Turkish Journal of Health Science and Life

GREEN SYNTHESIS AND CHARACTERIZATION OF ZINC OXIDE NANOPARTICLES BY USING *RHODODENDRON PONTICUM L.* LEAF EXTRACT

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ARTICLE INFO

RESEARCH ARTICLE

Article history:
Received: 14 March 2021
Accepted: 06 April 2021
Available : 07 April 2021

Key Words:
Green synthesis, ZnO nanoparticle, *Rhododendron ponticum L.*

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Turkish Journal of Health Science and Life
2021, Vol.4, No.1, 54-57.

ABSTRACT

In recent years, nanotechnology studies have gained importance in modern materials science. Green synthesized nanoparticles have attracted great attention due to some properties such as eco-friendly, nontoxicity and cost effectiveness. In this paper, the synthesis of zinc oxide nanoparticles (ZnO NPs) was carried out by using *Rhododendron ponticum L.* leaf extract. The characterization of the green biosynthesized ZnO NPs were carried out by scanning electron microscopy (SEM) with Energy dispersive X-ray analysis (EDX) and UV-Visible spectrophotometer. UV–visible absorption of ZnO NPs showed absorption band at about 345 nm. In addition, zinc and oxygen related sharp peaks were obtained in EDX analysis.

1. Introduction

Nanoscale (1-100 nm) materials that provide advanced technologies for biological applications are synthesized by nanotechnology. Nanoscale materials have unique physicochemical properties, such as ultra -small size and large surface area to volume ratio [1, 2]. Nanomaterials are used in a variety of applications in the biomedical and pharmaceutical industries [3-5]. Recently, metal oxide nanoparticles of copper, zinc, iron and cerium oxide have been the center of attention due to their unique biological, chemical and physical properties. [6, 7]. Zinc oxide nanoparticles (ZnO NPs) has been widely used in several applications such as UV absorber in cosmetics, active filler for rubber and plastic, gas sensor, antiviral agent in coating applications, and catalyst [8].

The various methods have been proposed for synthesis of ZnO NPs such as organo-metallic synthesis, Sol-gel processing, spray pyrolysis, homogeneous precipitation, thermal evaporation, mechano-chemical synthesis and mechanical milling, microwave methods [8] . However, these methods are generally unsafe to the environment, labor-intensive, and expensive. Chemical methods using toxic chemicals may cause dangerous effects in medical applications if toxic residues are present. [9, 10]. Besides, our environment is suffering from an enormous and harm quantity of unwanted materials [11, 12]. For the moment, we need to explore paradoxes that may exist in nature for alternative plans. In this way, we will be able to completely eliminate toxic substances with environmentally friendly materials. These new flawless skills can greatly decline environmental pollution and decrease the danger to human healthiness as a result of utilizing harmful solvents and chemicals [12, 13].

Compared to chemical and conventional physical methods, nanoparticle synthesis using plants is an eco -friendly way [14]. Usually, there are three main phases for the bio-reduction mechanism of metal nanoparticle in plants and plant extracts. The activation phase in which the reduction of metal ions and nucleation of the reduced metal atoms occur. The growth phase, referring to the spontaneous coalescence of the small adjacent nanoparticles into particles of a larger size, accompanied by an increase in the thermodynamic stability of nanoparticles, or a process referred to as Ostwald ripening and the termination phase in which the final shape of the nanoparticles formed [15, 16].

Rhodendron species used in traditional medicine for the treatment of inflammation, pain, colds, asthma, skin and gastrointestinal disease, widely distributed around the worldwide [17]. The most remarkable species found in forests in the northern coast of Turkey is *Rhodendron L.* The most common of the *Rhodendron L*. is *Rhododendron ponticum L* [18].

In the present research, ZnO NPs has been successfully synthesized through an easy method that avoids difficult experimental processes and toxic chemicals by using leaf extract of *Rhododendron ponticum L*. Then ZnO NPs was characterized by using UV-Visible spectroscopy, Scanning Electron Microscope (SEM) and Energy Dispersive X-ray spectroscopy (EDX).

2. Materials and Methods

Zinc acetate dihydrates were obtained from Sigma Aldrich. *Rhododendron ponticum L.* was collected from Black Sea Region of Turkey.

