Synthesis and Characterization of Black Currant Selenium Nanoparticles (Part I)

Masar J Al-Kurdy [1], Khalisa K Khudair [2] and Layla H Al-Kinani [3]

[1]Department of Nursing Techniques, Technical Institute in Al-Diwaniyah, AL-Furat AL-Awsat Technical University, Iraq, [2]Department of Physiology, Biochemistry and Pharmacology, College of Veterinary Medicine, University of Baghdad, Iraq, Discipline of Medical, Molecular and Forensic Sciences and School of Veterinary Medicine, Murdoch University, Murdoch, Western Australia

ABSTRACT

The present study aimed to synthesize selenium nanoparticles (SeNPs) using aqueous extract of black currant as a reducing agent. The green synthesized black currant selenium nanoparticles (BCSeNPs) were identified by color change. The characterization of SeNPs was achieved by Ultraviolet-visible (UV–VIS) spectroscopy, scanning electron microscopy (SEM), X–ray diffraction analysis (XRD), and Fourier transform infrared spectroscopy (FTIR). These tests were used to detect: stability, morphology, size, crystalline nature, and functional groups present on the surface of BCSeNPs. The results revealed appearance of the brick-red color indicating the specific color of selenium nanoparticles, and UV-Vis spectroscopy showed band absorbance at 265 nm of intense surface plasmon resonance manifesting the formation and stability of the prepared BCSeNPs. The SEM image showed the prevalence of spherical selenium nanosized, XRD at 2θ revealed crystallin selenium nanoparticles, the size was in the average of 18-50 nm. Furthermore, FTIR revealed the presence of functional groups of the plant which act as stabilizing and reducing agents. In conclusion, the aqueous black currant extract can act as a reducing and capping agent to synthesize BCSeNPs in nano-scale size by a simple method.

Keywords: Black currant extract, selenium, nanoparticles, XRD, SEM, FTIR

Introduction

Nanotechnology sciences allow to improve the experimental practice of the nanoscale constituent's preparation with exceptional possessions (1). Today, the production of nanoparticles (NPs) using biosynthetic techniques has been considered as a valuable method with increased attraction (2, 3). SeNPs could be chemically (4) or physically (5) synthesized. Moreover, it can even be obtained by the biological way, using microorganisms or extracts of different plants (6, 7). Chemically synthesized SeNPs were prepared by reduction of the selenious acid solution using ascorbic acid in the presence of polysaccharides such as acacia gum; glucomannan as well as carboxy methyl cellulose (8, 9). Besides, SeNPs could be synthesized via different Gram-negative (10, 11), Gram-positive (12) bacteria or fungi (13, 14). In the green synthesis of SeNPs, many plant extracts were used as reducing agents including tea extract (15), *Allium sativum* (16), ferulic acid (17), and *Clausena dentata* plant leaf extract (18). Besides, spherical SeNPs (size range of 13-18 nm) can be synthesized using dried fruit extract of *Vitis vinifera* (**19**). However, many disadvantages due to using chemical or physical methods of SeNPs have been identified, such as extreme temperature, high pH, environmental pollution, as well as they are very expensive methods (20, 21). On the contrary, using plant extract (green method) for biosynthesis of nanomaterials has been pointed to possess many advantages compared to biological methods, e.g. it is inexpensive and no special conditions were required (6, 22). According to great amount of active ingredients that act as inducing agents in the black currant, such as flavonoids, polyphenol, lignin's, and sugar, this study aimed to synthesize and characterize selenium nanoparticles (SeNPs)

*Correspondence: rosmaso@yahoo.com.
Department of Nursing Techniques, Technical Institute in Al-Diwaniyah, AL-Furat AL-Awsat Technical University, Iraq. Received: 7 May 2020, Accepted: 16 August 2020, Published: 28 December 2020.

DOI: https://doi.org/10.30539/ijvm.v44i2.974

through a biogenic method using aqueous black currantextract.

Materials and Methods

Black currant without seed (Vitis vinifera) was purchased from the local market of AL- Diwaniya, Iraq. The rating of black currant was done by the Ministry of Agriculture/ Stat Board for seed testimony in Abu Graib/ Baghdad.

