Article

JOURNAL OF UNIVERSITY OF BABYLON
For Pure and Applied Sciences (JUBPAS)
Special Issue 2: Proceedings of Al-Muthanna University's First Conference/Directing Scientific Research Towards Achieving Sustainable

Vol, 33; S.2 | 2025

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652

Green-Synthesis of ZnO, FeO And Fe doped ZnO Nanoparticles From Leave Extract of Leucaena Leucocephala *L.*

Ban Ghany Showy[1], Mahmood Basil Mahmood[2]

1College of science, University of Baghdad, ban.gany@yahoo.com,07717357472, Baghdad, Iraq,
2College of science, University of Baghdad, email:mahmoodbasel544@gmail.com, Baghdad, Iraq,

Corresponding Author: ban.gany@yahoo.com

Published: **31/8/2025**

ABSTRACT

Background: the green synthesis methods of nanoparticles have attracted great attention. Zinc oxide (ZnO) is considered one of the most studied nanoparticles due to its nontoxic nature and low ,cost and iron oxide (FeO) nanoparticles due to their superparamagnetic properties. In this study, ZnO, FeO and Fe-doped ZnO NPs were synthesized from leaf extract of Leucaena leucocephala *L.*

Methods: we have been using green methods in the synthesis of this nanoparticles by preparing plant extract and then preparing the Zno, FeO, Fe-doped ZnO nanoparticles and characterizing these nanoparticles by several methods to confirm the formation of nanoparticles.

Result: the green synthesis of the ZnO, FeO, doped Fe-ZnO nanoparticles was confirmed by AFM and further characterized by UV-Vis and EDX. UV-VIS showed peak at 290nm (ZnO), 190nm(FeO), 300nm Fe-ZnO Nps. AFM revealed an average diameter of ZnO 40.67nm, FeO was 42.44nm, while doped Fe-Zno was 122.8nm. EDX confirms the formation of ZnO, FeO, doped Fe-ZnO nanoparticles. this green synthesis method was observed to be ecofriendly and cost-effective method in the synthesis of ZnO, FeO, doped Fe-ZnO nanoparticles by Leucaena leucocephala *L.*

Conclusion: The result confirms the potential of Leucaena leucocephala *L* for the synthesis of the ZnO, FeO,-doped Fe-ZnO nanoparticles in simple, cost-effective, ,easy and ecofriendly methods.

Keyword: ZnO, FeO, doped Fe-ZnO, green synthesis, Leucaena leucocephala *L.*

Article
JOURNAL OF UNIVERSITY OF BABYLON
For Pure and Applied Sciences (JUBPAS)
Special Issue 2: Proceedings of Al-Muthanna University's First Conference/Directing Scientific Research Towards Achieving Sustainable
Vol, 33; S.2 | 2025

مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652

1. INTRODUCTION

The nanomaterials study is one of the most developed and fastest in the science of materials. Nanoparticle size less than 100 nm [1]. The NPs in nanoscale dimensions have high reactivity in contrast to larger forms of nanoparticles due to high surface area of Nps in nanoscale dimensions [2]. ZnO has attracted great interest in many fields, such as physics, ,chemistry ecology , ,medicine and many other fields [3]. There were many transition metal ions, as Cu^2, Co^2, and Fe3 have been used as dopants for Zno, with the object of adjusting some of their characteristics [4]. Specifically, iron has been investigated orderly to progress electrical, ,optical and magnetic characteristics [5]. Ferric was identified as a dopant of zinc oxide Nps because its d electron easily overlaps with the zinc oxide valence band [6]. Iron-doped zinc oxide Nps have an enhancement that includes antibacterial & magnetic properties; for this purpose, many approaches have been utilized for the zinc oxide-doped transition metal NPs. That mechanism involved the use of toxic chemical ,solvents which negatively affected the environment [7]. Iron-doped zinc oxide Nps can promote magnetic characteristics and antibacterial properties. Many producers used transition metal-doped Zinc oxide Nps, this technique included the use of harmful chemicals that harmfully affectthe ecology. Green synthesis of nanoparticles has attracted great attention due to the use of plants to for the manufacture of the Nps [8]. Many traditional methods have been used to synthesize of Nps as studies have shown it's effective but costly and generates toxic byproducts; many of these chemicals are dangerous to the ecosystem and human and animal's health due to the compound and reactive nature of these chemicals [9; 10].Unlike green-synthesis methods, they are much more effective in the generation of Nps, as they are inexpensive, easy to characterize, and less likely to fail [11;12].Plant extracts have great possibility for the manufacturing of nanoparticles with desired shape and size. Lately, the manufacture of nanoparticles by green methods has become common among investigators because it is cost effective and manufactured at low cost, synthesized in the surrounding environment, not toxic, etc. The extract of plant was very bright method for the simplistic manufacture of nanoparticles by green methods [13;14;7]. In this study, undoped ZnO, FeO and doped Fe-ZnO has been synthesis by using safe, ecofriendly green synthesis using leaf extract from Leucaena leucocephala *L*.

