aloe vera* is the most commercialized *Aloe* species and processing of the leaf pulp has become a large worldwide industry. In the food industry, it has been used as a source of functional foods and as an ingredient in other food products, for the production of gel-containing health drinks and beverages. In the cosmetic and toiletry industry, it has been used as base material for the production of creams, lotions, soaps, shampoos, facial cleansers and other products. In the pharmaceutical industry, it has been used for the manufacture of topical products such as intents and gel preparations, as well as in the production of tablets and capsules [6,7], important pharmaceutical properties that have recently been discovered for both the *Aloe vera* gel and whole leaf extract include the ability to improve the bioavailability of co-administered vitamins in human subjects [8].

In this study, the antibacterial effect of CdS / *Aloe vera* was evaluated against three pathogenic bacteria, including ***Pseudomonas aeruginosa***, ***Proteus vulgaris*** and ***Salmonella typhi was*** investigated.

EXPERIMENTAL WORK

- **Preparation of CdS nanoparticles**

CdS nanoparticles were synthesized via chemical method, using cadmium nitrate $Cd(NO_3)_2.4H_2O$ and thioacetamide (TA); they prepared in chemical lab. , other details of preparation method were described in Ref. [10]. The structure characterization of CdS nanoparticles were performed by X- ray diffract meter (Philips, PW/1710), with monochromatised CuKα radiation of wavelength 0.15418nm at 40KV and 30mA. A UV-VIS transmission spectrum was recorded employing a Cecile-7200 double beam UV/VIS spectrophotometer supplied by Aquarius Company for the wavelength range of 200-900 nm. The surface morphology and particle size were characterized using Atomic force microscopy (Advance angstrom Inc. SPM AA3000).

- **Preparation of extract**

Aloe vera extract was prepared from *Aloe vera* leaf gel with slight modifications of the procedure by Grieve [11]. Mature, healthy and fresh leaves of *Aloe vera* having a length of approximately 25 to 50 cm were washed with fresh water. The leaves were cut transversely into pieces. The thick epidermis was selectively removed. The solid gel in the center of the leaf was homogenized. The crude extracts were prepared freshly each time and administered orally . The dosing schedule used was once daily.

- **Antibacterial assay**

Three bacterial strains were used: ***Pseudomonas aeruginosa, Proteus vulgaris, Salmonella typhi*** .The bacterial suspension was prepared and adjusted by comparison against 0.5 Mc-Farland turbidity standard (5x 10^7 cell ml^{-1}) tubes. It was further diluted to obtain a final of 1.4 x 10^8 cell ml^{-1}. All bacteria strains were sub- culture on nutrient broth (8). The broth was inoculated by the 0.2 ml/10ml broth either with all bacteria strains, then added 1 ml of (2, 4, and 5 mg) *Aloe vera* and then added 1 ml of (2, 4, and 5 mg) *Aloe vera* & nano and other then added 1 ml of (2, 4, and 5 mg) Nano. The tubes were incubated at 37 C^0 for 24 h. The growth of control bacterial growth due to *Aloe vera*, *Aloe vera* & nano and nano was measured by turbidity at 600 nm wavelength. The mean values of inhibition were calculated from triple reading in each test. The minimum bactericidal concentration (MBC) of *Aloe vera*, *Aloe vera* & nano and nano was determined by the ten-fold dilution method against bacterial strains ***in vitro***.

- **Statistical data analysis:** Data were statistically analyzed using SPSS statistical software (version 11.5). The values are given as mean ± standard error.

RESULT AND DISCUSSION

Figure (1) shows the X-ray diffraction pattern of the CdS nanoparticles, XRD peaks were found at 2θ values of 26.5°, 44° and 52°, referring to diffraction from (002), (110) and (112) planes, reflections of the hexagonal modification or (111), (220) and (311) reflection of the cubical zinc blend CdS. Also there were shoulders around 25° and 28.3° corresponding to the hexagonal phase in the XRD spectrum [12]. Therefore, as-prepared sample is mixtures of cubical and hexagonal phases.

Figure (2) explain the transmission spectrum on CdS nanoparticles., from figure can notice that transmission (T%) reach to 2.5 at short wavelength and this attribute to high absorption of nanoparticles at these wavelength, then the transmission increased as s wavelength increased [13]. The energy gaps E_g of CdS nanoparticles is 2.85 eV was estimated using Tauc relation [14].Figure (3) shows the AFM images of CdS nanoparticles, the histogram of size distribution of CdS nanoparticlesFigure (3 b) shows particle size ranging from 7-20 nm.