The biogenic synthesis and characterization of SeNPs depended on using black currant aqueous extract without seeds. About 100 gm of black currant without seed was washed with distilled water several times and dried at 40°C (incubator) and grinded by blender. A solution of 10 gm of black currant in 100 mL distilled water was prepared and stirred at 45-50 °C for 10-20 min by magnetic hotplate stirrer, and then left at room temperature overnight. The solution was centrifuged at 1000 rpm for 15 min. Whatman® filter paper No.4 was used for separation and filtration of the supernatant. Centrifugation and filtration were repeated twice (23,24). Green synthesis of SeNPs using black currant aqueous extract was prepared as described by (25-27). The 0.1 M of sodium selenite was mixed with black currant extract in a volume ratio of 1:2 with adjustment of reaction medium pH to 8 by using 1 N of NaOH. The mixture was stirred via magnetic stirrer (600 rpm) at 60-65 ºC for 12 hours in the darkness. The solution was kept overnight, and observed for the formation of red brick color. Color changes occurred due to the reduction of $NaHSeO_3$ to selenium nanoparticles (BCSeNPs). The formation of SeNPs was markedly determined by the appearance of a red brick color. Separation of precipitate from the total solution was done by using high speed cold centrifuge at 15,000 rpm/30 min at 4 ºC. The obtained pellet was then resuspended in deionized water and centrifuged again under the same conditions. This process was repeated three times to remove the organic impurities that exist in BCSeNPs colloid and dried incubator at 45 ºC. Characterization of black currant SeNPs (BCSeNPs) was performed by: Ultraviolet–visible spectroscopy (UV-VIS), in which the bio-reduction property of black currants in the synthesis of SeNPs was investigated by UV-VIS spectrum (Metertech SP-8001 Taiwan), which is a significant technique to authenticate the formation and stability of BCSeNPs in the colloid as described by (28, 29). Furthermore, SEM technique (SEM-Tescan Vega III, Czech) was used to investigate the shape and size of the synthesized BCSeNPs as described by (30), and X-ray diffraction (Shemadzu-6000 Japan) was also used to determine the crystalline amorphous of BCSeNPs as describe by (31, 32). Fourier-transform infrared spectroscopy (Shemadzu-8400s, Japan) was used for detecting the functional groups in the biological compound involved in the reactions of nanoparticles synthesis as described by (33, 34).

Results and Discussion

Synthesis and characterization of BCSeNPs revealed brown color after 30 min and changed gradually to red-brownish color after 72 hours, later, the color became more stable (Figure 1). The biogenic synthesized SeNPs were proven via conversion of the colorless selenious acid to brick red color due to the possibility of conversion of multi-oxidized forms of selenium (Se^{-2}, Se^{+2}, Se^{+4} and Se^{+6}) to Se^{0} (35). Encapsulations of Se0 to organic molecules from the black currant give stabilization to these nanoparticles. The color change upon the addition of selenium selenite to the black currant extract was considered as an indication of SeNPs synthesis (36). This result has been previously obtained by many researchers using different types of green plants (37-40). The characteristic color was attributed to the excitation of the surface plasmon resonance (SPR) (41). The high ability of plants extracts to synthesize SeNPs was attributed to their high content of phenol and flavonoids, in addition to potent reduction capacity (39). The optical absorbance of synthesized BCSeNPs was measured using UV-Vis spectroscopy. An absorption peak between 265-370 nm confirms the presence of BCSeNPs (Figure 2). This absorbance indicated the formation of conjugated compounds, which appeared as indicator to the formed SeNPs. The bio-reduction property of black currants in the synthesis of SeNPs was investigated by UV-VIS spectrum, which is a significant technique to authenticate the stability and formation of BCSeNPs in the solution. The most well-defined peak at 265 nm represents the SPR of BCSeNPs. The current result is in agreement with the previous studies (42-44) using different types of bacteria and fungi. Concerning SPR, it has been reported that the smallest molecules give the highest peak at UV

spectroscopy between 280-320 nm (19). The current result was correlated with UV-visible spectra of SeNPs synthesized using orange peel aqueous extract (peak 265.5 nm) and the leaf of Petroselinum crispum (peak 270 nm) (45, 46).

While Menon and his colleagues (39) synthesized SeNPs using Zingiber officinalea reducing agent, where the peak value was between 370 and 420 nm that represent SPR. The spherical shape of BCSeNPs was observed according to SEM image with a diameter ranged from 18 to 50 nm with an average diameter size of 27.10±1.56 nm in an electron microscope (Figure 3; Histogram 1). The green synthesized SeNPs using black currant extract showed spherical amorphous NPs with different sizes between 18-50 nm. Spherical SeNPs were synthesized in a range of 30-50 nm (47, 48) and 97 nm size (49). Spherical shaped SeNPs was also documented by (50) and (39) with size range of 50-100 and 100-150 nm, respectively. Another author reported 30–40 nm as a range size of SeNPs (51). Black currant polyphenols were found to play a great role in particles size and the final structure of SeNPs dependent on pH, selenium salt molarity, reaction temperature, and reaction time, this result coincides with that of another study (52). In addition, SeNPs aggregation was prevented by organic compounds present in the blank current extract leading to stabilizing SeNPs (53). The usage of raisin or dried V. vinifera in the green synthesis of SeNPs was attributed to its contents of phenols and flavonoids, sugar, iron, calcium and potassium and some vitamins (54). In the current study, a pattern of X-ray diffraction peaks at theta angle-2 value of 14.421, 17.941, 24.542 and 29.972, respectively, correspondent to hkl values of 110, 101, 102, and 100 crystal planes, were observed (Figure 4). According to the results of XRD analysis in the current study, the physical characteristic of the particles in the prepared compounds is spherical and crystalized nanoparticles. The size of crystal was in a range of 18 to 50 nm**.** To clarify the crystalline nature of selenium nanoparticles, XRD analysis was applied, where the result showed different broad diffraction peaks at the lower angle, which goes in line with (55) and (56) using different plant extracts and with (19) and (57) using raisin.

