https://journal.utripoli.edu.ly/index.php/Alqalam/index eISSN 2707-7179

Original article

Synthesize Iron Oxide and Zinc Oxide Nanoparticles Using Plant Extracts

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ARTICLE INFO

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Received: *18-12-2023*
Accepted: *02-01-2024*
Published: *04-01-2024*

Keywords. *(Fe_2O_3-NPs), (ZnO-NPs) Green Synthesize, UV-Vis analysis.*

ABSTRACT

Recently, a plant-mediated approach to synthesizing nanoparticles via unconventional, eco-friendly technique-based techniques involving natural materials was developed. In this work, the microwave method has been used, where Hibiscus rosa sinensis flower extract and Myristica Fragrans have been used as reducers and stabilizers to synthesize iron oxide nanoparticles (α-Fe_2O_3) and zinc oxide nanoparticles (ZnO), respectively. The melting point and ultraviolet-visible spectrometer (UV-Vis) have been utilized to investigated and characterized the synthesized iron oxide and Zinc oxide nanoparticles. The results showed that the melting point of Fe_2O_3-NPs and ZnO-NPs were above ~300 °C, which indicated the melting of nanoparticle. Nanoparticles exhibit a significant in melting point as their size goes below ≈10 nm. in addition, the UV-Vis absorption spectra of the synthesized iron oxide NPS show peak surface plasmon resonance (SPR) band around 320 nm and Zinc oxide NPS shown peak surface plasmon resonance (SPR) band around 370 nm. The microwave method has been successfully used in this study, which has advantages over the other methods.

Cite this article. *Ibrahim D, Abdelghani K, Anwagy S, Rizkallah R. Synthesize Iron Oxide and Zinc Oxide Nanoparticles Using Plant Extracts. Alq J Med App Sci. 2024;7(1):11-14.* https://doi.org/10.54361/ajmas.2471003

INTRODUCTION

Nanoparticles gain great attention due to their many uses in the domains of electronics, optoelectronics, and medicine, including therapy, diagnostics, water purification, and medication delivery [1–3]. Developing of appropriate techniques to synthesize nanoparticles has drawn a lot of attention from scientists. Nanoparticles may be created using a variety of techniques, including chemical, physical, and green techniques. The disadvantage of the chemical method is that it has chemical agents that cause a large amount of chemical waste as a byproduct, which leads to environmental contamination issues. The Physical method using pulse laser ablation, gamma irradiation and spark discharge to synthesize nanoparticles, and these methods are effective; however, they require relatively expensive apparatus. Green methods involving plant extracts, bacterial, and fungal forms are the most considered to produce various nanoparticles [4, 5].
The advantage of green synthesis is that plant extracts often include sugars, polyphenols, terpenoids, alkaloids, phenolic acids, and proteins, which are in charge of stabilizing and reducing nanoparticles [9]. It has been confirmed that functional groups found in phenolic compounds, such as -C-O-C-, -C-O-, -C=C-, and -C=O-, can assist in the creation of nanoparticles

[6]. Many forms of nanoparticles have been produced by extracting plant material from a variety of plant components, including bark, stems, roots, leaves, fruits, flowers, and seeds [7-9].
In this study, we synthesize iron oxide nanoparticles (α-Fe_2O_3 NPs) and zinc oxide nanoparticles (ZnO), using iron chloride tetrahydrate and zinc nitrite dehydrate, respectively, as a precursor. The various phytochemicals present in the Hibiscus rosa sinensis flower leaves and Myristica Fragrans act as reducing and capping agents for the synthesis of NPs. The modern technique of UV-V absorption spectra has been used in this work to characterize the green synthesized nanoparticles.

METHODS

Synthesis of Fe_2O_3 Nanoparticles

Collecting hibiscus rosa sinensis flowers from a local garden was the first step to preparing the Fe_2O nanoparticles, followed by washing and rinsing them with distilled water to remove dust particles. They used an oven to dry the washed flowers at a temperature of 60 degrees Celsius for 24 hours. After drying the flowers, they were ground, and 5 grams of ground hibiscus were dissolved in 100 ml of double-distilled water. The mixture was boiled for five minutes using a convector, then left for an hour until it settled. Use filter paper twice in a row to filter the extract. 0.02 g of iron chloride tetrahydrate ($FeCl_{2.4}H_2O$) was used and dissolved in 100 ml of distilled water to prepare a 1 mM FeCl2.4H2O solution.
The synthesis of iron nanoparticles was done by heating a mixture of 1 mM $FeCl_{24}H_2O$ and hibiscus Rosa sinensis flower extract using a convector. The last step in the synthesis of iron nanoparticles was centrifuging the solution with a volume ratio of 1:2 at 3000 rpm for 30 minutes. The supernatant was discarded, and the pellet was washed with distilled water and centrifuged again. This process is repeated three times to remove any impurities. The compound was validated by subjecting the synthesized Fe_2O_3NPs powder to different properties, such as melting point and UV radiation.

Synthesis of ZnO-NPs. Zinc oxide nanoparticles

The first step to preparing the synthesis of ZnO nanoparticles was collecting Myristica fragrans from a local market in Albyda, and then an electric grinder was utilized to obtain the fine powder of the plant material for the preparation of extracts. The soaked powder was kept in an incubator at 37°C overnight to obtain maximum extraction. The main step to the synthesis of ZnO nanoparticles has been done by adding 6.0 g of zinc nitrite dehydrate ($Zn(NO_3)_2$·2H2O) to 100 mL of extract, and a magnetic stirrer was used at 60 °C for 2 hours. The mixture was cooled down to 25 °C and centrifuged at 10,000 rpm for 10 min. The pellets were washed twice with distilled water and dried in an oven at 90°C. The dried material was ground into a fine powder.

RESULTS AND DISCUSSION

Melting temperature

A material's melting temperature is one of its basic characteristics. In theory, a bulk material's melting point is independent of its size. On the other hand, the melting temperature scales with the material dimensions as a material gets smaller and closer to the atomic scale, or nanoscale size. The melting temperature of a nanomaterial, such as nanoparticles or nanorods, is related to other fundamental physical properties for nanomaterial applications.
The result showed that the melting point of Fe_3O_4 NPs was higher than $320^{°C}$, which indicated the melting of the nanoparticles. The nanoparticles showed a significant decrease in melting point as their size decreased to less than ≈10 nm. The melting point of ZnO NPs was higher than 350 °C, indicating the melting of the nanoparticles. Nanoparticles show a significant drop in melting point as their size is less than ≈10 nm.

UV-Vis Spectroscopy

The synthesis of iron oxide nanoparticles has been confirmed when the iron salt solution is added to the extract, where the characteristic color of the extract solution changes from yellow to a dark solution, which agrees with [10] while The synthesis of Zn oxide nanoparticles has been confirmed when the Zn salt solution is added to the extract, where the characteristic color of the extract solution changes from green to a dark solution.
The range of UV-Vis spectroscopy has been taken between 200 and 800 nm in this work. The formation of an SPR band has been observed as a result of nanoparticles. The position of the SPR band depends on the particle size and shape, as well as the aggregation state of the nanoparticles.

The UV-Vis absorption spectra of the chemically synthesized iron oxide NPS from hibiscus flower extract are shown in figure 1. The spectra demonstrated a characteristic peak surface plasmon resonance (SPR) band around 320 nm, which agrees with the reported SPR for Fe_3O_4 NPs using hibiscus leaves [11].

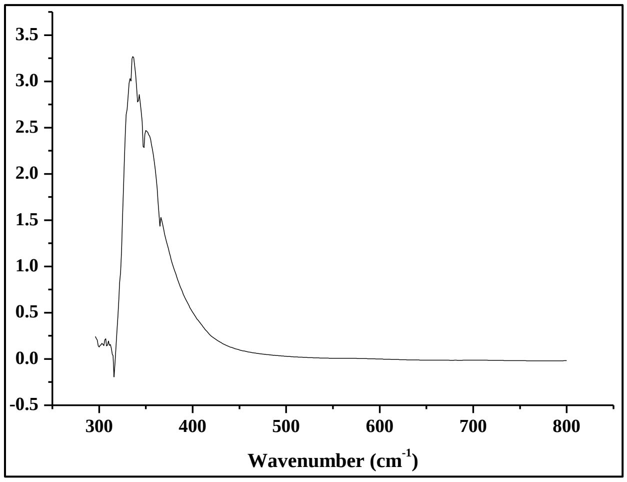

Figure3. The absorption peaks for hibiscus extracts

While figure 2 shows the UV-Vis absorption spectra of the synthesized Zn oxide NPS from Myristica fragrans extract. The spectra demonstrated a characteristic peak surface plasmon resonance (SPR) band around 370 nm.

