Synthesis, Characterization and Biological Evaluation of Cu-Ni Bimetallic Nanoparticle

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Abstract

A novel green method in which Tulsi was used as a precursor. Cu-Ni bimetallic nanoparticles (NPs) were obtained by mixing solutions related to metal salts with plant extracts. The plant extracts contain various photochemical contents which behaves as reducing and capping agents towards the metal ions in the solution. The synthesized particles showed UV absorption of 0.085 and 0.347 at 368nm and 206nm, respectively. The FTIR spectrum of Copper-nickel bimetallic nanoparticles was noticeable in 400-4000 cm^{-1} range. The widespread peaks were seen sort of 817cm^{-1}which forecast the existence of the =C-H group on the surface of NPs. Particles not shown any zone of inhibition against Staphylococcus aureus (+) and E-coli(-)

Keywords: *Bimetallic, biological evaluation, antimicrobial activity, capping agent, FTIR spectrum, plant extract, precursor.*

1. Introduction

According to the International Organization of Standardization (ISO) and the American Society for Testing and Materials (ASTM) nanoparticles are those particles whose one or more dimensions are at the nanoscale or between 1nm-100nm (Ealias and Saravanakumar 2017). