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Characterization and Antioxidant Activity of Platinum Nanoparticles Synthesized by Using *Cetraria Islandica* Extract

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ABSTRACT

Platinum nanoparticles (Pt NPs) have structural properties that differ from their bulk forms, such as physical and chemical properties. The cost and toxicity problems caused by the synthesis of Pt NPs, which are widely used in biomedical fields, by laser ablation, aerosol, sol-gel, co-precipitation, and chemical reduction techniques are eliminated by the biological synthesis method. In this study, the biosynthesis of Cetraria islandica extract based Pt NPs was performed in PBS buffer (pH 7.4) and their antioxant activity was evaluated. With FE-SEM images, it was observed that Pt NPs had a spherical structure, aggregation tendency and an average diameter of 62 nm. The presence of Pt in the structure of NPs was observed by EDX analysis. With the peaks obtained by FT-IR analysis, the presence of C=O (amide), C-O (aliphatic ether), CO-O-CO (anhydride), C=C (alkene) and Pt were recorded and biomolecular groups that play a role in the synthesis were revealed. It was determined that Pt NPs synthesized via C. islandica extract had antioxidant activity (92.4 ug/ml, R2=0.8727). As a conclusion, biosynthesis of Pt NPs with C. islandica extract was carried out as an alternative to physical and chemical methods, and its antioxidant activity was revealed. It is thought that the obtained data can be used in biomedical fields.

KEYWORDS: Cetraria islandica; Pt Nanoparticles; Antioxidant activity.

INTRODUCTION

The fact that nanoparticles (NPs) exhibit different physical, chemical and biological properties from bulk forms due to their morphological and structural properties has attracted the attention of researchers to this point. Platinum NPs (Pt NPs) have application potential in electronics, petrochemica, catalyst, automobiles, photonics, optics, sensors, biomedicine, and pharmaceutics. Pt NPs, which are widely used, are synthesized via tradational methods such as vapor deposition, flame pyrolysis, laser ablation, deposition, arc discharge, milling (physical methods), sol-gel process, chemical vapor deposition, pyrolysis, microemulsion, hydrothermal and, polyol (chemical methods). However, these methods involve undesirable conditions such as high energy and cost requirements and the use of harmful chemicals [1].

In recent years, the biological synthesis method, which has emerged with the claim of clean, biocompatible, non-toxic and eco-friendly, has attracted the attention of researchers to this point due to the advantages it provides and the biosynthesis of various metallic NPs has taken its place in the literature. Mavukkandy et al. (2016) synthesized 35 nm Pt NP with Lantana camara extract [2]. Fahmy et al. (2021) demonstrated the potential antitumor activity of Pt NPs synthesized with Peganum harmala extract [3]. Ayguna et al. (2020) noted the antimicrobial and anticancer activity of Pt NPs synthesized with black cumin seed extract [4]. Soundarrajan et al., (2012) suggested that Pt NPs synthesized with Ocimum sanctum extract can be used in water electrolysis applications [5]. Sahin et al., (2018) reported cytotoxicity of Pt NPs synthesized with pomegranate extract against MCF-7 cell line [6]. Sheny et al., (2013) determined that Pt NPs synthesized with Anacardium occidentale leaf extract exhibit catalytic activity [7]. Ghosh et al., (2015) reported that Pd-Pt bimetallic nanocomposites synthesized with Dioscorea bulbifera extract exhibit antioxidant activity [8]. In addition, biosynthesis of Azadirachta indica [9], Diopyros kaki [10], Cochlospermum gossypium [11] extracts based Pt NPs are available in the literature.

This study aimed to, i) synthesize the Cetraria islandica extract based Pt NPs for the first time. (ii) antioxidant activity of Cetraria islandica based Pt NPs.

MATERIALS AND METHODS

Green synthesis of Pt NPs

(Pt NPs) synthesized according to previous studies with modifications [10]. For the obtain extract of *Cetraria islandica*, approximately 10 g of lichen samples were infused for 1 h in 100 ml of distilled water and filtered. Pt NP synthesis was carried out as a result of the reaction at 80 ^{o}C by adding 1 ml of extract, and 32 mg Hexachloroplatinic acid ($H_2PtCl_6.6H_2O$) to 20 ml of Phosphate-buffered saline (PBS) (pH 7) containing 1 ml of formic acid. Particles dried after centrifugation were used in characterization studies. Field Emission Scanning Electron Microscopy (FE-SEM), Energy Dispersive Spectroscopy (EDX), and Fourier-transform infrared spectroscopy (FT-IR) analysis, respectively used to determine the morphology, elemental analysis, and functional groups.