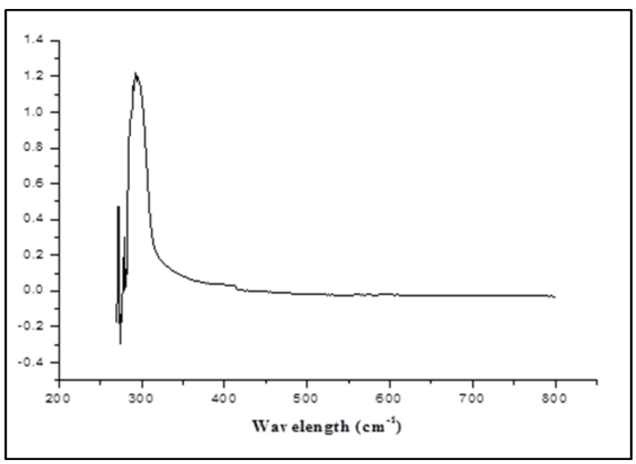

Figure** Error! No text of specified style in document.. **The absorption peaks for Myristica fragrans extracts

CONCLUSIONS

The green synthesis of nanoparticles using plant extracts is a promising method for obtaining environmentally friendly nanomaterials for biological applications. In this work, iron oxide nanoparticles (α-Fe_2O_3) and zinc oxide nanoparticles (ZnO) have been synthesized from Hibiscus rosa sinensis flower extract and Myristica Fragrans using iron chloride tetrahydrate and zinc nitrite dehydrate as reducers, respectively. The microwave method has been successfully used in this study, which has advantages over the other methods. These include rapid heating, being environmentally friendly, and being low-cost. The synthesized nanoparticles were characterized by different techniques, such as melting points and ultraviolet (UV) spectroscopy.

Acknowledgements

The authors are grateful to Omar Al-Mukhtar University especially, the Department of Chemistry.

Conflict of Interest

There are no financial, personal, or professional conflicts of interest to declare.

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تصنيع جزيئات أكسيد الحديد وأكسيد الزنك النانوية باستخدام المستخلصات النباتية

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المستخلص

في الآونة الأخيرة، تم تطوير النهج النباتي لتصنيع الجسيمات النانوية عبر تقنيات غير تقليدية وصديقة للبيئة تعتمد على مواد طبيعية. في هذا العمل، تم استخدام طريقة الميكروويف، حيث تم استخدام مستخلص زهرة الكركديه الوردية وجوز الطيب لتصنيع جسيمات أكسيد الحديد النانوية (α-Fe_2O_3) وجسيمات أكسيد الزنك النانوية (ZnO) على التوالي. تم استخدام درجة الانصهار ومطياف الأشعة فوق البنفسجية المرئية (UV-Vis) لفحص وتوصيف الجسيمات النانوية لأكسيد الحديد وأكسيد الزنك. وأظهرت النتائج أن درجة الانصهار Fe_2O_3-NPs و ZnO-NPs كانت أعلى من 300 درجة مئوية تقريبًا، مما يشير إلى تكوين الجسيمات النانوية. تظهر الجسيمات النانوية ارتفاعا كبيرًا في درجة الانصهار حيث يقل حجمها عن ≈10 نانومتر. بالإضافة إلى ذلك، يُظهر أطياف امتصاص UV-Vis لجسيمات أكسيد الحديد النانوية نطاق ذروة رنين البلازمون السطحي (SPR)حوالي 320 نانومتر وجسيمات أكسيد الزنك النانوية يظهر نطاق ذروة رنين البلازمون السطحي (SPR) حوالي 370 نانومتر. لقد تم استخدام طريقة الميكروويف بنجاح في هذه الدراسة، والتي تتمتع بمزايا مقارنة بالطرق الأخرى.

الكلمات الدالة. (Fe_2O_3-NPs)، (ZnO-NPs)، التوليف الأخضر، تحليل الأشعة فوق البنفسجية.