2.MATERIALS AND METHODS

Zinc acetate dehydrate ($Zn(CH_3COO)_2 . {}_2H_2O$). Ferric acetate dehydrates ($Fe (CH3COO)_3 . {}_2H_2O$), deionized sterile and distilled water.

2.1 Green method in synthesis of undoped zinc oxide, IRON oxide and Fe doped ZnO Nps by Leucaena leucocephala *L*

Fresh leaves of Leucaena leucocephala *L* plants were collected, weighed (30g) and rinsed by tap water to eliminate the dust and then rinsed by distilled water. Afterward, in 100 ml of distilled water, the washed leaves are ground by a grinder. A mixture was filtered using filter paper; after that, the mixture was centrifuged by centrifuge at 6000 rpm for 25 min, then the supernatants were filtered, and then the extract was refrigerated at 4 ºC for further use.

2.2 Method of synthesis

2.2.1 Preparation of ZnO Nps

It's done according to [15] with some modification by adding 10 grams of zinc acetate into 100 ml of plant extract; afterwards, a mixture has been cultivated at 37°C for twenty-four hours and shaken at 120 rpm. The color change is an indication of synthesis of ZnO. The mixture has been centrifuged after twenty-four hours, and then a precipitate followed by washing thrice by deionized water to remove any residual plant extract. The supernatant was dried in an incubator at 37°C and kept for further examination.

2.2.2 Preparation of FeO Nps

It's done by adding 10 g of $Fe (CH_3COO)_2 . {}_2H_2O$ in to100ml of plant extract; afterward a mixture has been cultivated at 37°C for 24hr. then in shaking condition for 120 rpm. The color change is an indication of the synthesis of Nps. A mixture has been centrifuged after 24 hr. Afterward, a precipitate followed, washed thrice by deionized water to remove any residual plant extract. The supernatant was dried in an incubator at 37°C and kept for further examination.

2.2.3 Preparation of Fe doped ZnO Nps

It's done according to [16].by adding 10 g of $Zn (CH_3COO)_2 . {}_2H_2O$ and 10 g of $Fe (CH_3COO)_2 . {}_2H_2O$ in to 200ml of plant extract; afterward, a mixture has been cultivated at 37°C for twenty-four hours also in shaking condition at 120 rpm. The color change is an indication of the synthesis of Nps. A mixture has been centrifuged for twenty-four hours. Then collected a precipitate, followed by washing thrice with deionized water to remove any residual plant extract. The supernatant was dried in an incubator at 37°C and kept for further examination.

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652

مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652

2.3 Characterization of nanoparticles

Several analysis methods were used to characterize the Nps.

2.3.1 Ultra-Violate Visible Light Spectroscopy (UV-Vis)

An optic absorbs part of the spectrum. Nanoparticle solutions have been examined using a double-beam Uv-vis spectrometer model (Shimad zu1 1800). The examination of the UV-Vis spectra was completed between 190 and 1200 nm.

2.3.2 Atomic force spectroscopy (AFM)

The AFM system (AA-300-USA) has been used to determine topography surface, granular and coarse size and other surface features of undoped ZnO, FeO, doping Fe-ZnO nanoparticles. A glass slide was created with a thin coating of nanoparticles. Adding 50 µl of the particles and letting them dry for 5 min, the slides were scanned. Root mean square roughness and grain size. Were chosen as typical data from AFM height images. According to [17], the crystalline coefficient was extraction.

