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Antioxidant Activity of Green Synthesized Platinum Nanoparticles by Using *Tornabea scutellifera* Extract

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***Abstract*— First time in this study *Tornabea scutellifera* extract were used for synthesis of Platinium nanoparticles (Pt NPs). The DPPH scavenging activity of *T. scutellifera*-based Pt NPs was determined and its usability as antioxidant activity was evaluated. With characterization tests, it was observed that Pt NPs were in spherical structure and had an average diameter of 88.7 nm. Functional groups that play a role in the synthesis were determined by FT-IR analysis with the peaks determined at 1623 cm^{-1}, 1146 cm^{-1}, 1042 cm^{-1}, 987 cm^{-1}, 625 cm^{-1} ve 558 cm^{-1}. Elemental structure (presence of Pt) was revealed by EDX analysis. It was determined that *T. scutellifera*-based Pt NPs exhibited anti-oxidant activity against DPPH (184.06 µg/ml, R2=0.8727). It is thought that the study can be used in nanotechnology-related multidisciplinary studies.**

Keywords*— Green synthesis, Platinum nanoparticles, antioxidant activity, nanotechnology, *Tornabea scutellifera

I. Introduction

Inorganic NPs are located in new application areas with wide surface areas, surface loads, dimensions, morphologies, amorphous and crystal structures and high reactivity [1, 2, 3]. Although the success of metallic NPs is associated with its structural properties in the industrial field, many parameters such as reaction time, temperature, pH, reduction agent, metal type and concentration affects these structural properties [3].

Synthesis method of metallic NPs each of each physical, chemical and biological synthesis have advantages and disadvantages. The green synthesis (biological synthesis) method, which is one of the popular subjects of recent years, includes the synthesis of algae, lichen, mushrooms and plant extracts. In the biological synthesis of metallic NPs, have advantages because of don't need secondary chemical agents extreme laboratory conditions (high temperature, pressure) and easy to apply. The structural properties of metallic NPs such as size, morphology can be controlled by factors such as reaction, pH, biological extract type and concentration. Song et al., (2010) synthesized Diopyros kaki leaf extract based Pt NP [4]. Researchers emphasized that the extract concentration and reaction temperature affects the PT NP synthesis as the use of optimum synthesis as a temperature of 95 ° C and more than 10 %. Kumar et al., (2019) inform that cubic and 22 nm Pt NPs synthesized by using Xanthium strumarium extract have antimicrobial and antifungal activities [5]. Soundarrajan et al., (2012) reported that the PT NPs (23 nm) they synthesized with *Ocimum sanctum* can be applied in electrolysis applications [6]. Şahin et al., (2019), declarated that Punica granatum extract based Pt NPs have anticancer activity against the human breast cancer cell line [7]. Dobrucka et al., (2019) reported that Fumariae herba based Pt NPs have dye degradation properties against to methylene blue [8]. Mohamadi et al. (2020) reported that Pt NPs synthesized by using Nymphaea alba extract have average of 35 nm diameter, and the NPs can be used as a sensor in the detection of H_2O_2 [9]. According to the literature review, there are many synthesis of Pt NPs with various biological extracts and synthesis. However, for the first time in this study, *T. sccutellifera* extract was used the synthesis of Pt NPs and also evaluated antioxidant activity of T. scutellifera-based Pt NPs.

II. Materials and Methods

Synthesis of Pt NP

For the synthesis of Pt NPs, literature were performed with small modifications [10]. For synthesis, 20 ml PBS (10 mm, pH

7), 1 ml extract and 1 ml formic acid was added to the reaction by vortexing. After this process, the mixtures prepared under different conditions were kept in the water bath for about 1.5 h at 60 ^{o}C. Following the observation of the color change, the tubes were centrifuged (4000 rpm, 20 min.) The precipitors were dried (70 ^{o}C) and were kept for use in antioxidant studies. FE-SEM, EDX and FT-IR analyzes were used for determination of morphology, elements and functional components that play a role in synthesis, respectively.

