Uluslararası İleri Doğa Bilimleri ve Mühendislik Araştırmaları Dergisi
Sayı 8, S. 479-483, 2, 2024

Araştırma Makalesi

IJANSER
https://as-proceeding.com/index.php/ijanser
ISSN: 2980-0811

International Journal of Advanced Natural Sciences and Engineering Researches
Volume 8, pp. 479-483, 2, 2024

Research Article

Green Synthesis, Morphological and Optical Characterization of ZnO Nanostructures Using of Tilia Extract

Busra Zeyneb Altintas [1*], Feyza Oke-Altuntas[1], Selin Saritan[1], Halit Altuntas[2] and Hakan Colak [3,4]

[1] *Department of Biology, Faculty of Science, Gazi University, Turkey*
[2] *Department of Physics, Faculty of Science, Cankiri Karatekin University, Turkey*
[3] *Department of Chemistry, Faculty of Science, Cankiri Karatekin University, Turkey*
[4] *Central Research Laboratory (CANKAM), Cankiri Karatekin University, Turkey*

(Received: 11 March 2024, Accepted: 12 March 2024)

(4th International Conference on Innovative Academic Studies ICIAS 2024, March 12-13, 2024)

ATIF/REFERENCE: Altintas, B. Z., Oke-Altuntas, F., Saritan, S., Altuntas, H. & Colak, H. (2024). Green Synthesis, Morphological and Optical Characterization of ZnO Nanostructures Using of Tilia Extract. *International Journal of Advanced Natural Sciences and Engineering Researches, 8(2), 479-483.*

Abstract **–** Nanomaterials consist of particles of size 1-100nm, and nanoparticles have high catalytic reactivity, thermal conductivity, chemical stability and optical performance. Nanoparticles have gained importance in many application areas, making a green and environmentally friendly method in their production necessary. Green synthesis is the synthesis in which nanoparticles are using living organisms such as plant extracts, organisms or their components, it is an environmentally friendly method compared to other physical and chemical methods, biocompatible, safe and low-cost synthesis produced with. ZnO nanoparticles create new opportunities in many application areas due to their optical and chemical properties, biocompatibility, high solubility and non-toxicity. ZnO nanoparticles are characterized by wide band gap (3.37eV), high binding energy (60meV), optical and UV filtering properties. Tilia is a plant native to Europe and Western Asia. Its main active ingredients include flavonoids, mucilage, essential oil, phenolic acids, amino acids and others. In this research, green synthesis of ZnO nanoparticles was carried out using Tilia extract. The morphology of the obtained nanoparticles was examined by FE-SEM technique and round structures were observed. Also, UV-Vis measurements were made and changes were detected depending on different zinc sources.

Keywords – Green Synthesis, Zno Nanostructures, Tilia, Nanotechnology.

I. INTRODUCTION

Nanotechnology is a developing branch of science and is gaining importance in various application areas (N. Sözer., J.L. Kokini. 2009). Nanomaterials consist of particles of size 1-100nm, and nanoparticles have high catalytic reactivity, thermal conductivity, chemical stability and optical performance due to the surface/volume ratio (Tabrez, S.; Musarrat, J.; Al-khedhairy, A.A. 2016). Nanoparticles have gained importance in various fields such as food, healthcare and cosmetics, making a green and environmentally friendly method in their production necessary (Rao, M.D.; Gautam, P. 2016). Nanostructured materials have attracted great interest from various fields because they exhibit special physicochemical properties. Reducing particle size results in high surface-to-volume ratio, which can be used to modify interesting properties of nanomaterials, including catalytic activity, optical absorption, and electrical properties.

Inorganic transition metal oxides, in particular, are thought to be promising nanomaterials with vital applications in photocatalysis, electronics, medicine, biology, energy conversion and storage, and magnetic storage devices.

Zinc oxide (ZnO) nanoparticles have attracted attention in recent years due to their ease of preparation, low-cost production, safety and diversity of applications in biomedical systems, electronics and optics (Anbuvannan et al. 2015). ZnO nanoparticles are characterized by wide band gap (3.37eV), high binding energy (60meV), photocatalytic and photo-oxidation activity, optical and UV filtering properties (Agarwal, Kumar, Rajeshkuma, 2017; Deepali Sharma et al. 2010).

ZnO nanoparticles can be synthesized using various chemical and physical methods. However, these methods generally require high temperatures, high pressure, hazardous chemicals and have a negative impact on the environment. Therefore, as a result of the increasing interest in environmental protection, researchers have turned to environmentally friendly synthesis methods that do not use toxic components (Aldeen et al. 2022). Green synthesis is an easy, fast and environmentally friendly method in which ZnO nanoparticles are synthesized using bio-renewable resources. Additionally, nanomaterials synthesized by this method are biocompatible and non-toxic (Mina Zare et al. 2019). The green synthesis method, in which plant extracts are used in the synthesis of nanomaterials, is the most advantageous method compared to other biological methods (Aldeen et al. 2022). Because it is non-pathogenic, low-cost, renewable and sustainable. In green synthesis using plant extracts, phytoconstituents (flavonoids, terpenoids, polyphenols, quinones, catechins, organic acids and amines) found in plants serve as reducing and stabilizing agents. Therefore, they are considered excellent sources for the synthesis of nanoparticles (Mina Zare et al. 2019).