F-TIR spectroscopy for selenium nanoparticles (Figure 5) showed a distinct peak of BCSeNPs at 3352.39 cm^{-1}corresponding to OH: NH due to Stretch Vibrationin Amide A. While an absorption peak at 2931.90 cm-^{1} corresponded to C-H in -CH_2 in aliphatic compounds, the band at 1608.69cm^{-1} indicated NH_2 in primary amides. The peak at 1514.17 cm^{-1} is due to NH in secondary amides (AmideII). The peak at 1359.86 cm^{-1} attributed to the C-H bending in alkanes. However, the peaks at 1066.67 and 1035.81 cm^{-1} confirmed C–O, C–C Stretching Vibrations, C–O–H, C–O–C bending vibrations in polysaccharides, protein and polyesters. C–X stretching in alkyl halides causes a band at 871.85 and 835.21 cm^{-1}. The bands at 590.24 and 547.80 cm^{-1}were due to C–N–C bending in amines (58-60). The appearance of many peaks in green synthesized SeNPs indicates different vibrations due to different IR absorption, which is in accordance with (61, 62). Also, the characterization of selenium nanoparticles from V. viniferausing FTIR was clarified by (19), who demonstrated the presence of different peaks due to the occurrence of different active components of this plant, which acts as reducing agent. As well as, the presence of lignin in raisin could be claimed by (63), where lignin could be responsible for stabilization of the nanoballs, and this was previouslysuggested by (64). Chen and his colleagues (65) documented that in green synthesis of SeNPs, a high concentration amount of sugars present in dried V. vinifera, such as fructose and glucose, could act as reducing agents. Many amorphous and crystalline forms of selenium can be exist, however the structure, size and shape of SeNPs depend on temperature, concentration, PH, as well as the nature of biomolecules (42, 66). In conclusion, it seems that the best conditions for synthesizing selenium nanoparticles using aqueous black currant extract as a reducing agent were under alkaline pH (pH 9) and range of temperature between (60-65 ºC). This technique can be considered as a good source to synthesize stable SeNPs in lesser time and cost.

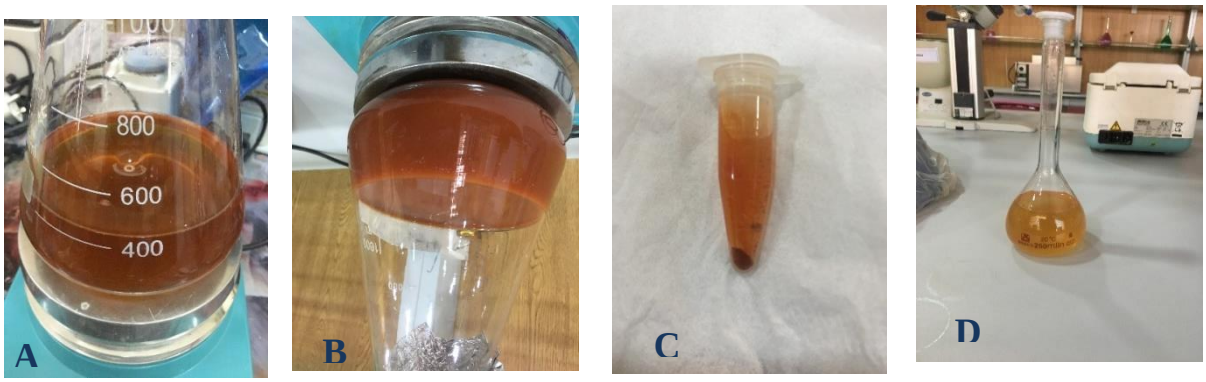


Figure 1. Changing the color after the reduction of sodium selenite to BCSeNPs using black currant extract. A: Image shows black currant aqueous extract, B: Image showed mixture of sodium selenite and black currant extract, C: Image showesBCSeNPs after 48-72 hour, D: Image shows BCSeNPs after centerfication

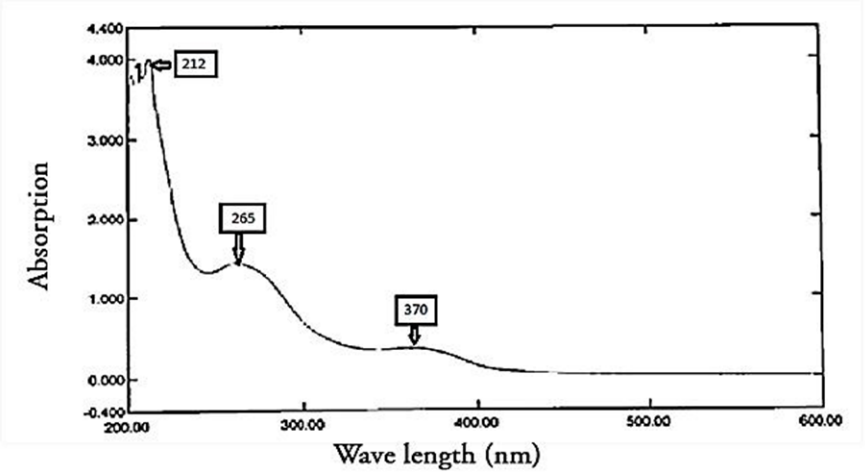


Figure 2. UV-Vis spectroscopy shows absorbance of selenium nanoparticles made from sodium selenite with black currant extract in PH 9

