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A Review On: Green Synthesis Of Copper Nanoparticles By Using Neem Leaves Extract And Their Conjugation With Eggshell Derived Calcium Carbonate For Targeted Drug Delivery

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Abstract

Nanoscale metals are mainly synthesized by chemical methods that have unwanted & noxious effects such as environmental
pollution, more energy consumption, and health problems. By addressing this challenges, green synthesis in which plant extracts are used instead of industrial chemical agents to reduce metal ions, has been developed. The research focus on an eco-friendly method to synthesis copper nanoparticles using neem (*Azadirachta indica*) leaf extract, which naturally work as a reducing and stabilizing the particles. It also involves extracting calcium carbonate ($CaCO_3$) from discarded eggshells and combining it with the nanoparticles to produce a CuNP–$CaCO_3$ nanocomposite. This sustainable process will avoids harmful chemicals and makes use of biodegradable waste. The final nanocomposite will be stable, biocompatible, and shows promise for use in drug delivery and other medical applications.

Keywords: Green synthesis, nanoparticles, eco-friendly medicine, drug delivery.

Introduction

Nanotechnology has grown a lot lately, especially in making nanoparticles for medicine. Copper nanoparticles (CuNPs) are popular because they can kill bacteria and fungi and have other helpful properties. In this study, these copper nanoparticles will synthesis using neem leaves, which help both to turn copper ions into particles and to keep them stable without harmful chemicals. At the same time, calcium carbonate ($CaCO_3$) will extract by using eggshells, a natural and safe material often used in medicine to carry drugs because it can break down under certain conditions. The copper nanoparticles and calcium carbonate will be combining using a biodegradable polymer that will hold them together and help control drugs released. After combining, these materials are expected to work better together—copper nanoparticles fight germs while calcium carbonate helps deliver the medicine effectively. Although this idea is still theoretical, it suggests a new, environmentally friendly way to deliver drugs that could be safer and more efficient.

Ingredients

I. Biological agent**:**

- Plant name- Neem
- Scientific name- *Azadirachta indica*
- Chemical constituents-

Fig no. 1 Neem Leaves

Azadirachtin: A potent insect repellent and growth inhibitor, also exhibiting anti-inflammatory and antimicrobial properties.

Nimbidin: An anti-inflammatory and analgesic compound.

Nimbin: Another limonoid with anti-inflammatory and insecticidal properties. Gedunin: A limonoid with anti-inflammatory and antiviral properties.

Quercetin: A flavonoid with antioxidant and anti-inflammatory effects.

II. Bio-waste:

Eggshells- for extraction of calcium carbonate III.Metal salt:

Copper sulphate IV.Distilled water

V. ph stabilizing agent: NaOH

Requirement

Fig no. 2 Eggshells

Equipment	Glassware
Magnetic stirrer	Beaker
Hot plate	Flask
Ultrasonic bath	Pipettes
Oven	Petri dish

1. Green synthesis of CuNP

2. Neem leaves extraction

First of all washing neem leaves with tap water thoroughly, washing off dirt properly. Then wash with distilled water to make more clean. Dry the leaves at room temperature for eliminating moisture content from leaves. After drying weigh 20-25g of neem leaves, emerge the leaves into distilled water (250-300ml). Boil the leaves for 45min. Cool it. After cooling, filter the extract and store at cool place for further use.

3. Preparation of metal solution

Make a stock solution, 0.1M of CuSO (in 100ml distilled water). Store for further use.

4. Mixing

Mix 80ml of salt solution into 20ml of neem extract. Adjust the pH of solution at 12 by adding 2M of NaOH. Heating and mixing simultaneously at 60°C for 4hrs.

Colour changes & brown ppt will form. Store the obtained solution at dark place for whole night.

5. Centrifugation

Next day centrifuge the solution at 5000rpm for 10-15min.

6. Collection of NP

Discard the liquid then collect the settled ppt.

7. Washing & Drying of NP

Wash the nanoparticles with distilled water until the debris flow off. Dry the particles at 50°C for half hour. Store at cool & dry place.

1.A Confirmatory test for Neem extract

❖ Alkaloid test

Add few drops of Mayers reagent to the extract. Cream/ white ppt indicates presence of alkaloids.