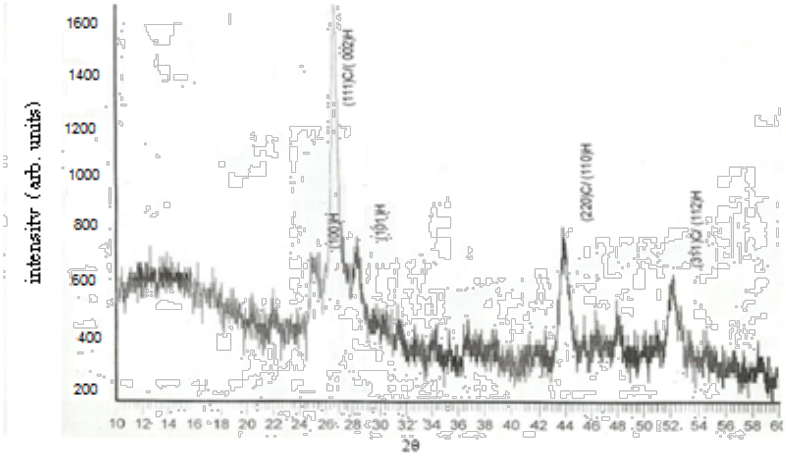

Figure (1) X-ray diffraction pattern of CdS nanoparticles.

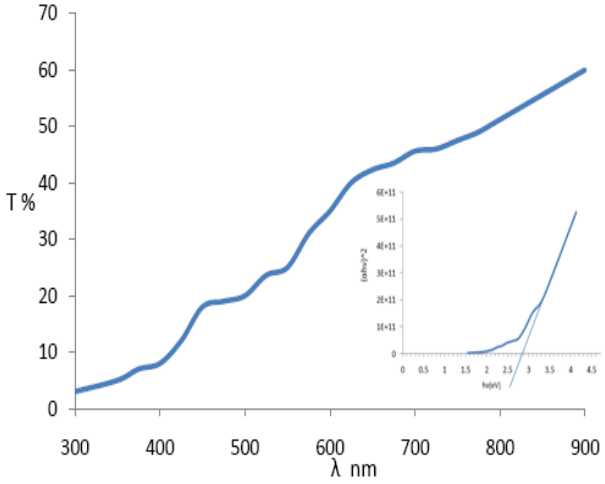

Figure (2) Optical transmission spectra of CdS nanoparticles.

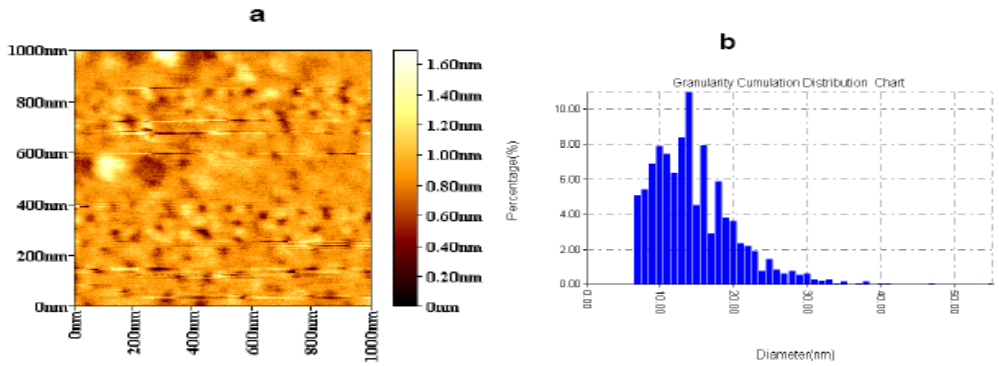

Figure (3) AFM image of CdS nanoparticles; a) two dimensional image. b) Histogram of crystal size distribution.

This study confirms the antibacterial effect of *Aloe vera* extract on various Gram-negative and Gram-positive bacteria. In particular, crude of *Aloe vera* is a very potent inhibitor of growth of bacteria such as clinical isolates of ***Pseudomonas aeruginosa***, ***Proteus vulgaris***, and ***Sallmonellia typhi.*** All bacterial pathogens failed to grow in lower and higher concentrations of *Aloe vera* extract, *Aloe vera* nano and nano (Table 1, 2 and 3).