2.3.3 Energy dispersive X-ray (EDX)

The EDX was a mechanism of basic examination linked with electron microscopy that depended on X-rays that show the existence of compounds found in the sample [18].

3. RESULT AND DISCUSSION

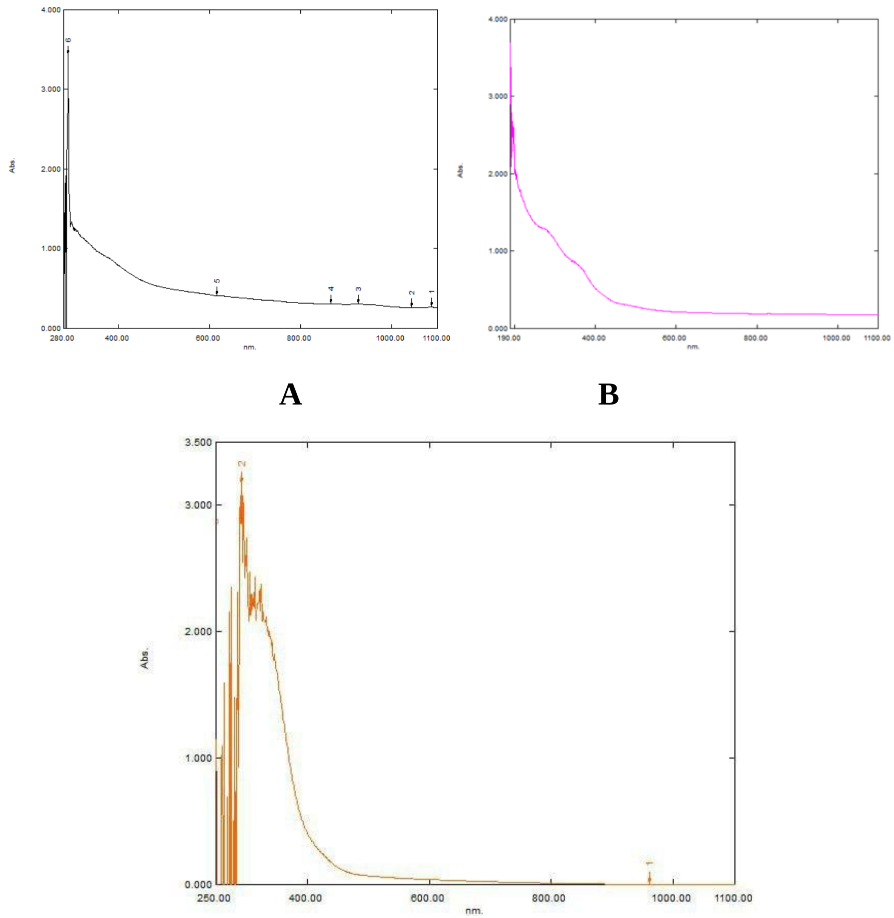
3.1 Characterization Nanoparticles

3.1.1 Ultra-Violet Visible Light Spectroscopy (UV-VIS)

It reveals the optical character of green synthesis ZnO Nps. Absorbance peak existence at around 290nm as shown in figure (1, A) this finding is similar to another finding reported by [19]. While the result shown in fig (1, B) represents UV-VIS to FeO nanoparticles, this peak was observed to be around 190nm due to surface plasma resonance of synthesized FeO nanoparticles. The peak in figure (1, C) represents the result of ZnO-FeO nanoparticles; it is revealed around 300nm.

مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652



C

Figure (1): A: Range of ZnO. B: Rang of FeO. C: rang of ZnO-FeO nanoparticles synthesis by Leucaena leucocephala *L*.

3.1.2 Atomic Force Microscope (AFM)

Used to examine a crystalline structure, the surface features, and the coarseness of the zinc oxides, FeO and Fe-doped zinc oxide Nps nanoparticles thin film. The average diameter of the Zno was :40.67 nm, this finding agrees with [20], which ranged from 20-40 nm. While average diameter of FeO is 42.44nm as show in figure (4) this result agree with [21] The average diameter of doped ZnO-FeO is 122.8nm figure (6) .

