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Original article

Synthesize Iron Oxide and Zinc Oxide Nanoparticles Using Plant Extracts

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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.

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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. Physical, chemical, and green techniques are the three main techniques that have been used in previous studies to synthesize nanoparticles. The physical techniques include three methods: gamma irradiation, spark discharge, and pulse laser ablation. These methods are effective in synthesizing the nanoparticles; however, they require very expensive apparatus. The chemical techniques are low-cost compared with the physical techniques. Unfortunately, it caused environmental pollution due to chemical waste. The green methods are low-cost and environmentally friendly, and because of that, they are commonly considered to synthesize 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]. Previous studies have confirmed that functional groups present in phenolic compounds, for example, the ester group, carbonyl group, and alkene group, are the primary groups in the creation of nanoparticles [6]. Many forms of nanoparticles have been produced by extracting plant

material utilizing a range of plant components, for example, bark, seeds, fruits, flowers, roots, stalks, and leaves [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. The phytochemicals work as capping and reducing agents to synthesize the nanoparticles, which are extracted from Myristica Fragrans and Hibiscus rosa sinensis in this work. 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

To prepare the Fe2O nanoparticles, the first step is collecting hibiscus flower, 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 sixty degrees Celsius for one day. After the drying process, 5 grams of hibiscus were grounded and dissolved in 100 ml of distilled water, which was distilled twice. Boiling the mixture 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. To prepare a 1 mM $FeCl_2.4H_2O$ solution, 0.02 gram of iron chloride tetrahydrate (FeCl2.4H2O) has been used and dissolved in 100 ml of distilled water.

The synthesis of iron nanoparticles has been achieved by heating a mixture of 1 mM $FeCl_{24}H_2O$ and hibiscus flower extract using a convector. The final stage in the extraction of iron nanoparticles was centrifuging the solution at a speed of 3000 rpm for thirty minutes while maintaining a volume ratio of 1:2. After discarding the supernatant, the pellet underwent further centrifugation after being cleaned with distilled water. In order to get rid of any impurities, this procedure is done three times. 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 thirty-seven degrees Celsius 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 ($Zn(NO_3)_2·2H_2O$) to 100 mL of extract, and a magnetic stirrer was used at sixty degrees for 2 hours. The mixture was cooled down to 25 °C and centrifuged at speed 10,000 rpm for 10 minutes. The distilled water has been used to wash the pellets; this process was repeated two times, and then it was dried in an oven at a temperature of ninety degrees Celsius. Finally, the dried material has been ground to convert it 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. For applications involving nanomaterials, the melting temperature of a material, such as nanoparticles or nanorods, is connected to other essential physical characteristics.

The result showed that the melting point of Fe_3O_4 NPs was higher than 320^{oC}, 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 size, shape, and state of aggregation of the nanoparticles all these parameters affect the SPR band's location.

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].

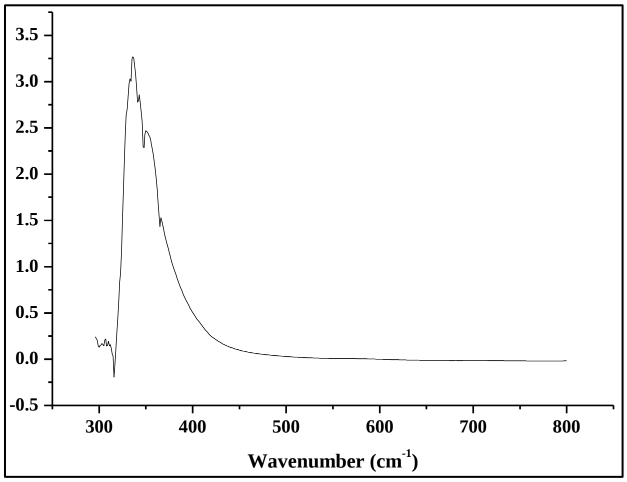

Figure3. The absorption peaks for hibiscus extracts

The UV-Vis absorption spectra of the Zn oxide NPS that was produced using Myristica fragrans extract is illustrated in figure 2. A distinctive peak surface plasmon resonance (SPR) band at around 370 nm was seen in the spectra.

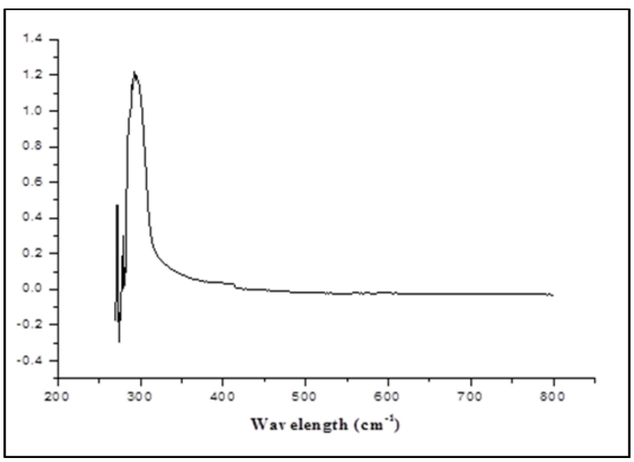

Figure *Error! No text of specified style in document.*. ***The absorption peaks for Myristica fragrans extracts***

CONCLUSIONS

One promising technique for creating environmentally acceptable nanomaterials for biological applications is the green production of nanoparticles utilizing plant extracts. 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 in that it is low-cost, has rapid heating, and is environmentally friendly compared to other methods. The synthesized nanoparticles were characterized by different techniques, such as melting points and ultraviolet (UV) spectroscopy.

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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.