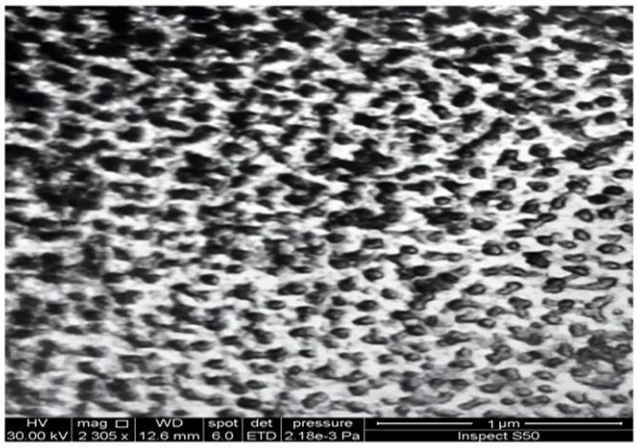
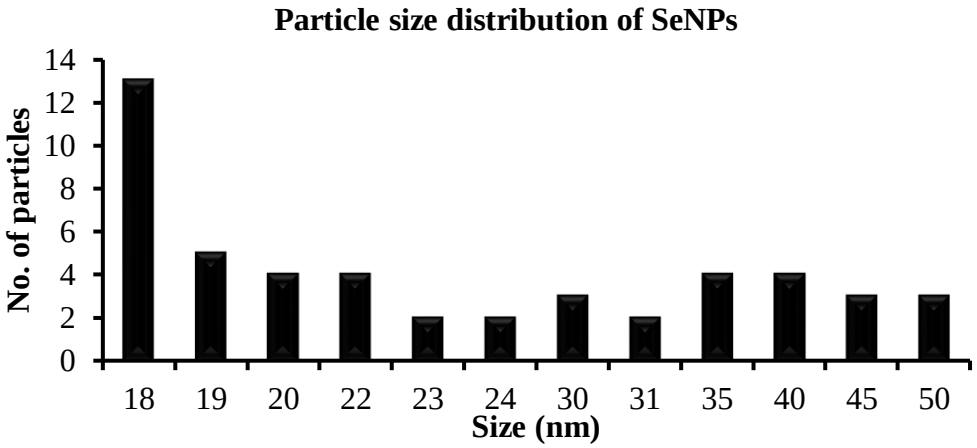


Figure 3. SEM image (1µm) of the selenium nanoparticles made from sodium selenite with black currant extract in percentage 1:2, v: v ratio in PH 9



Histogram 1. Diameter distributions of SeNPs

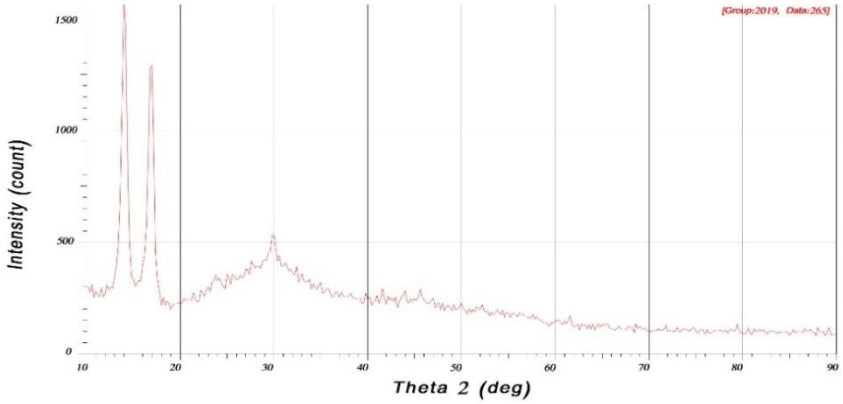


Figure 4. X-ray diffraction pattern for selenium nanoparticles made from sodium selenite with black currant extract in PH 9

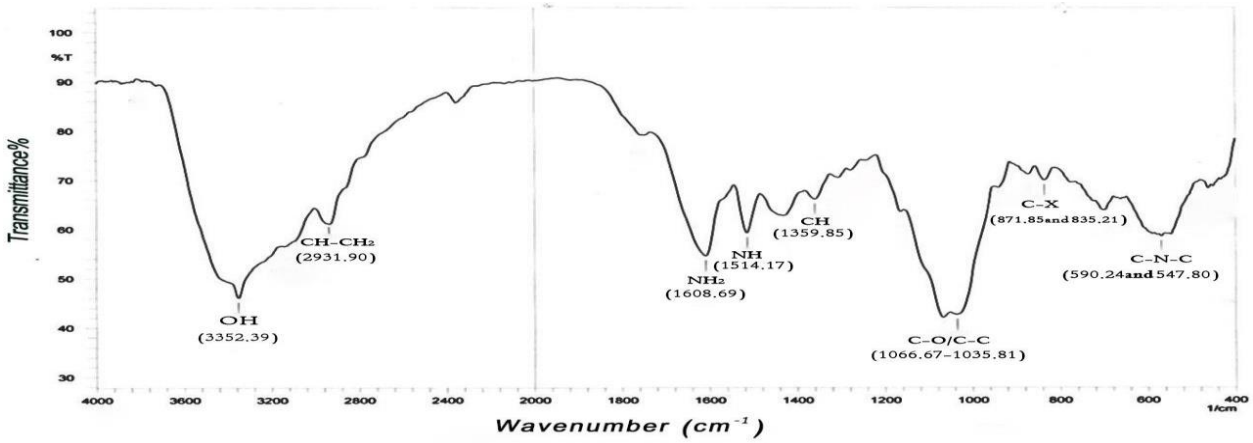


Figure 5. FT-IR spectroscopy for selenium nanoparticles made from sodium selenite with black currant extract in PH 9