Article
JOURNAL OF UNIVERSITY OF BABYLON
For Pure and Applied Sciences (JUBPAS)
Special Issue 2: Proceedings of Al-Muthanna University's First Conference/Directing Scientific Research Towards Achieving Sustainable
Vol, 33; S.2 | 2025

مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652

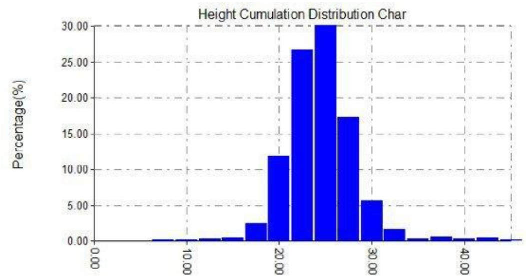
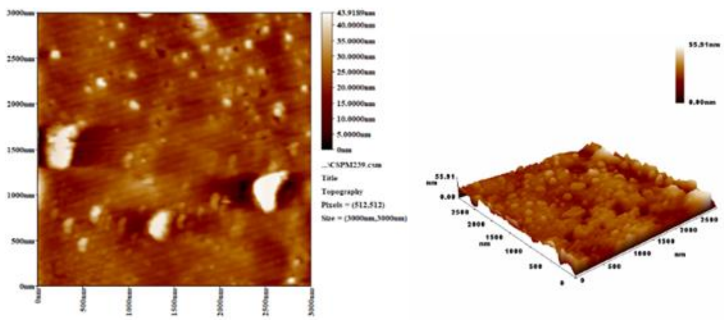


Figure (2): average size of zinc oxides Nps



2D 3D

Figure (3):AFM of ZnO nanoparticles synthesis by Leucaena leucocephala *L*

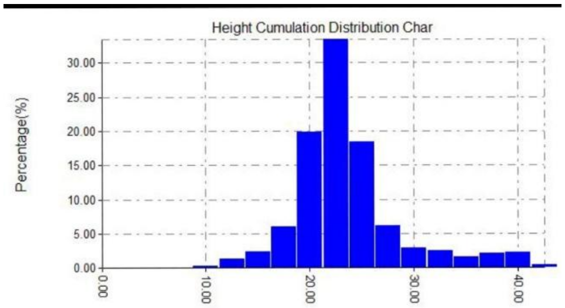
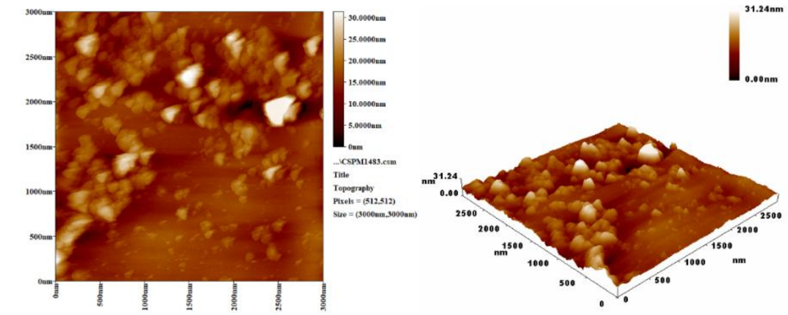
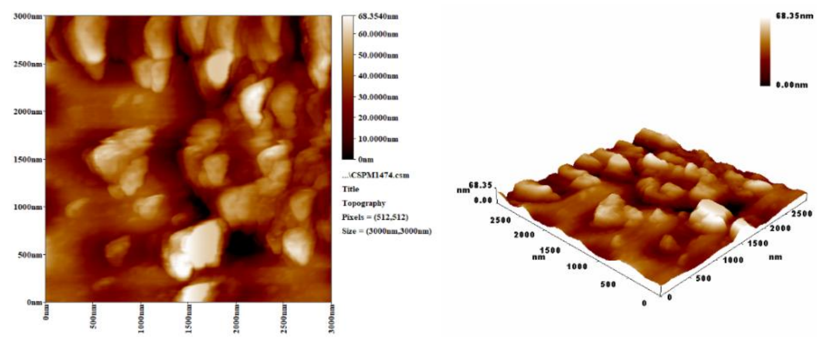