Table (1) Antibacterial properties of *Aloe vera.*

Strains	Optical Density 600 nm			
	Concentration of *Aloe vera* mg ml^{-1}*			Control
	2	4	5	
Pseudomonas aeruginosa	0.244±0.34	0.125±0.11	0.123±0.20	0.679±0.28
Proteus vulgaris	0.539±0.25	0.317±0.30	0.110±0.22	0.849±0.19
Salmonella typhi	0.140±0.24	0.125±0.19	0.101±0.22	0.246±0.10

* Values: Mean ± S.E

Table (2) Antibacterial properties of *Aloe vera* & CdS nanoparticles.

Strains	Optical Density 600 nm			
	Concentration of *Aloe vera* & CdS nanoparticles mg ml^{-1}*			Control
	2	4	5	
Pseudomonas eruginosa	0.321±0.31	0.313±0.15	0.303±0.30	0.679±0.28
Proteus vulgaris	0.334±0.15	0.309±0.23	0.303±0.32	0.849±0.19
Salmonella typhi	0.234±0.14	0.219±0.17	0.206±0.32	0.246±0.10

* Values: Mean ± S.E

Table (3) Antibacterial properties of CdS nanoparticles.

Strains	Optical Density 600 nm			
	Concentration of CdS nanoparticles mg ml^{-1} *			Control
	2	4	5	
Pseudomonas aeruginosa	0.348±0.24	0.225±0.21	0.170±0.10	0.679±0.28
Proteus vulgaris	0.640±0.15	0.436±0.13	0.153±0.21	0.849±0.19
Salmonella typhi	0.235±0.24	0.215±0.14	0.187±0.12	0.246±0.10

* values: Mean ± S.E

Pseudomonas aeruginosa: The results indicated that *Aloe vera* is exhibited antibacterial activity at concentrations of 4 mg ml $^{-1}$ (0.125 ± 0.11) and *Aloe vera* & CdS NPs above (0.313±0.15) and CdS NPs (0.225±0.21) as compared with control (0.679 ± 0.28) Table (1, 2 and 3). There was also an obvious decrease in the number of viable cells of ***Pseudomonas aeruginosa*** especially at the higher concentration (5 mg ml^{-1}) was (2.272 x10^{8}) , (2.272 x10^{8}), (1.275 x10^{8}) CFU (Colong Forming Unit) ml $^{-1}$ as compared with control(5.096 x10^{8}) CFU ml $^{-1}$ Table (4,5,6). The MBC of *Aloe vera* was 4 mg ml^{-1}.

Proteus vulgaris: The results indicated that *Aloe vera* exhibited antibacterial activity at concentrations of 2mg ml $^{-1}$ (0.539±0.25), (0.334±0.15), (0.640±0.15) and above as compared with control (0.849±0.19) Table (1, 2, 3). There was also an obvious decrease in the number of viable cells of ***Proteus vulgaris*** especially at the higher concentration (4 and 5 mg ml^{-1}) were 2.321 x10^{8} and 2.272 x10^{8} CFU (Colong Forming Unit) ml $^{-1}$ and in *Aloe vera* & CdS NPs 2.321 x10^{8} CFU (Colong Forming Unit) ml $^{-1}$, respectively as compared with control 1.07x10^{9} CFU (Colong Forming Unit) ml $^{-1}$. The MBC of propolis was 2 mg ml^{-1}.

Salmonella typhi: The results indicated that propolis exhibited antibacterial activity at concentrations of 1mg ml $^{-1}$ (1.23±0.19) and above as compared with control 1.32±0.10 (Table 1). There was also an obvious decrease in the number of viable cells of ***Salmonella typhi*** especially at the higher concentrations (4 and 5 mg ml^{-1}) was

1.642 x10^8 and 1.545x10^8 CFU ml^{-1}, respectively as compared with control 1.845 x10^8 CFU ml^{-1} . The MBC of *Aloe vera* was 2 mg ml^{-1}.

Table (4) Antibacterial properties of *Aloe vera.*

Strains	No. of cell $\times10^8$			
	Concentration of propolis mg ml^{-1}			**Control**
	2	4	5	
Pseudomonas aeruginosa	2.407±0.14	2.347±0.15	2.272±0.21	5.096±0.18
Proteus vulgaris	2.505±0.15	2.321±0.20	2.272±0.12	6.367±0.16
Salmonella typhi	1.758±0.21	1.642±0.18	1.545±0.19	1.845±0.15

Table (5) Antibacterial properties of *Aloe vera* & CdS Nanoparticles .