Determination of Antioxidant Activity

The antioxidant activity of *Cetraria islandica* -based Pt NPs was determined by their 2,2-diphenyl-1-picrylhydrazyl (DPPH) scavenging ability. Measurements were made with measurements recorded at 515 nm in the spectrophotometer. For this purpose, the method applied by Dorbucka (2018) and given in detail was used [12].

RESULTS AND DISCUSSION

Characterization of Pt NPs

When the morphological characters of Pt NPs evaluated with FE-SEM images were examined, it was observed that the NPs had an average diameter of 62 nm, tended to aggregation and had a spherical structure (Figure 1). Mohammed et al., (2022) determined the mean diameter of Pt NPs synthesized with oliva leaf extract at 9.2 nm [13]. While the sizes of Pt NPs synthesized with tea and Atriplex halimus extracts were determined at 2.7 nm and 1-3 nm, respectively; the size of Ag NPs synthesized with tea extract was determined at 15-33 nm, and the average diameter of Au NPs synthesized with Atriplex halimus extract was determined at 2-10 nm [14-17]. According to this research data, the morphological properties such as size of the NPs obtained by the biosynthesis process are related to the reducing bioagent and the reduced metal.

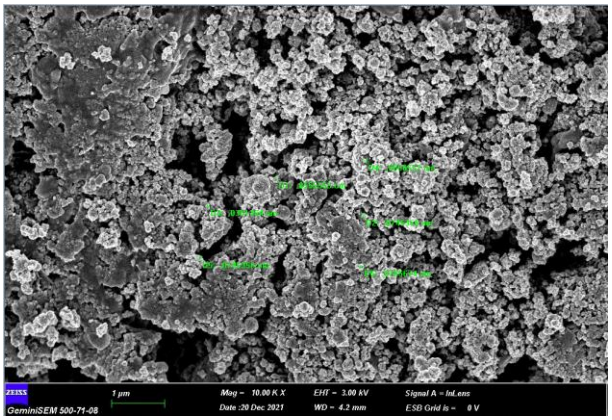

Figure 1. FE-SEM analysis of Pt Nanoparticles synthesized with *Cetraria islandica* extract.

EDX skeletons of *Cetraria islandica* -based Pt NPs confirmed the presence of structural Pt, and other elements in the synthesis solution (Figure 2). The presence of Na and Cl observed in the analysis of NP can be explained by NaOH and HCl used for pH adjustment in PBS buffer. With this data, it was confirmed that the synthesized NPs were Pt NPs.

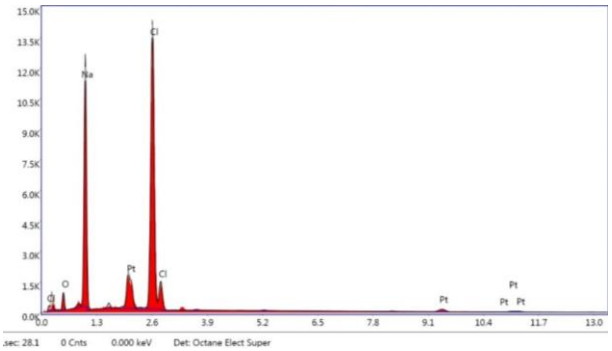

Figure 2. EDX skelleton of Pt Nanoparticles synthesized with *Cetraria islandica* extract.

The presence of biofunctional structures that act as reducing and capping bio-agents in the biosynthesis process of Pt NPs was determined by FT-IR analysis (Figure 3). The peaks observed in the analysis at 1619 cm-1, 1144 cm-1, 1042 cm-1 and 988 cm-1 were amide (C=O), aliphatic ether (C-O), anhydride (CO-O-CO) and alkene, respectively. Paired with (C=C) groups. The presence of Pt (627 cm-1, 558 cm-1) in the structure of NPs was also recorded.