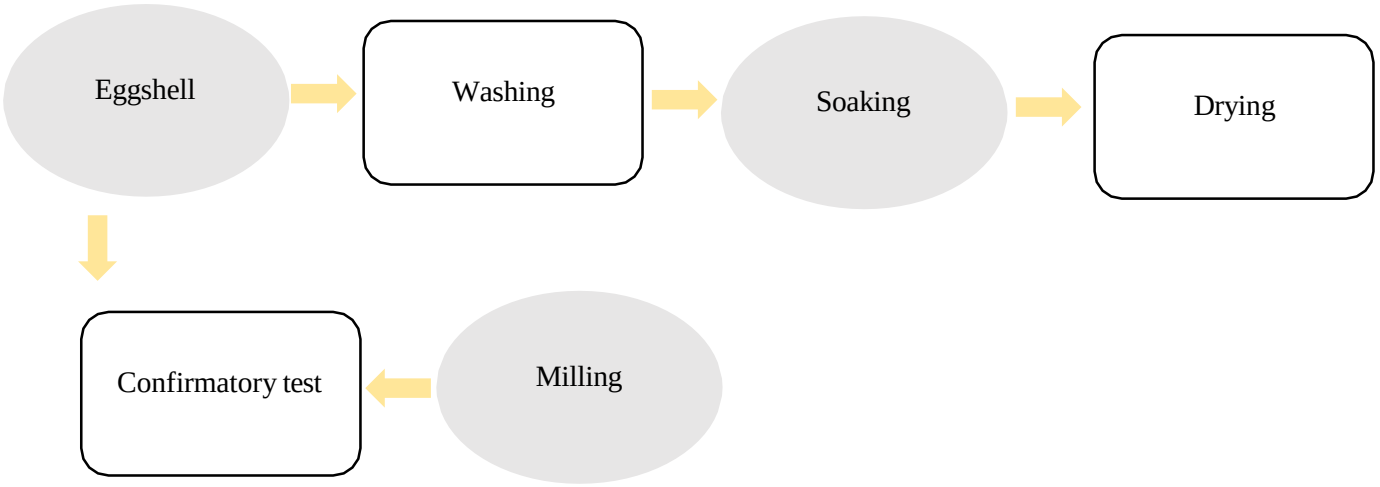
❖ Tannis test

Add few drops of 1% of ferric chloride to the extract. Greenish- black colour indicates presence of tannis.

❖ Terpenoids test

Add chloroform & conc. H_2SO_4 to the extract. Reddish- brown interface indicates presence of terpenoids.

2. Extraction of Calcium carbonate



2.A Confirmatory test for $CaCO_3$

- Acid test:

When a sample of calcium carbonate is treated with a dilute acid hydrochloric acid (HCl) fizzing or effervescence is seen.

- Flame Test:

Calcium carbonate contains calcium ions (Ca^{2+}). When a sample of calcium carbonate is heated in a flame, it will produce a brick- red color in the flame.

- Water test:

When we add calcium carbonate in water, calcium carbonate is insoluble and a layer will form.

3. Conjugation of CuNP & $CaCO_3$

Mixing copper nanoparticles & calcium carbonate with the help of bio-degradable polymer for a novel drug delivery. Bio-degradable polymers are:

1. Cellulose
2. Starch
3. chitin
4. Polylactic acid (PLA)
5. Polyglycolic acid (PGA)

Characterization of CuNP

1. UV Spectroscopy of copper nanoparticles

It used to evaluate the absorbance of nanoparticle at different concentration.

Methodology: Dissolving copper nanoparticles in suitable solvent (like methanol, ethanol).

2. XRD of copper nanoparticles

It shows the size & shape of a particle.

Drug Delivery

After forming a nanocomposite, drug delivery is done by using UV Spectroscopy. The analysis will provide clear and unambiguous data.

Applications

Copper nanoparticles (CuNPs) are widely recognized for their strong antimicrobial properties. When incorporated into a calcium carbonate ($CaCO_3$) matrix, the resulting nanocomposite exhibits enhanced surface area and stability, making it highly effective in antimicrobial applications. These composites can be utilized in:

- Wound Dressings: The antibacterial action of CuNPs helps prevent infections and promotes a sterile healing environment.
- Surgical Instruments: Coatings of CuNPs-$CaCO_3$ nanocomposites on surgical tools can reduce the risk of bacterial contamination during medical procedures.
- Antibacterial Paints and Textiles: The nanocomposite can be applied to coatings or fabrics to provide long-term antimicrobial protection in clinical, industrial, or consumer settings.
- Targeted Drug Delivery: Calcium carbonate serves as a safe, biodegradable carrier that can release drugs in response to pH changes in the body. When paired with CuNPs, the composite not only delivers medication effectively but may also assist in imaging or provide therapeutic effects due to copper's biological activity.
- Bone Regeneration and Healing: $CaCO_3$ contributes to bone growth due to its similarity to natural bone minerals. Adding CuNPs enhances the material by encouraging new blood vessel formation (angiogenesis) and preventing bacterial infections, making it promising for use in bone implants or scaffolds.

