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Green Synthesis of Copper Oxalate Nanopowder Using Plant Extract for Sustainable Nanomaterial Applications

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Abstract- — The development of eco-friendly nanomaterials has gained significant attention due to increasing environmental concerns associated with conventional chemical synthesis. This study focuses on the green synthesis of copper oxalate nanopowder using plant extracts as natural reducing and stabilizing agents. Plant-derived phytochemicals such as flavonoids, phenolics, and proteins facilitate nanoparticle formation under mild conditions. The synthesized nanopowder was characterized using basic analytical techniques including UV–Visible spectroscopy, pH measurement, conductivity analysis, viscosity studies, and flame photometry. The results confirmed successful formation of copper oxalate nanoparticles, indicated by characteristic spectral features and stable physicochemical properties. The green synthesis approach proved to be cost-effective, safe, and environmentally benign. The study highlights the potential of plant-mediated synthesis for developing sustainable nanomaterials and their possible applications in catalysis, environmental remediation, and material science.

Keywords— Copper oxalate, Nanopowder, Green synthesis, Plant extract, Nanotechnology, Sustainable chemistry.

I. INTRODUCTION

Nanotechnology has emerged as a transformative field with applications in material science, medicine, and environmental engineering. Metal-based nanoparticles, including copper compounds, are widely studied due to their unique physicochemical properties.

Conventional synthesis methods often involve toxic chemicals, high energy consumption, and hazardous by-products. These limitations have led to the adoption of green chemistry approaches that utilize plant extracts for nanoparticle synthesis. Plant extracts contain bioactive compounds such as flavonoids, alkaloids, and phenolic acids, which act as reducing and stabilizing agents. This study focuses on the green synthesis of copper oxalate nanopowder using plant extract and evaluation of its physicochemical properties.

II. MATERIALS AND METHODS

1. Materials

- Copper salt (Cu^{2+} source)
- Oxalic acid
- Plant extract
- Distilled water

2. Preparation of Plant Extract

- Fresh plant material collected and washed
- Dried and crushed
- Boiled in distilled water
- Filtered to obtain extract

3. Synthesis of Copper Oxalate Nanopowder

- Copper solution mixed with plant extract
- Oxalic acid added gradually
- Reaction maintained under controlled temperature
- Formation of precipitate observed

4. Characterization Techniques

- UV–Visible Spectroscopy
- pH Measurement
- Conductivity Measurement
- Redwood Viscometer
- Flame Photometry

III. RESULTS AND DISCUSSION

1. Formation of Nanopowder

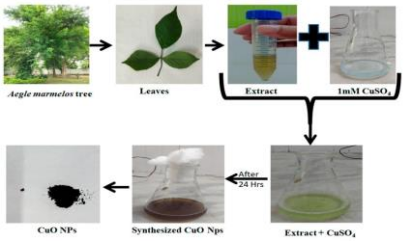

Figure 1: Green synthesis mechanism of copper oxalate nanopowder

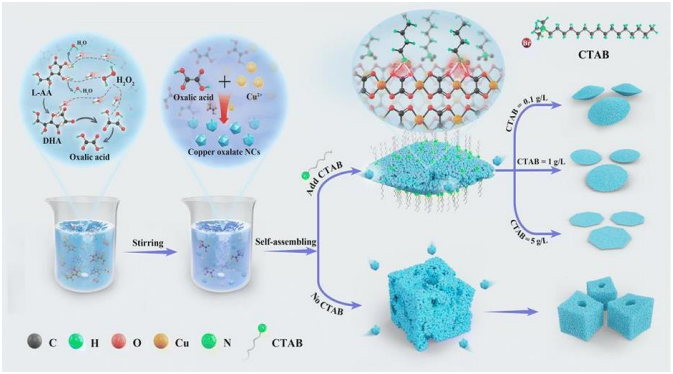

Figure 2: Visual formation of nanopowder (color change & precipitation)

2. UV–Visible Analysis

Table 1: UV–Visible Spectral Data

Sample	Observation
Copper solution	Initial peak
Nanopowder	Shifted peak

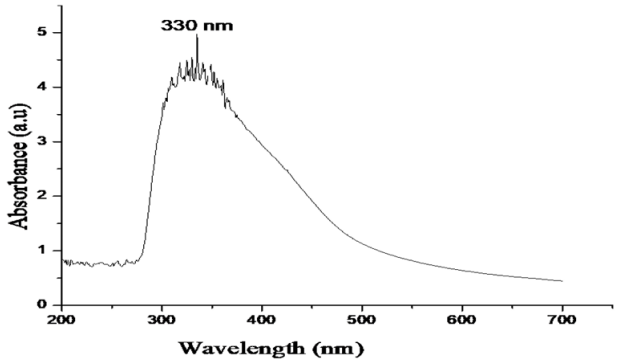

Figure 3: UV–Visible spectrum of copper oxalate nanopowder

3. Physicochemical Properties

Table 2: pH and Conductivity Analysis

Parameter	Observation
pH	Stable
Conductivity	Slight variation

4. Viscosity Studies

Table 3: Viscosity Measurements

Sample	Observation
Reaction mixture	Moderate viscosity

5. Flame Photometric Analysis

Table 4: Elemental Analysis

Element	Observation
Metal ions	Trace detected

6. Mechanism of Green Synthesis

- Reduction of metal ions by phytochemicals
- Stabilization by plant biomolecules
- Formation of nanoscale particles

Table 5: Conventional vs Green Method

Parameter	Conventional	Green
Toxicity	High	Low
Cost	High	Low
Environmental impact	Harmful	Eco-friendly

8. Applications of Copper Oxalate Nanoparticles

- Catalysis
- Sensors
- Environmental remediation
- Advanced materials

and preparation process

IV. CONCLUSIONS

The study successfully demonstrates the green synthesis of copper oxalate nanopowder using plant extracts. The synthesized nanoparticles exhibit stable physicochemical properties and confirm successful formation through UV–Visible and other analytical techniques. The method is eco-friendly, cost-effective, and suitable for sustainable nanomaterial production. This approach holds potential for applications in catalysis, environmental protection, and advanced material science.

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