IOCN 2025 Conference
The 5th International Online Conference on Nanomaterials
22–24 September 2025 | Online
MDPI

A Sustainable Route to Iron Oxide Nanoparticles: A Plant-Based Approach Using Spinach

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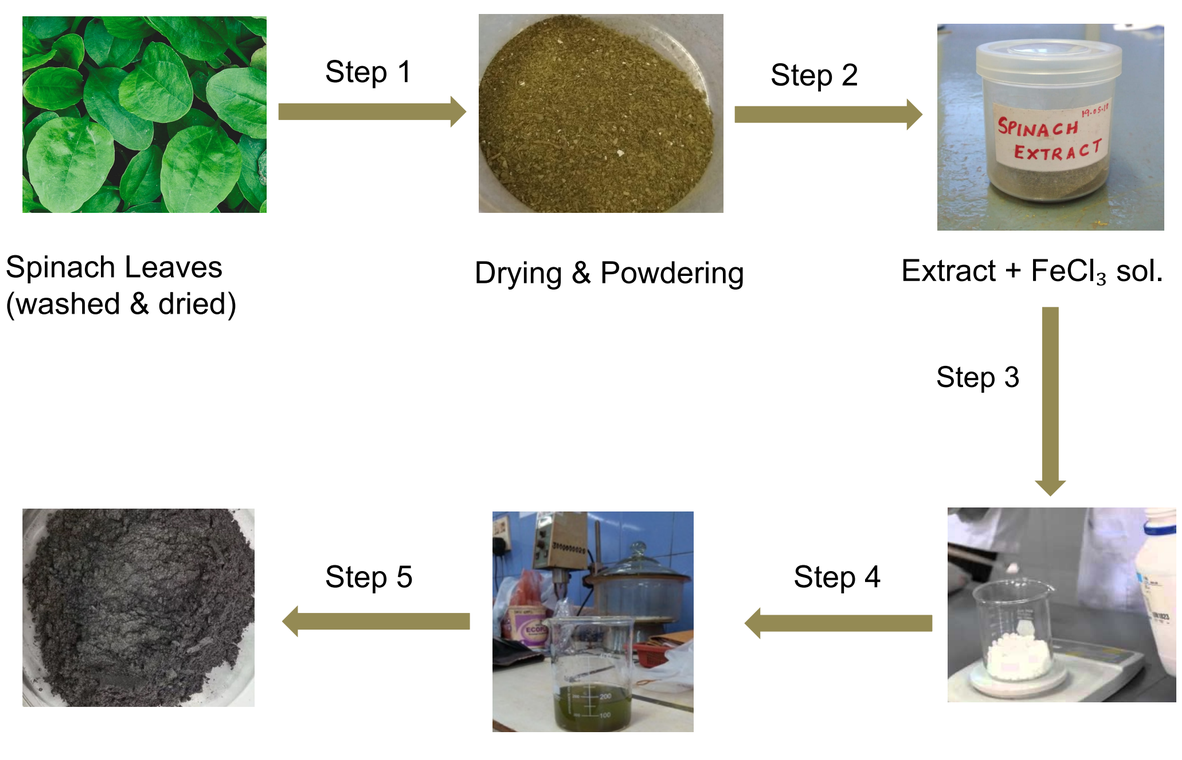
Introduction & Aim

Background
- Conventional nanoparticle synthesis relies on toxic chemicals and energy-intensive processes.
- Green synthesis avoids hazardous chemicals & energy-intensive processes.
- Plant extracts = natural reducing & stabilizing agents (flavonoids, phenolics, ascorbic acid).
- Sustainable nanomaterials align with green chemistry principles and reduce environmental impact.

Why Spinach?
- Spinacia oleracea = high iron content, easy to process.
- Rich in phytochemicals that assist nanoparticle formation.
- Widely available, low-cost, edible source.

Aim of Study
- Synthesize iron oxide nanoparticles using spinach leaf extract.
- Conduct preliminary characterization (XRD and TEM) with further analysis in progress.
- Explore potential applications as eco-friendly pigments with a minimal environmental footprint.