Preparation of the extract

About 10 g portion of thoroughly washed *Rhododendron ponticum L.* leaves were finely cut and boiled with deionized water. Then the extracts were cooled to room temperature and filtered using Whatmann No. 1 filter paper. The extract was stored in a refrigerator for further studies

Green synthesis of ZnO NPs

The ZnO NPs were synthesized using *Rhododendron ponticum L.* leaves as illustrated previously by Dönmez [19], with small modification. Briefly, 50 ml of zinc acetate solution (0.02 M) was prepared with deionized water. Then, zinc acetate solution was mixed with 20 ml of *Rhododendron ponticum L.* leaves extract and subsequently adjusted pH 10 with 1.0 M sodium hydroxide. The reaction mixture was heated at 80 °C under continuous stirring with a magnetic stirrer until a pale white precipitate was formed. The precipitate was purified by several re-dispersions in deionized water and ethanol to remove the unwanted impurities. The final product was dried overnight in an oven at 60°C. For calcinations process, ZnO NPs heated at 350 °C for 3 h in a muffle furnace. In Fig. 1, the experimental steps are presented schematically.

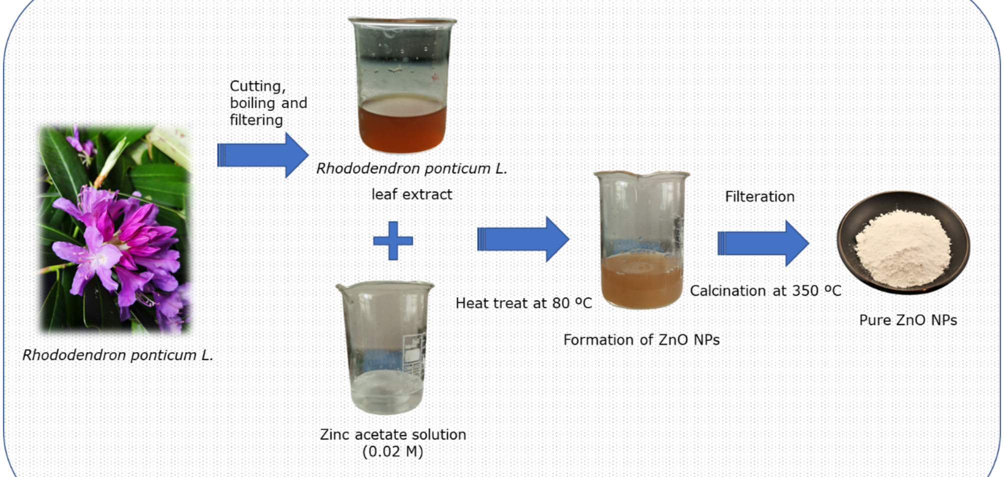

Figure 1. Experimental steps of green synthesized ZnO NPs

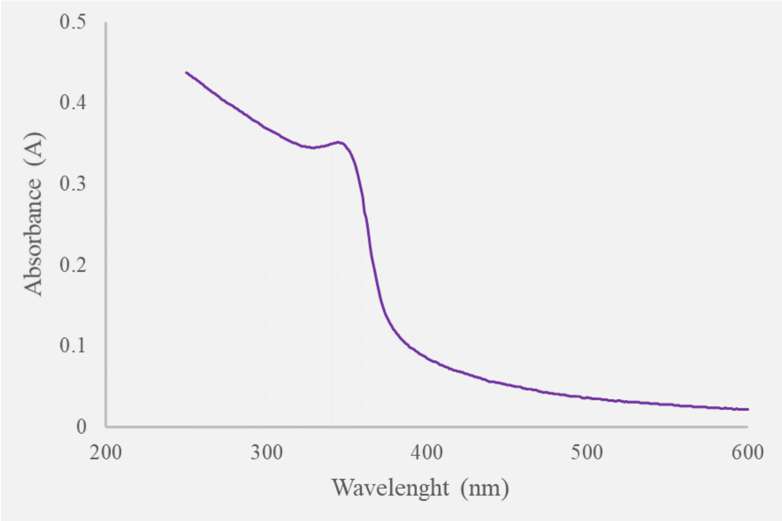

Figure 2: Uv-Visible spectrum of ZnO NPs

Characterization of ZnO NPs

The ZnO NPs were characterized by different techniques. UV–Vis spectral analysis (Pg instrument, T60 UV-Visible Spectrophotometer) was performed in the range from 250 to 600 nm. The morphology of the nanoparticles was monitored by the Scanning electron microscopy (SEM) technique (JEOL SEM-7100-EDX). Energy-dispersive x-ray spectrometer (EDX) was utilized to analyze the elemental composition of the synthesized particles.