Acknowledgements

Authors would like to express sincere gratitude to the College of Veterinary Medicine /University of Bagdad for supporting this work.

Conflicts of interest

The authors declare that there is no conflicts of interest.

References

1. Prasad M,Lambe UP, Brar B, Shah I,Manimegalai J, Ranjan K**,** *et al*. Nanotherapeutics: an insight into healthcare and multi-dimensional applications in medical sector of the modern world. Biomed. Pharmacother. 2018;97: 1521-37.
2. Ebrahimi K, Shiravand S, Mahmoud H. Biosynthesis of copper nanoparticles using aqueous extract of Capparis spinosa fruit and investigation of its antibacterial activity. Marmara Pharm J. 2017;21(4): 866- 71.
3. Khatami M, Amini E,Amini A, Mortazavi SM, Kishani Farahani Z, Heli H. Biosynthesis of silver nanoparticles using pine pollen and evaluation of the antifungal efficiency. Iran J Biotechnol.2017;15: 1–7.
4. Zhang SY, Zhang J, Wang HY, Chen HY. Synthesis of selenium nanoparticles in the presence of polysaccharides. Mater Lett. 2004;58(21):2590–94.
5. Quintana M,Haro-Poniatowski E, Morales J, Batina N. Synthesis of selenium nanoparticles by pulsed laser ablation. Appl Surf Sci.2002; 195(1):175–186.
6. Ramamurthy CH, Sampath KS,Arunkumar P, Kumar MS, Sujatha V,PremkumarK**,** *et al*. Green synthesis and characterization of selenium nanoparticles and its augmented cytotoxicity with doxorubicin on cancer cells. Bioprocess Biosyst Eng. 2013;36(8):1131–39.
7. Shoeibi S, Mashreghi M.Biosynthesis of selenium nanoparticles using Enterococcus faecalis and evaluation of their antibacterial activities. J Trace Elem Med Biol.2017; 39:135–39.
8. Agnihotri SA, Mallikarjuna NN, Aminabhavi TM. Recent advances on chitosan-based micro- and nanoparticles in drug delivery. J Control Release.2004;100(1):5–28.
9. Saini D, Fazil M, Ali MM, Baboota S,Ameeduzzafar A, Ali J. Formulation, development and optimization of raloxifene-loaded chitosan nanoparticles for treatment of osteoporosis. Drug Deliv.2015; 22(6):823–836.
10. Dwivedi S,AlKhedhairy AA, Ahamed M,Musarrat J. Biomimetic synthesis of selenium nanospheres by bacterial strain JS-11 and its role as a biosensor for nanotoxicity assessment: a novel Se-bioassay. PLoS One. 2013;8(3): 57404.
11. Kazempour ZB,Yazdi MH,Rafii F, Shahverdi AR. Sub-inhibitory concentration of biogenic selenium nanoparticles lacks post antifungal for *Aspergillus niger* and *Candida albicans* and stimulates the growth of *Aspergillus niger*. Iran J Microbiol.2013; 5(1):81–85.
12. Domokos-Szabolcsy E, Marton L, Sztrik A, Babka B, Prokisch J, Fari M. Accumulation of red elemental selenium nanoparticles and their biological effects in *Nicotinia tabacum*. Plant Growth Regul.2012;68:525–31.
13. Forootanfara H, Zare B,Fasihi-Bam H, Amirpour-Rostami S, Ameri A,Shakibaie M, *et al*.Biosynthesis and characterization of selenium nanoparticles produced by terrestrial actinomycete *Streptomyces microflavus* strain FSHJ31. Res Rev J Microbiol Biotechnol.2014; 3(1):47–53.
14. Ahmad M, Yasser M,Sholkamy E, Ali A,Mehanni M. Anticancer activity of biostabilized selenium nanorods synthesized by *Streptomyces bikiniensis* strain Ess_amA-1. Int J Nanomedicine. 2015; 10:3389–3401.
15. ZhangW, Zhang J, Ding D, Zhang L,Muehlmann LA, DengSE, *et al*. Synthesis and antioxidant properties of *Lycium barbarum* polysaccharides capped selenium nanoparticles using tea extract. Artif Cells Nanomed Biotechnol.2017;46(7):1463-1470.
16. Ezhuthupurakka lPB, Polaki LR, Suyavaran A,Subastri A, Sujatha V,Thirunavukkarasu C. Selenium nanoparticles synthesized in aqueous extract of *Allium sativum* perturbs the structural integrity of calf thymus DNA through intercalation and groove binding. Mater Sci Eng C Mater Biol Appl.2017; 74:597–608.