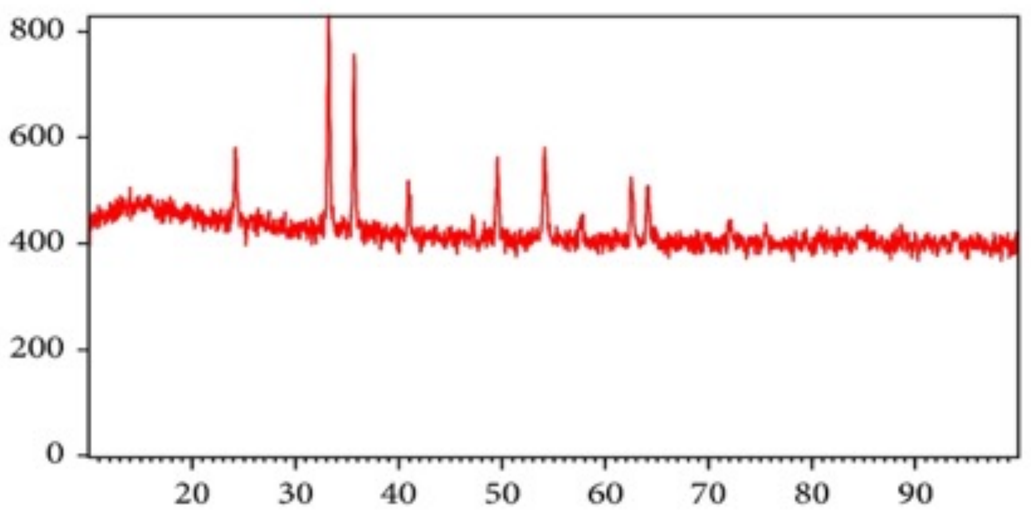
Method



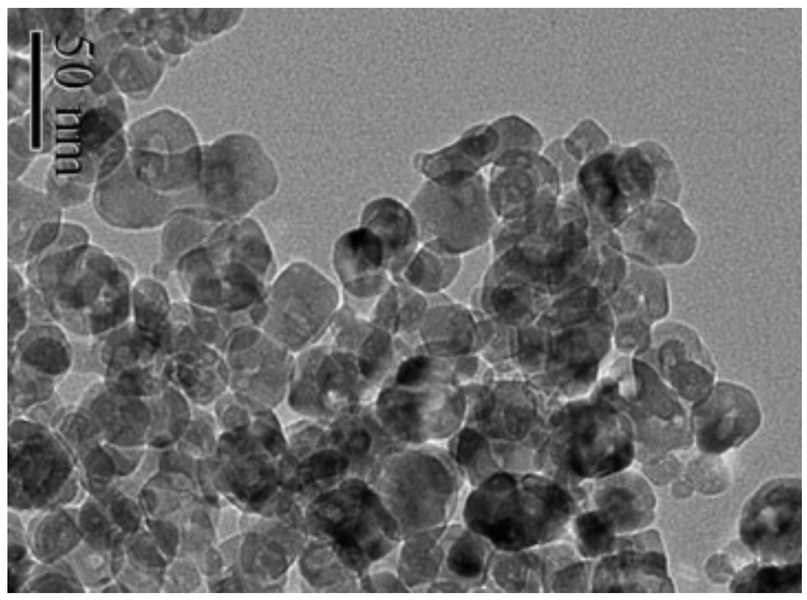
Results & Discussion

Visual Observation
- Distinct Color change (green → brownish-black) confirmed nanoparticle formation.
- Pigment-like appearance consistent with iron oxide nanoparticles.

XRD Analysis
- XRD showed distinct peaks at ~33° and ~35° (2θ), corresponding to the (104) and (110) planes of α-Fe_2O_3 (hematite, JCPDS standard).
- Peak broadness suggested nanoscale crystallite size (~20–40 nm, Scherrer's equation).



TEM Analysis
- Revealed nearly spherical nanoparticles.
- Average particle size: ~20–50 nm.
- Some agglomeration observed, typical of iron oxide nanoparticles.
- Nanoparticles well-dispersed after milling, though clustering still present.



Conclusion & Future Directions

Key Observations:
- Distinct Brownish-black color = high potential as natural pigment.
- Eco-friendly synthesis: avoided toxic by-products & high calcination temperatures.
- Spinach phytochemicals served as natural reducing & stabilizing agents.

Future Directions:
- Explore applications in pigments, catalysis, and biomedical fields.
- Investigate scalability of plant-based synthesis for industrial prodcuction.
- Compare with other plant extracts for improved efficiency and nanoparticle properties.

References

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[2] Devatha C., Thalla A. K., and Katte S. Y., Green synthesis of iron nanoparticles using different leaf extracts for treatment of domestic wastewater, *Journal of Cleaner Production*. (2016) 139, 1425–1435, https://doi.org/10.1016/j.jclepro.2016.09.019, 2-s2.0-84995612411.