Strains	No. of cell $\times10^8$			
	Concentration of propolis mg ml^{-1}			
	2	4	5	**Control**
Pseudomonas aeruginosa	2.407±0.24	2.347±0.18	2.272±0.11	5.096±0.18
Proteus vulgaris	2.505±0.25	2.321±0.21	2.272±0.15	6.367±0.16
Salmonella typhi	1.758±0.21	1.642±0.18	1.642±0.15	1.845±0.15

Table (6) Antibacterial properties of CdS Nanoparticles.

Strains	No. of cell $\times10^8$			
	Concentration of propolis mg ml^{-1}			
	2	4	5	Control
Pseudomonas aeruginosa	2.613±0.21	1.691±0.17	1.275±0.21	5.096±0.18
Proteus vulgaris	4.803±0.19	3.270±0.10	1.147±0.12	6.367±0.16
Salmonella typhi	1.766±0.21	1.612±0.19	1.406±0.28	1.845±0.15

CONCLUSIONS

CdS Nano particle was synthesized using chemical method extract of *Aloe vera* leaf. The CdS NPs were characterized by XRD, UV- Visible and AFM measurements. The results suggested that *Aloe vera* plays an important role in the reduction and stabilization of nanoparticles. Study also found that the CdS NPs / *Aloe vera* shows antibacterial activity on both Gram positive and Gram negative bacteria and should be explored further for antimicrobial applications.

REFERENCES

[1].Newton, L.E. Aloes in habitat. In *Aloes* the Genus *Aloe*; Reynolds, T., Ed.; CRC Press: Boca Raton, 3-36, **2004**.

[2].Habeeb, F.; Shakir, E.; Bradbury, F.; Cameron, P.; Taravati, M.R.; Drummond, A.J.; Gray, A.I.; and Ferro, V.A. Screening methods used to determine the anti-microbial properties of *Aloe vera* inner gel. Methods. 42, 315-320**, 2007**.

[3].Ni, Y.; and Tizard, I.R. Analytical methodology: the gel-analysis of aloe pulp and its derivatives. In *Aloes* the Genus *Aloe*; Reynolds, T., Ed.; CRC Press: Boca Raton, 111-126, **2004**.

[4].Ni, Y.; Turner, D.; Yates, K.M.; and Tizard, I. Isolation and characterization of structural components of *Aloe Vera* L. leaf pulp. Int. Immunopharmacol. 4, 1745-1755, **2004**.

[5]. Dagne, E.; Bisrat, D.; Viljoen, A.; and Van Wyk, B-E. Chemistry of *Aloe* species. Curr. Org. Chem. 4, 1055-1078, **2000**.

[6].Eshun, K.; and He, Q. *Aloe vera*: A valuable ingredient for the food, pharmaceutical and cosmetic industries – A review. Crit. Rev. Food Sci. Nutr. 44, 91-96, **2004**.

[7].He, Q.; Changhong, L.; Kojo, E.; and Tian, Z. Quality and safety assurance in the processing of Aloe vera gel juice. Food Control. 16, 95-104, **2005**.

[8].Vinson, J.A.; Al Kharrat, H.; and Andreoli, L. Effect of *Aloe vera* preparations on the human bioavailability of vitamins C and E. Phytomedicine 12, 760-765 , **2005**.

[9].Jing Z., Tan L., Li F., Wang J., Fu Y. and Li Q. Photocatalytic and antibacterial activities of CdS nanoparticles prepared by solvothermal method. Indian J. Chem. 52A, 57-62, **2013**

[10].Khawla S. khashan, Synthesis, structure and optical properties of CdS nanoparticles prepared by chemical method, Eng. &Tech. J. 31(1) ,39, **2013**

[11].Grieve M: A Modern Herbal. Ed. Leyel CF, Jonathan Cape Ltd, London, 26–29, **1975.**

[12].Cao H., Wang G., Zhang S., Zhang X., & Rabinovich D. "Growth and optical properties of wurtzite –type CdS nanocrystals" Inorg. Chem.45(13), 5103,**2006**.

[13].Dwivedi D.K., Ashankar D., & Dubey M., "Synthesis, structural and opticalcharacterization of CdS nanoparticles" J. Ovon. Resea. 6 (1), 57, **2010.**

[14].Singh V., and Chauhan P.," Structural and optical characterization of CdS nanoparticles prepared by chemical precipitation method" J. Phys. Chem. Solid, 70(7), 1074, **2009.**