17. Cui D, Yan C, Miao J, Zhang X, Chen J, Sun L**,** *et al*. Synthesis, characterization and antitumor properties of selenium nanoparticles coupling with ferulic acid. Mater Sci Eng C. 2018; 90: 104-112.

18. Sowndarya P, Ramkumar G, Shivakumar M. Green synthesis of selenium nanoparticles conjugated *Clausena dentata* plant leaf extract and their insecticidal potential against mosquito vectors. Artif Cells Nanomed Biotechnol.2016; 45(8): 1490–1495.

19. Sharma G, Sharma AR, Bhavesh R, Park J, Ganbold B, Nam JS, *et al*. Biomolecule-mediated synthesis of selenium nanoparticles using dried *Vitis vinifera* (raisin) extract. Molecules.2014;19:2761–70.

20. Iranifam M, FathiniaM, Rad TS, Hanifehpour Y, Khataee AR, JooSW. A novel selenium nanoparticles-enhanced chemiluminescence system for determination of dinitrobutylphenol. Talanta. 2013;107: 263–269.

21. Paulraj S, Kumar MS. Biofortification of Food Crops. 8th. New Delhi; Springer. 2016. Chapter 22, Selenium bioavailability through microbes; p.303-316.

22. Ali ZS, Khudiar kk. Synthesis, characterization of silver nanoparticles using *Nigella sativa* seeds and study their effect on serum lipid profile and DNA damage in blood of hydrogen peroxide treated rats. (Part I). Iraqi J. Vet. Med. 2019; 43(2): 23-37.

23. Mahmood MS, Gilani AH, Khwaja A, RashidA, AshfaqMK. The *in vitro* effect of aqueous extract of *Nigella sativa* seeds on nitric oxide production. Phytother Res.2003;17(8): 921-924.

24. Awan MA, AkhterS, Husna AU, Ansari MS,RakhaBA, AzamA,*et al.*Antioxidant activity of *Nigella sativa* seeds aqueous extract and its use for cryopreservation of buffalo spermatozoa. Andrologia. 2018;50(6): e13020.

25. Gottimukkala K, Harika R, Deeveka Z.Green synthesis of iron nanoparticles using green tea leaves extract. J Nanomedine Biotherapeutic Discov. 2017; 7: 1 – 5.

26. Kaikai B,Bihong H,Jianlin H,Zhuan H, Ran T. Preparation and antioxidant properties of selenium nanoparticles-loaded chitosan microspheres. Int J Nanomedicine. 2017;12: 4527–4539.

27. Wang Z, Cheng F, Mallavarapu M. Characterization of iron polyphenol nanoparticles synthesized by three plant extracts and their fenton oxidation of azo dye. ACS Sustain Chem Eng.2014; 2 (4): 1022–1025.

28. Mittal AK,Chaisti Y, Banerjee UC.Synthesis of metallic nanoparticles using plant extracts. Biotechnol. Adv.2013. 31:346-356.

29. Banerjee P, Satapathy M,Mukhopahayay A. Das P. leaf extract mediated green synthesis of silver nanoparticles from widely available indian plants: synthesis, characterization, antimicrobial property and toxicity analysis. Bioresour Bioprocess. 2014;1: 3.

30. Mittal AK, Tripathy D, Choudhary A, Aili PK, ChatterjeeA, Singh IP. Biosynthesis of silver nanoparticles using *Potentilla fulgens* Wall. ex Hook. and its therapeutic evaluation as anticancer and antimicrobial agent. Mater Sci Eng C.2015; 53:120–127 .

31. Rolim WR, Pelegrino MT, de Araújo Lima B, Ferraz LS, Costa FN,Bernardes JS.Green tea extract mediated biogenic synthesis of silver nanoparticles: Characterization, cytotoxicity evaluation and antibacterial activity. Appl Surf Sci.2019; 463:66–74 .

32. Rietveld HA. Profile refinement method for nuclear and magnetic structures. JAppl Crystallogr.1969; 2:65-71.

33. Holzwarth U, Gibson N. The scherrer equation versus the Debye-Scherrer equation. Nat Nanotechnol.2011; 6:534.

34. Khoshnamv M, Huo C, Liu J. Silver nanoparticles synthesis using *Allium ampeloprasum* L. leaf extract: characterization and performance in catalytic reduction

of 4-nitrophenol and antioxidant activity. J. Mol. Struct.2018; 1175:90-96.

35. Torres SK, Campos VL, León CG, Rodríguez-Llamazares SM, Rojas SM, González M ,*et al*. Biosynthesis of selenium nanoparticles by *Pantoe aagglomerans* and their antioxidant activity. J Nanopart Res. 2012;14 (11):1236.

36. BajajM, Schmidt S, WinterJ. Formation of Se (0) nanoparticles by *Duganella*sp. and *Agrobacterium* sp. isolated from Se-laden soil of North-East Punjab, India.Microb. Cell Fact. 2012;11(1):64.