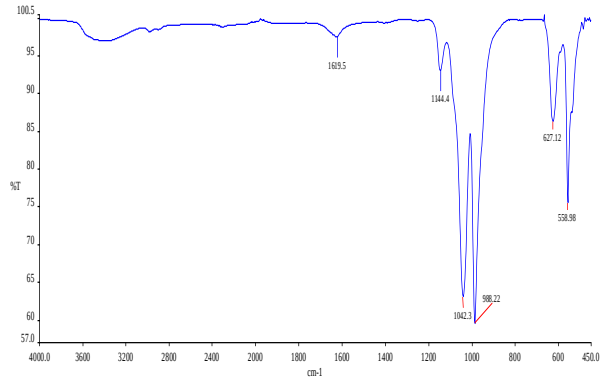

Figure 3. FT-IR Analysis of Pt Nanoparticles synthesized with *Cetraria islandica* extract.

Antioxidant Activity of Pt NPs

In order to cope with the oxidative damage caused by free radicals carrying unpaired electrons, studies are carried out with the antioxidant activity of the nanomaterials. In this study, antioxidant activity of C. *islandica* extract-based Pt NPs was determined by DPPH radical scavenging assay method. Ijaz et al., (2017) determined the IC50 values against DPPH of CuO NPs synthesized with Abutilon indicum extract in the range of 40-84 µg/ml depending on the concentration [18]. It has been noted that A. halimus extract-based Pt NPs exhibit antioxidant activity (IC50=36 µg/ml) against DPPH [15]. In this study, the IC50 of Pt NPs synthesized with Cetraria islandica extract was determined at 92.4 ug/ml (Figure 4).

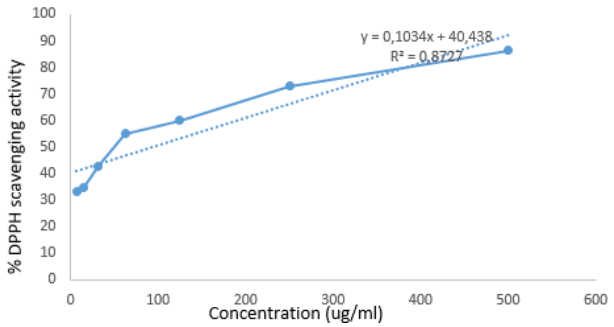

Figure 4. Antioxidant Activity of Pt Nanoparticles synthesized with *Cetraria islandica* extract.

CONCLUSIONS

In this study, biosynthesis of Pt NPs, which has the potential to be applied in wide industrial areas, was carried out with *C. islandica* extract in a simple, inexpensive, environmentally friendly and effective method. Synthesized Pt NPs are thought to have antioxidant activity. It is thought that the study data will be a guide for multidisciplinary studies in life sciences and nanotechnology.

Disclosure and Conflict of Interest: The authors declare that they have no conflicts of interest.

Author Contributions: All authors contributed equally in writing original draft preparation, all authors have read and agreed to the published version of the manuscript.

Informed Consent: All patients gave their written informed consents before inclusion.

REFERENCES

[1] K.Bloch, K.Pardesi,C. Satriano, ,S. Ghosh, Bacteriogenic Platinum Nanoparticles for Application in Nanomedicine, Frointers in Chemistry, 9, 624344, 2021.

[2] M.O. Mavukkandy,S. Chakraborty, T. Abbasi, S.A. Abbasi,. A Clean-Green Synthesis of Platinum Nanoparticles Utilizing a Pernicious Weed Lantana (Lantana Camara), American Journal of Engineering and Applied Sciences, 9 (1):PP 84-90,2016.

[3] S.A.Fahmy, I.M. Fawzy, B.M. Saleh, M.Y. Issa, U.Bakowsky, H. Azzazy, H. Green Synthesis of Platinum and Palladium Nanoparticles Using Peganum harmala L. Seed Alkaloids: Biological and Computational Studies. Nanomaterials, 11, 965, 2021.

[4] A.Ayguna, F. Gülbagcaa, L.Y. Ozerb, B.Ustaogluc, Altunogluc Y.C., Balogluc M.C., Atalard M.N., Almae M.H., Sena F. Biogenic platinum nanoparticles using black cumin seed and their potential usage as antimicrobial and anticancer agent. Journal of Pharmaceutical and Biomedical Analysis179:112961, 2020.