Tilia is a plant native to Europe and Western Asia. Its main active ingredients include flavonoids, mucilage, essential oil, phenolic acids, amino acids and others. Tilia flowers are used to treat muscle spasms, as an expectorant, and to cure colds. In this research, green synthesis of ZnO nanoparticles was carried out using Tilia extract serving as a stabilizing agent. The resulting nanoparticles were characterized by different techniques to reveal their composition, morphology and optical properties.(Corciova, A.et al. 2018).

In a study by Cardoza-Avendan et al 2023, green synthesis of ZnO nanoparticles was carried out using different amounts of Tilia extract with zinc nitrate hexahydrate (Zn(NO3)2-6H2O), which served as a stabilizing agent. The resulting nanoparticles were characterized by different techniques to reveal their composition, structure, morphology and optical properties.

In this study, it was aimed to create Zno nanostructures from the tilia plant by green synthesis using different zinc sources and to characterize the resulting nanostructures optically and morphologically.

II. MATERIAL AND METHOD

Material

Zinc acetate dehydrate ($Zn(Ac)_2.2H_2O$) and zinc nitrate hexahydrate ($Zn(NO_3)_2.6H_2O$) used in this study were purchased from Sigma-Aldrich. Tilia was purchased from a herbalist.

Method

Preparation of plant extract

First, 50g of dried tilia was added to 500 ml of boiling water and allowed to brew. Then the extract was cooled to room temperature and filtered with filter paper.

Green Synthesis of ZnO Nanoparticles

Zinc acetate dehydrate was added to the tilia extract and mixed until it gelled in a heated magnetic stirrer. Then, the resulting gel was kept in the muffle furnace for 30 minutes. As a result, the powdered ZnO nanoparticle sample was ground in a mortar and bottled for use in other studies. These steps were repeated for zinc nitrate hexahydrate. Preparation of plant extract and obtaining nanostructure by green synthesis are schematized in figure 1.

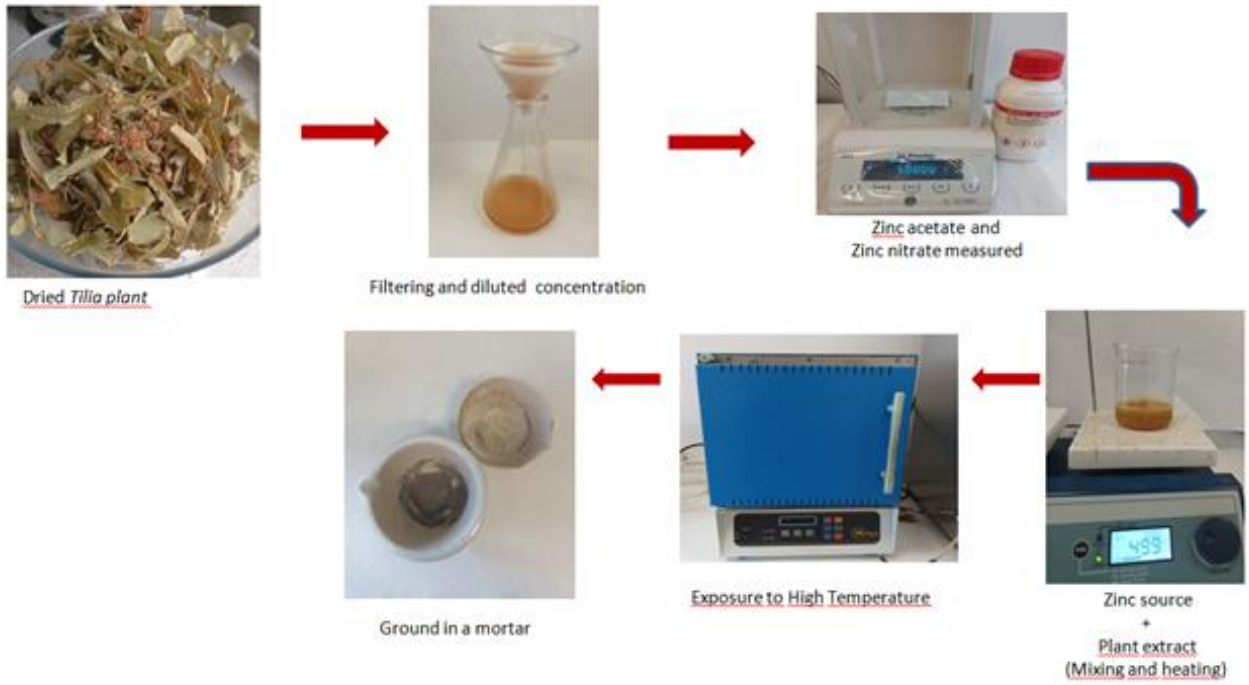

Fig.1. Scheme for the preparation of green synthesis ZnO nanoparticles using the Tilla extract

Characterization of ZnO Nanoparticles

Optical Characterization

Optical characterization of the synthesized ZnO nanoparticles was carried out by UV-Vis measurements. UV measurements were made by measuring the %T value in the range of 300-1000nm with Rayleigh UV-2601.