37. Cui D, LiangT, Sun L, Meng L, Yang C, Wang L, *et al.* Green synthesis of selenium nanoparticles with extract of hawthorn fruit induced HepG2 cells apoptosis. Pharmaceutical Biology.2018; 56(1): 528–534.

38. AL-Taie AT. Physiological Role of Propolis Biogenic Selenium Nanoparticles on Intestinal Homeostasis of Heat Stressed Rats [Dissertation]. Baghdad, Iraq: university of Baghdad; 2019.

39. Menon S, KS SD, Agarwal H, Shanmugam VK. Efficacy of biogenic selenium nanoparticles from an extract of ginger towards evaluation on anti-microbial and anti-oxidant activities. Colloid Interface Sci Commun.2018; 29:1-8.

40. Sofer Z, Bartůněk V, Junková J, Ulbrich P, Babuněk M, Kuchař M. Synthesis of spherical amorphous selenium nano and microparticles with tunable sizes, Micro Nano Lett. 2016;11:91–93

41. Wang T, Yang L, Zhang B, Liu J. Extracellular biosynthesis and trans-formation of selenium nanoparticles and application in H_2O_2 biosensor. Colloids Surf B Bio-interfaces. 2010;80(1): 94–102.

42. Fesharaki P, Nazari P, Shakibaie M, Rezaie S, Banoee M, Abdollahi M. Biosynthesis of selenium nanoparticles using *Klebsiella pneumoniae* and their recovery by a simple sterilization process. Braz. J. Microbiol. 2010; 41: 461–466.

43. Zhang W, Chen Z, Liu H, Zhang L, Gao P, Li D. Biosynthesis and structural characteristics of selenium nanoparticles by *Pseudomonas alcaliphila*. Colloids Surf B.2011; 88:196–202.

44. Harikrishnan H, Abdullah N, Ponmurugan K, Shyam R. Microbial synthesis of selenium nanocomposite using *Saccharomyces cerevisiae* and its antimicrobial activity against pathogens causing nosocomial infection. Chalcogenide Lett.2012; 9: 509–515.

45. Sasidharan S, Sowmiya R, Balakrishnaraja R.Biosynthesis of selenium nanoparticles using citrus reticulata peel extract. World J. Pharm. Res.2014; 4: 1322-1330.

46. Fritea L, Laslo V,Cavalu S, Costea T,Vicas SI.Green biosynthesis of selenium nanoparticles using parsley (petroselinum-crispum) leaves extract. Studia Univ. VG, SSV.2017; 27(3): 203-208.

47. Bunglavan SJ, Garg AK, Dass RS, Shrivastava S. Effect of supplementation of different levels of selenium as nanoparticles/sodium selenite on blood biochemical profile and humoral immunity in male Wistar rats. Vet World. 2014; 7(12):1075-1081.

48. Riva B, Bellini M, Corvi E, Verderio P, Rozek E,Colzani B, *et al*. Impact of the strategy adopted for drug loading in nonporous silica nanoparticles on the drug release and cytotoxic activity. J Colloid Interface Sci.2018; 519:18-26.

49. Gautam PK, Kumar S,Tomar MS, Singh RK, Acharya A, Ram B. Selenium nanoparticles induce suppressed function of tumor associated macrophages and inhibit Dalton's lymphoma proliferation. BiochemBiophys Rep.2017; 12:172-184.

50. Bai K, Hong B, Huang W, He J. Selenium-nanoparticles-loaded chitosan/chito oligosac-charide microparticles and their antioxidant potential:a chemical and *in vivo* investigation. Pharmaceutics.2020; 12(1), 43.

51. Bhattacharjee A,Basu A, Ghosh P, Biswas J, Bhattacharya S. Protective effect of selenium nanoparticle against cyclophosphamide induced hepatotoxicity and genotoxicity in swiss albino mice. J Biomater Appl. 2014; 29(2): 303-317.

52. Razi MK, Maamoury RS, Banihashemi S. Preparation of nanoselenium particles by water solution phase method from industrial dust. dust. Int. J. Nano. Dim.2011; 1(4):261–7.

53. Suresh D, Nethravathi PC, Udayabhanu H, Rajanaika H, Nagabhushana H, Sharma SC. Green synthesis of multifunctional zinc oxide nanoparticles using *Cassia fistula* plant extract and their photodegradative, antioxidant and antibacterial activities. Mater Sci Semicond Process. 2015; 31: 446–454.

54. Wu CD.Grape products and oral health. J Nutr.2009; 139(9): 1818S-1823S.

55. Ingole A, Thakare S, Khati N, Wankhade A, Burghate D. Green synthesis of selenium nanoparticles under ambient condition. chalcogenide Lett. 2010; 7:485-489.

56. Saratale RG, Benelli G, Kumar G, Kim DS, Saratale GD. Bio-fabrication of silver nanoparticles using the leaf extract of an ancient herbal medicine, dandelion (*Taraxacumofficinale)*, evaluation of their antioxidant, anticancer potential, and antimicrobial activity against phytopathogens. Environ Sci Pollut Res.2017; 25(11):10392–10406.

57. Sarkar B, Bhattacharjee S, Daware A, Tribedi P, Krishnani KK, Minhas PS. Selenium nanoparticles for stress-resilient fish and livestock. Nanoscale Res Lett.2015; 10(1): 371.