Figure (4): average size of FeO nanoparticles



2D 3D

Figure (5):AFM of FeO nanoparticles synthesis by Leucaena leucocephala *L*



2D 3D

Figure (6): AFM of ZnO-FeO nanoparticles synthesis by Leucaena leucocephala *L*

3.1.3 Energy dispersive x-ray (EDX)

EDX was used to define the composition of elements of the sample's chemical composition. Figure (9) shows the presence of a peak of Zn and O, indicating the formation of ZnO nanoparticles. The composition of FeO nanoparticles was analyzed by using EDX and confirmed the formation of FeO nanoparticles, figure (10) represent peak of Fe and O. while figure (11) show result of EDX technique of the doped Zno-FeO nanoparticles.

مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652

مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652

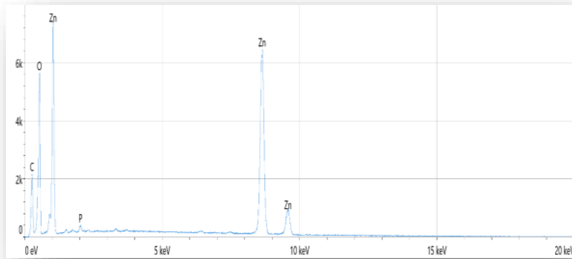


Figure (7): EDX of ZnO nanoparticles

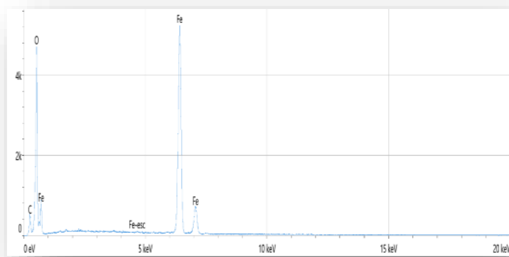


Figure (8): represent EDX of FeO nanoparticles

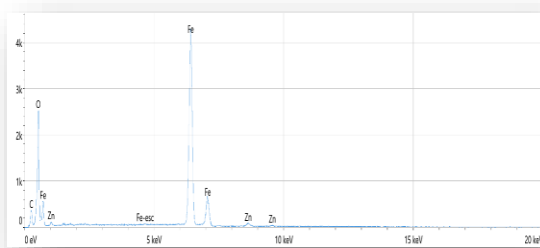


Figure (9): represent EDX of Fe doped ZnO nanoparticles

5. CONCLUSION

ZnO, FeO, doped Fe-ZnO were successfully synthesized by leaf extract of Leucaena leucocephala *L*. Verified by UV-VIS, AFM, and EDX techniques. UV–Vis analysis showed a surface plasmon resonance band; this indicates the presence of ZnO, FeO, doped Fe-ZnO. EDX has proven the purity of synthesized ZnO, FeO and doped Fe-ZnO. The result confirms the potential of Leucaena leucocephala *L* for the synthesis of the ZnO, FeO, and doped Fe-ZnO nanoparticles in simple, cost-effective, easy, and ecofriendly methods.

6. ACKNOWLEDGMENT

I gratefully thank my supervisor, Dr. Mahmood Basil Mahmood, who has always been generous during all phases of the research, and I owe so much to my whole family for their support and their unwavering belief that I can achieve so much because of their unconditional love and prayers.

Conflict of interest.

There are non-conflicts of interest.

References

1. N. Joudeh, and D. Linke . Nanoparticle classification, physicochemical properties, characterization, and applications: a comprehensive review for biologists. *J Nanobiotechnol* **20**, 262. https://doi.org/10.1186/s12951-022-01477-8,2022.
2. A.K.N AL-jubouri. and M. A. Kadhim. Anti-inflammantory and anti-bacterial activity of copper nanoparticles synthesized from myrtus communis leaves extract. Iraqi Journal of agriculture sciences, 53(3), 698-711,2022.
3. T. Lakshmipriya and S. Gopinath. Introduction to nanoparticles and analytical devices. Nanoparticles in Analytical and Medical Devices. Pages 1-29,2021.
4. Sikam, Pornsawan; Moontragoon, Pairot; Ikonic, Zoran; Kaewmaraya, Thanayut; Thongbai, Prasit . The study of structural, morphological and optical properties of (Al, Ga)-doped ZnO: DFT and experimental approaches. Applied Surface Science, (), S0169433219306129–. doi:10.1016/j.apsusc.2019.02.25, 2019.
5. Y. Liang, J. Xie, J.Yu, Z. Zheng, F. Liu, & A. Yang. Recent advances of high performance magnetic iron oxide nanoparticles: Controlled synthesis, properties tuning and cancer theranostics. Nano Select, 2(2), 216–250. doi:10.1002/nano.202000169,2020.

مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652

6. M. Carofiglio, S. Barui, V. Cauda and M. Laurenti. Doped Zinc Oxide Nanoparticles: Synthesis, Characterization and Potential Use in Nanomedicine. Appl Sci (Basel). Jul 28;10(15):5194. doi: 10.3390/app10155194. PMID: 33850629; PMCID: PMC7610589,2020.

7. H.Y. Chai, S. M. Lam, and J.C. Sin. Green synthesis of magnetic Fe doped ZnO nanoparticles via Hibiscus rosa-sinensis leaf extracts for boosted photocatalytic, antibacterial and antifungal activities. Materials Letters,116, 2019.

8. W. Bousslama, H. Elhouichet and M. Ferid. Enhanced photocatalytic activity of Fe doped ZnO nanocrystals under sunlight irradiation. Optik. 134,88–98,2017.

9. I.N.B Hussain, A. Singh, *et al*. Green synthesis of nanoparticles and its potential application. Biotechnol Lett, 38:545-560,2016.

10. A. Gour and N. K. Jain. Advances in green synthesis of nanoparticles. Artificial cells Nanomedicine and biotechnology, 47(1),844-851.2019.

11. Hussain, H. M., Mahmood, M. B., & Yaaqoob, L. A. (2024). The Biological Effect of Synthesized Zinc Oxide Nanoparticles on Organic Pollutions in Drinking Water. Iraqi Journal of Science. 65 (8), 4246-4255 DOI: 10.24996/ijs.2024.65.8.10.

12. H.M. Abuzeid, CH. M. Julienm and Zhu L. and A. M. Hashem. Green synthesis of nanoparticles and their energy storage, environmental and biomedical applicaton Crystals,13(11) :1576,2023.

13. M.A. Al-Shammary, and I.K. Al-Mayaly (2024). Green synthesis of zinc oxide nanoparticles from Lyngbya sp. and their antibacterial activity, Iraqi Journal of Science, 65(8), Article 13,2024.

14. M.J. Tuama, and M.F.A. Alias. Ecofriendly synthesis of ZnO nanoparticles using Zingiber officinale and Syzygium aromaticum extracts for antibacterial applications. Iraqi Journal of Science, 65(8-SI), 4772-4787,2024.

15. N. Bala, S. Saha, M. Chakraborty, M. Maiti, S. Das and R. Basu and P. Nandy. Green synthesis of zinc oxide nanoparticles using Hibiscus subdariffa leaf extract: effect of temperature on synthesis, anti-bacterial activity and anti-diabetic activity. RSC Advanced.,5, 4993-5003,2015.

16. M. Alnuaimi, N. Hamdan, and E. Al-Rheem & Z. Al-Janabi. Biodegradation of malathion pesticide by silver bio nanoparticles of Bacillus licheniformis extracts. Research on Crops, vol.20,79-S84, 2019

17. M. D. A. Ali, T. Ahmed, W. Wu, A. Hossain, Hafeez M. D., M. Masum , Y. Wang, Q. An, and G. Sun & Li B. Advancements in plant and microbe-based synthesis of metallic nanoparticles and their antimicrobial activity against plant pathogens. Nanomaterials.6(10),2020

18. L. Yang, L. Y Tu and H. Tan. Influence of atomic force microscope (AFM) probe shape on adhesion force measured in humidity environment. Applied Mathematics and Mechanics, 35, 567–574, 2014.

19. G. H.Vale De Macedo, G.D Costa , E. R. Oliveira, G. V. Damasceno, J. S. Mendonça, L. D. Silva, V. L. Chagas, J. M Bazán, A. S. Aliança, R. D. Miranda, A. Zagmignan, A. D. Monteiro, and L. C. Da Silva.

مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652

Interplay between ESKAPE Pathogens and Immunity in Skin Infections: An Overview of the Major Determinants of Virulence and Antibiotic Resistance. Pathogens,10, 2021.

20. T. Shah and S. Surendar & Singh S. green synthesis of zinc oxide nanoparticles using annas colossus extract: preparation, characterization and antimicrobial efficacy, cureus., 15,2023.

21. N. Goswami and D. Sharma .Structural and optical properties of unannealed and annealed ZnO nanoparticles prepared by a chemical precipitation technique. PhyisicaE: Low Dimensional systems and Nanostructures, 42,168,2010.

مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652

Article

JOURNAL OF UNIVERSITY OF BABYLON
For Pure and Applied Sciences (JUBPAS)
Special Issue 2: Proceedings of Al-Muthanna University's First Conference/Directing Scientific Research Towards Achieving Sustainable

Vol, 33; S.2 | 2025

باستخدام مستخلص اوراق نبات اللوكاينا ليكوسيفالا ZnO, FeO And Fe doped ZnO التخليق الاخضر للجسيمات

بان غني شواي[1] محمود باسل محمود[2]

[1] كلية العلوم, جامعة بغداد07717357472,ban.gany@yahoo.com, بغداد, العراق

[2]كلية العلوم, جامعة بغداد.email:mahmoodbasel544@gmail, بغداد العراق

الخلاصة:

الخلفية: تُعد جسيمات أكسيد الزنك من أكثر الجسيمات النانوية دراسة نظرًا لكونها غير سامة ومنخفضة التكلفة، في حين أن جسيمات أكسيد الحديد تحظى باهتمام كبير لامتلاكها خصائص فائقة المغناطيسية. في هذه الدراسة تم تحضير اكسيد الزنك واكسيد الحديد والحديد المتحد باوكسيد الزنك باستخدام مستخلص أوراق نبات اللوكاينا ليوكوسيفالا.

الطرق: تم استخدام الطرق الخضراء في تحضير هذه الجسيمات النانوية من خلال إعداد مستخلص نباتي وقد جرى توصيف هذه الجسيمات باستخدام عدة تقنيات لتأكيد تكوينها.

النتائج: تم تأكيد التخليق الأخضر لجسيمات اكسيد الزنك,اكسيد الحديد والزنك المتحد بالحديد باستخدام مجهر القوة الذرية، إضافةً إلى توصيفها بواسطة مطيافية الأشعة فوق البنفسجية المرئية وتحليل حيود الأشعة السينية المشتتة للطاقة. واظهرت نتائج طيافية الأشعة فوق البنفسجية المرئية قمم امتصاص عند 290 نانومتر لاكاسيد الزنك، و190 نانومتر لاكاسيد الحديد، و300 نانومتر لـ اكاسيد الزنك المتحدة بالحديد. أما نتائج مجهر القوة الذرية فقد بينت أن متوسط القطر كان 40.67 نانومتر لـ اكاسيد الزنك، و42.44 نانومتر لاكاسيد الحديد ، و122.8 نانومتر لاكاسيد الزنك المتحدة بالحديد وأكدت نتائج تحليل حيود الأشعة السينية المشتتة للطاقة تكوين الجسيمات النانوية الثلاثة. وقد لوحظ أن هذه الطريقة الخضراء تُعد صديقة للبيئة وذات جدوى اقتصادية في تحضير الجسيمات النانوية.

الاستنتاج: تؤكد النتائج إمكانية استخدام مستخلص اوراق نبات اللوكاينا في تحضير جسيمات اكاسيد الزنك واكاسيد الحديد والزنك المتحد بالحديد بطريقة بسيطه, صديقة للبيئه ومنخفضة التكاليف.

الكلمات المفتاحية: اكاسيد الزنك, اكاسيد الحديد, اكاسيد الزنك المتحد بالحديد, الصناعه الخضراء, اللوكاينا.

مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية مجلة جامعة بابل للعلوم الصرفة والتطبيقية

info@journalofbabylon.com | jub@itnet.uobabylon.edu.iq | www.journalofbabylon.com ISSN: 2312-8135 | Print ISSN: 1992-0652