[5] C. Soundarrajan,A. Sankari, P. Dhandapani, S.Maruthamuthu, S. Ravichandran,G. Sozhan,N. Palaniswamy. Rapid biological synthesis of platinum nanoparticles using Ocimum sanctum for water electrolysis applications. Bioprocess Biosyst. Eng.;35:pp.827-833, 2012

[6] B. Sahin,A. Aygün, H. Gündüz,K. Sahin, E. Demir, S. Akocak,F. Sen. Cytotoxic effects of platinum nanoparticles obtained from pomegranate extract by the green synthesis method on the MCF-7 cell line. Colloids Surf. B Biointerfaces. 2018;163:pp.119–124,2018.

[7] D.S.Sheny, D. Philip, J. Mathew. Synthesis of platinum nanoparticles using dried Anacardium occidentale leaf and its catalytic and thermal applications. Spectrochim. Acta A Mol. Biomol. Spectrosc.;114:pp.267–271, 2013.

[8] S. Ghosh, R. Nitnavare,A. Dewle, G.B.Tomar, R. Chippalkatti.,P. More, B.A., B.A. Chopade. Novel platinum–palladium bimetallic nanoparticles synthesized by Dioscorea bulbifera: Anticancer and antioxidant activitiesInt. J. Nanomed.;10:pp7477–7490, 2015.

[9] A.Thirumurugan, P. Aswitha,C. Kiruthika, S. Nagarajan,A.N. Christy. Green synthesis of platinum nanoparticles using Azadirachta indica—An eco-friendly approach. Mater. Lett.;170:pp,175–178,2016.

[10] J.Y, Song,E.Y. Kwon ,B.S. Kim Biological synthesis of platinum nanoparticles using Diopyros kaki leaf extract. Bioprocess Biosyst. Eng.;33:159–164, 2010.

[11] V.Vinod,P. Saravanan, B.Sreedhar, D.K.Devi, R.A. Sashidhar. facile synthesis and characterization of Ag, Au and Pt nanoparticles using a natural hydrocolloid gum kondagogu (Cochlospermum gossypium) Colloids Surf. B Biointerfaces. 83:291–298, 2011.

[12] S. H. Sun,D. Q. Yang,D. Villers,G. X. Zhang,E. Sacher,J. P. Dodelet. Template and surfactant-free room temperature synthesis of self-assembled 3D Pt nanoflowers from single-crystal nanowires, Advanced Materials, 20: 571-574, 2008.

[13] R..Dobrucka. Antioxidant and catalytic activity of biosynthesized CuO nanoparticles using extract of galeopsidis herba. Journal of Inorganic and Organometallic Polymers and Materials, 28: 812-819, 2018.

[14] S.H. Mohammed,A. Rheima,F.,M.F. Al-jaafari, Z. Abbas, Z.Green synthesis of Platinum Nanoparticles using Olive Leaves Extracts and its Effect on Aspartate Aminotransferase Activity. Egyptian Journal of Chemistry, 65, 377-382,2022.

[15] H. Hu, F. Wang, X. Ding, S. Imhanria, W.Wang, J. Zhang,. Green fabrication of Pt nanoparticles via tea-polyphenols for hydrogen peroxide detection. Colloids and Surfaces A: Physicochemical and Engineering Aspects, 637, 128201,2022.

[16] A.S. Eltaweil, M. Fawzy, M.Hosny, E.M.Abd El-Monaem, T.M.Tamer, A.M.Omer. Green synthesis of platinum nanoparticles using Atriplex halimus leaves for potential antimicrobial, antioxidant, and catalytic applications. Arabian Journal of Chemistry, 15, 103517,2022.

[17] H.A. Widatalla, L.F. Yassin, A.A.Alrasheid, S.A.R. Ahmed, M.O Widdatallah, S.H. Eltilib, A.A. Mohamed, A.A. Green synthesis of silver nanoparticles using green tea leaf extract, characterization and evaluation of antimicrobial activity. Nanoscale Advances 4,PP 911-915,2021

[18] M.Hosny, M.Fawzy, A.M. Abdelfatah, E.E. Fawzy, A.S. Eltaweil. Comparative study on the potentialities of two halophytic species in the green synthesis of gold nanoparticles and their anticancer, antioxidant and catalytic efficiencies. Adv. Powder Technol. 32, 3220–3233,2022.

[19] F. Ijaz,S. Shahid,S.A. Khan,W. Ahmad, , S. Zaman. Green synthesis of copper oxide nanoparticles using Abutilon indicum leaf extract: Antimicrobial, antioxidant and photocatalytic dye degradation activities. Tropical Journal of Pharmaceutical Research, 16 (4): 743-753, 2017.

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