Morphological Characterization

The surface morphology of the synthesized ZnO nanoparticles was examined by FE-SEM technique. (Carl Zeiss/Sigma 300 VP)

III. RESULTS

Optical Characterization

Optical characterization of the synthesized ZnO nanoparticles was determined by making %T measurements in the range of 300-1000nm with the UV-visible spectrophotometer UV-2601. It has been determined that zinc acetate-based nanoparticles create a wider band gap compared to zinc nitrate-based nanoparticles (Fig.2A and B).

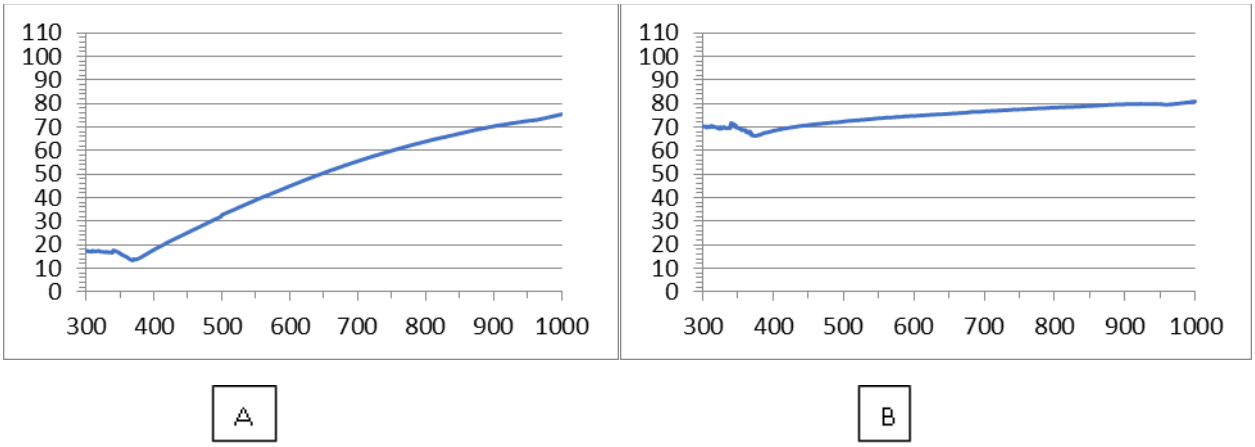

Fig 2. UV-visible spectrophotometry results of synthesized ZnO nanoparticles. A) ZnAc based nanostructure B) ZnN based nanostructure

Morphological Characterization

It was observed that nanoparticles synthesized from both zinc sources formed round structures(Fig.3(A) and (B) and ZnAc based nanostructures have more symmetrical circular shapes.

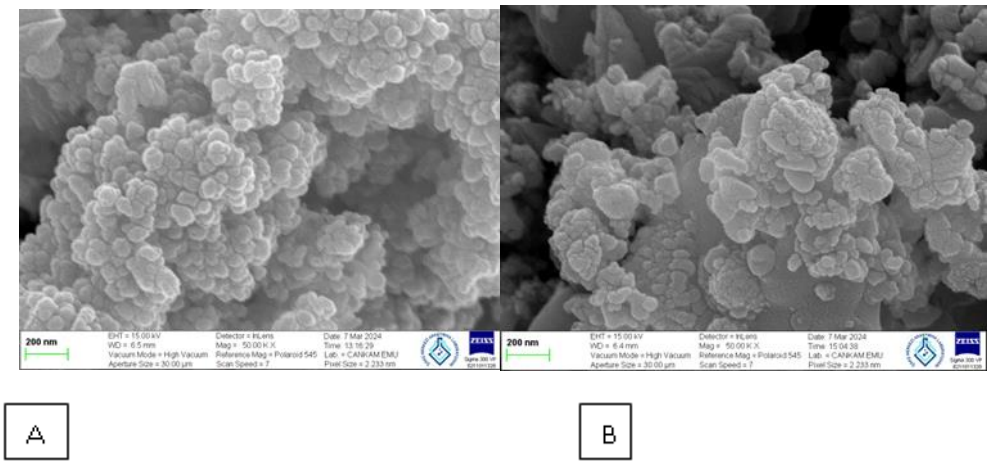

Fig 3. FE-SEM images of the surface morphology of the synthesized ZnO nanoparticles. A) ZnAc based nanostructure B) ZnN based nanostructure

IV. CONCLUSION

As a result, ZnO nanoparticles were successfully grown with green synthesis, and the band gaps obtained in the optical characterization were found to have appropriate values when compared with the literature.

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