Antioxidant Activity of Pt NPs

In this test based on DPPH oxidation [11], PT NPs with DPPH (0.15625, 0.3125, 0.625, 1.25, 2.5, 5 and 10 mg/ml) reacted. After the mixture was incubated in the dark for 30 min, samples with color changes (mordan orange) were read at 517 nm wavelengths. The following formula has been used to determine DPPH activity:

DPPH clarivate activity (%)=[$Abs_{control}$-($Abs_{samples}$-Abs_{blank})]/Abscontrol×100

99.5 % ethanol was used as Abscontrol.

III. RESULTS AND DISCUSSIONS

Characterization of Pt NP

The morphological characterization of the Pt NPs synthesized by using the *Tornabea scutellifera* as a reduction and coating agent was demonstrated by FE-SEM analysis (Figure 1).

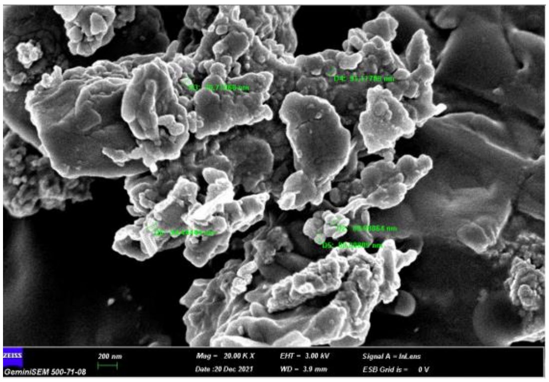

Figure 1. FE-SEM images of Pt NP

According to FE-SEM images, Pt NPs were have an average diameter of 88.7 nm. It was also noted that Pt NPs tend to cluster and have a rounded morphology. By EDX analysis, Pt element and salt components (Na and CI), O and C elements found in the structure of NPs were determined and given in Figure 2. The functional groups involved in the synthesis of *T. scutellifera*-based Pt NPs are C=O (amide), C-O (aliphatic ether), CO-O-CO (anhydride) and C=C (alkene), determined at 1623 cm^{-1}, 1146 cm^{-1}, 1042 cm^{-1} and 987 cm^{-1}, respectively. In the analysis, the peaks observed at 625 cm-1 and 558 cm-1 were also associated with metal (Pt).