58. Kamnev AA, Mamchenkova PV, Dyatlova YA, Tugarova AV. FTIR spectroscopic studies of selenite reduction by cells of the rhizobacterium *Azospirillum brasilense* Sp7 and the formation of selenium nanoparticles. J Mol Struct.2017;1140: 106-112.

59. Tugarova AV,Mamchenkova PV,Dyatlova YA,Kamnev AA. FTIR and Raman spectroscopic studies of selenium nano-particles synthesised by the bacterium *Azospirillum thiophilum*. Spectrochim Acta A Mol BiomolSpectrosc. 2018; 192: 458-463.

60. Alagesan V, Venugopal S. Green synthesis of selenium nanoparticle using leaves extract of *withania somnifera* and its biological applications and photocatalytic activities. Bionanoscience. 2019; 9(1): 105-116.

61. Xu C, Zhang S, Chuang C, Miller E, Schwehr K, Santschi P. Chemical composition and relative hydrophobicity of microbial exopolymeric substances (EPS) isolated by anion exchange chromatography and their actinide binding affinities. Marine Chemistry. 2011;126: 27–36.

62. Wang L, Wang L, Ren X, Ye X, Li W, Yuan S, *et al*. pH dependence of structure and surface properties of microbial EPS. Environ. Sci. Technol.2012; 46: 737–744.

63. Arias MC. Binderless fiberboard production from *Cynara cardunculus* and *Vitis vinifera* [Dissertation]. Tarragona and Reus,Spain: UniversitatRoviraiVirgili; 2008.

64. Coccia F,Tonucci L, Bosco D,Bressand M, D'Alessandro N. One pot synthesis of lignin-stabilized platinum and palladium nanoparticles and their catalytic behavior on oxidation and reduction reactions. Green Chem.2012; 14:1073–1078.

65. Chen A, Shin D, Nam J, Kwon K, Yoo J. Selenium nanowires and nanutubes synthesized via a facile template-free solution method. Mater Res Bull. 2010;45: 699–704.

66. Yu Y, Bai F, Wang W, Liu Y, Yuan Q,Qu S,*et al*. Fibroblast growth factor 21 protects mouse brain against d-galactose-induced aging via suppression of oxidative stress response and advanced glycation end products formation. Pharmacol Biochem Behav.2015; 133, 122-131.

تصنيع وتشخيص جسيمات السيلينيوم النانوية باستخدام الزبيب الاسود (الجزء الاول)

مسار جبار جري الكردي[1]، خالصة كاظم خضير [2]، ليلى الكناني[3]

[1] قسم تقنيات التمريض، المعهد التقني في الديوانية، جامعة الفرات الاوسط التقنية، العراق
[2] فرع الفسلجة والكيمياء الحياتية والادوية، كلية الطب البيطري، جامعة بغداد، العراق
[3]تخصص العلوم الطبية والجزيئية والطب الشرعي، كلية الطب البيطري، جامعة مردوخ، مردوخ، غرب أستراليا

الخلاصة

هدفت الدراسة الحالية الى تصنيع جسيمات السيلينيوم النانوية باستخدام المستخلص المائي للزبيب الأسود كعامل اختزال. التصنيع الحيوي لجسيمات السيلينيوم النانوية المرتبطة مع الزبيب الاسود تم تمييزه بواسطة تغيرات اللون. تم تشخيص جزيئات السيلينيوم النانوية باستخدام التحليل الطيفي المرئي للأشعة فوق البنفسجية ، تقنيات الفحص المجهري الإلكتروني , تحليل حيود الأشعة السينية ,التحليل الطيفي بالأشعة تحت الحمراء. تم استخدام هذه الاختبارات لمعرفة مايلي على التوالي و الثبات، الشكل، الحجم، الطبيعة البلورية والمجاميع الفعالة الموجودة في جسيمات السلينيوم النانوية المصنعة بإستخدام الزبيب الأسود .أظهرت النتائج ظهور لون أحمر قرميدي المميز لجسيمات السيلينيوم النانوية، اما مطياف الأشعة فوق البنفسجية- المرئية أظهرت الامتصاصية عند الحزمة 265 نانومتر من رنين البلازمون المكثف على السطح، والذي يتجلى في تكوين واستقرار جسيمات السلسنيوم النانويه المحضرة ،أظهرت صورة المجهر الألكتروني انتشار بلورات السيلينيوم الكروية، وكان حيود الأشعة السينية عند الزاوية 2 كشف جسيمات السلينيوم النانوية البلورية, الحجم كان بحدود 18-50 نانوميتر.علاوة على ذلك، فقد كشف فحص التحليل الطيفي بالأشعة تحت الحمراء ظهور المجاميع الفعالة للنبات والتي تعمل كعوامل اسقرار واختزال. نستنتج من الدراسة ان مستخلص الزبيب الأسود المائي يعمل كعامل اختزال يستخدم في تخليق جسيمات السلينيوم النانوية بحجم نانو وطريقة بسيطة.

الكلمات المفتاحية: مستخلص الزبيب الأسود، السيلينيوم، الجسيمات النانوية، التصنيع الحيوي.