3. Results and Discussion

UV-Vis analysis

The UV-VIS spectrum of eco-friendly synthesized ZnO NPs using grape seed are shown in Fig 2. The absorption peak observed at the wavelength about 345 nm within the UV–Vis range of 250–600 nm. Similar results have been reported by Fakhari et al [20]. Furthermore, the absorption peak of *Ruta graveolens (L.)* assisted synthesized ZnO Np by Lingaraju et al was observed at 355nm, the absorption peak of *Scutellaria baicalensis* assisted synthesized ZnO Np by Chen et al was observed at 360 nm, and the absorption peak of *C.abyssinica* assisted synthesized ZnO Nps by Safawo et al was observed at 360 nm [21-23]. All of these studies showed similar absorption peaks and therefore supported our results.

SEM-EDX anlysis

The SEM image of prepared ZnO NPs is shown in Fig. 3. The SEM image illustrates the ZnO NPs are pre-dominantly spherical in shape and aggregate into larger particles. The EDX profile demonstrates the chemical analysis of green synthesized ZnO NPs. In Fig. 3, The EDX pattern shows major emission energy at 1 keV and 0.5 keV which are the binding energy for zinc and oxygen respectively. The atomic percentages

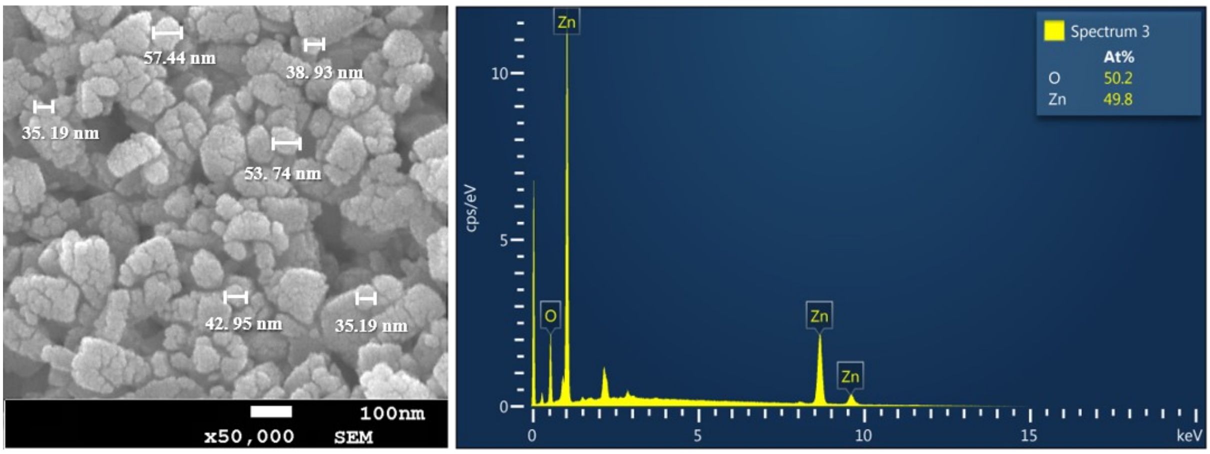

Figure 3: SEM images of ZnO NPs with EDX spectrum

of ZnO NPs were 50.2 % for zinc and 49.8 % for oxygen. The SEM image and the EDX result are similar to the study conducted by Janaki et al [24]. The green synthesized ZnO NPs in the range of about 30-60 nm. The larger ZnO NPs resulted from agglomeration of smaller nanoparticles.

4. Conclusion

This study demonstrate that green, inexpensive, and eco-friendly approach is best convenient way for the synthesis of ZnO NPs using *Rhododendron ponticum L.* leaf extract. The green synthesized ZnO NPs demonstrated a characteristic UV-vis absorption peak at about 345 nm. The present work has also a great social relevance because of its cost-effective and non -hazardous material. The green synthesized ZnO NPs may have potential applications in the areas of environment, pharmaceuticals, and biomedicine.

Acknowledgments

The author is thankful to Nilay TEZEL (Çanakkale Onsekiz Mart University, Science and Technology Application and Research Centre) for her technical assistance.

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