Conclusion

Green synthesis of nanoparticles approaches environmental friendly method that uses natural materials to produce nanoparticles. It offers a wide range of advantages such as improved safety, best performance, reduces environmental impact, and potential for large-scale use. With applications for areas like healthcare, environmental protection, energy, and electronics, this technology plays a key role in driving innovation toward more sustainable and eco-friendly solutions. Green-synthesized of Copper nanoparticles conjugated with eggshell-derived calcium carbonate offer a novel, sustainable & biocompatible platform for targeted drug delivery, enhancing drug loading and release. Further research will highlight clinical applications.

References

1. Mongar Priya *et al.*, Green synthesis, characterization, antibacterial and antifungal activity of copper oxide derived from

Morinda citrifolia leaf extract, Scientific Reports, 13: 18838 (2023)

2. Mrs.D.Gueudevi, Dr.Ch.Sirisha, Green synthesis of copper nanoparticles using neem *(Azadirachta Indica*) leaf extract and their antimicrobial activity, UGC Care Group I. Journal, Dogo Rangsang Research Journal, Vol- 13, Issue-2, no.1, February 2023

3. Akshit Singh *et al*, Review on the extraction of calcium supplements from eggshells to combat waste generation and chronic deficiency, Environmental Science and Pollution Research (2021)

4. Hayrunnisa nadaroğlu1, azize alayli güngör, selvi ince, Synthesis of Nanoparticles by Green Synthesis Method.

5. Shuaixuan Ying a, Zhenru Guan a *et al.*, Green synthesis of nanoparticles: Current developments and limitations.

6. Jagpreet Singh, Tanushree Dutta *et al.*, Green synthesis of metals and their oxide nanoparticles: applications for environmental remediation.

7. Asmaa Mohamed El Shafey, Green synthesis of metal and metal oxide nanoparticles from plant leaf extracts and their applications: A review.

8. Hutchison JE. Greener nanoscience: a proactive approach to advancing applications and reducing implications of nanotechnology. ACS Nano. 2008;2(3):395–402. doi: 10.1021/ nn800131j.

9. Singh, R. K., *et al*. "Green synthesis of nanoparticles using plant extracts." Journal of Nanoscience and Nanotechnology

18.10 (2018): 1-9

10. Singh, R. K., *et al*. Green Synthesis of Nanoparticles. Springer Nature, 2020.

11. Albrecht, M. A., *et al*. Green Nanotechnology: A Guide to the Synthesis and Applications of Green Nanomaterials. CRC Press, 2019.

12. Lema Yadeta Gemachu & Asnake Lealam Birhanu, Green synthesis of ZnO, CuO, and NiO nanoparticles using Neem leaf extract and comparing their phoyocatalytic activity under solar irradiation, Green chemistry letters and reviews, pg no. 3 (2023).

13. Akshita Singh *et al*, Review on the extraction of calcium supplements from eggshells to combat waste generation and chronic calcium deficiency, Published online: 16 July 2021.

14. Miss. Durvakshi Mahajan, Mr. Satish Thakar, Calcium Extraction from Waste Egg Shell: A Novel Approach.

15. Pralhad K. Kande *et al*., A review on disintegrating control matrix tablet, journal of drug delivery and therapeutics. 2018;8(5):19-22.

16. Mrs. D. Gurudevi et al., Green synthesis of copper nanoparticles using neem (*Azadirachta Indica*) leaf extract and their antimicrobial activity, Dogo Rangsang research journal vol-13, issue 2, no.1 Feb 2023.

17. Ana M. Ferreira *et al*., $CaCO_3$ crystals as versatile carriers for controlled delivery of antimicrobials, journal of controlled released 328 (2020) 470-489, 5 September 2020.