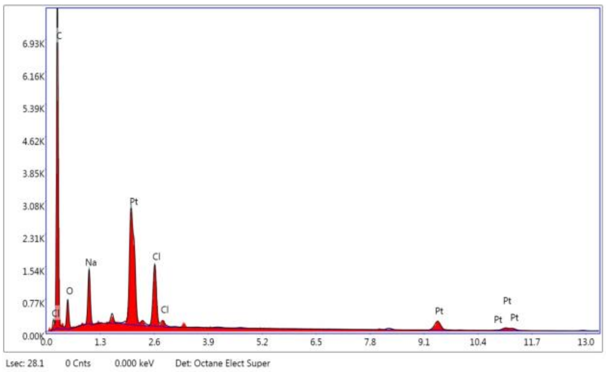

Figure 2. EDX anaylsis of Pt NP

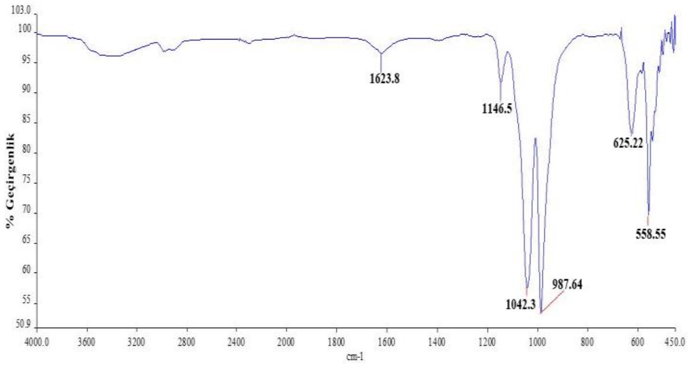

Figure 3. FT-IR anaylsis of Pt NP

It was noted that the sizes of Pt NPs synthesized by using T. scutellifera extract as a reducing and coating agent differ depending on the extract. Mohammed et al. (2022) determined the avarage diameter of Pt NPs synthesized with olive leaf extract at 9.2 nm [12]. The sizes of Pt NPs synthesized with tea and Atriplex halimus extracts were 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 [13-16]. Yang et al. (2007) reported that the reducing agent concentration used in the biosynthesis of Pt NPs is an important parameter that affects the size of the NP [17]. Al-Radadi (2019) evaluated the morphology of Pt NPs synthesized with bioextract at different pH [18]. The researcher reported that the pH of synthesis medium has an effect on the morphology and heterogeneous/homegeneous structure of the synthesized Pt NPs. In addition, it was revealed that reaction temperature, reducing agent concentration and reaction time parameters were factors that manipulated Pt NP morphologies. It has been noted that Pt NPs synthesized with *Anacardium occidentale* extract have irregular shape [19]. The diameters of Pt NPs synthesized with extracts of Plectonemaboryanum cyanobacteria, Padina gymnospora and Neurospora crassa were measured at 30 nm–0.2 µm, 5-20 nm, and 4-35 nm, respectively [20-22]. In another study, it was noted that Pt NPs synthesized with *Fusarium oxysporum* mushroom extract have various geometric shapes such as hexagon, pentagon, spherical and square in the range of 10-100 nm depending on the synthesis conditions [23]. According to the literature review, it is predicted that the active ingredient composition of the biomaterial used as a reducing agent has important effects on the morphology of the synthesized Pt NPs. In previous studies, it was determined that the structural properties of Pt NPs were manipulated by factors such as synthesis method, type of reducing metal, type of reducing and coating agent, concentration, reaction time, ambient pH and temperature, and this supports our data.

Antioxidant Activity of Pt NPs

While free radicals that occur in metabolic reactions cause oxidative damage, antioxidants prevent damage caused by reactive oxygen species (ROS) [13, 24]. Eltaweil et al. (2022) reported that DPPH is reduced and cleared by the reaction of a DPPH solution with a substance that releases hydrogen atoms [13].

The IC50 value of Pt NPs synthesized with Tornabea scutellifera extract was determined at 184.06 ug/ml (R^2=0.8727) (Figure 99). It has been noted that Pt NPs synthesized with T. scutellifera extract exhibit concentration-dependent antioxidant activity against DPPH. The antioxidant activity of A. halimus extract-based Pt NPs against DPPH (IC50 = 36 µg/ml) has been noted to increase with increasing concentration [13]. It has been shown that Pt NPs containing polyacrylic acid have antioxidant activity (IC50=1.6) µm [25]. It was noted that Dioscorea bulbifera-based Pt NP, Pd NP and Pt-Pd NPs exhibited antioxidant activity against DPPH (DPPH scavenging percentage 30%, 28.9%, 38.49%, respectively) [26]. Our findings are also consistent with the literature, suggesting that Pt NPs exhibit concentration-dependent antioxidant activity.

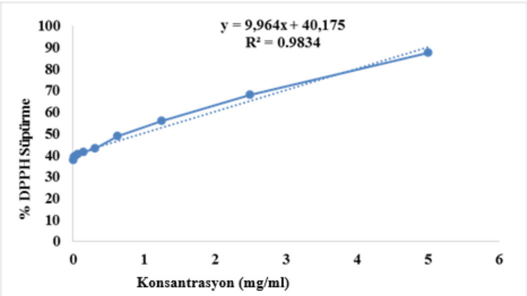

Figure 4. Antioxidant activity of of Pt NP

IV. CONCLUSIONS

In this study, *T. scutellifera* extract and Pt coordinated NPs 88.7 nm diameter and spherical. Pt NPs were synthesized and characterized. The metabolite groups contained in the *T. scutellifera* extract played an active role in Pt reduction and NP capping. Antioxidant activity and DPPH scavenging ability of *T. scutellifera*-based Pt NPs were demonstrated. We think that the findings can be used in the field ofnanotechnology and biomedicine.

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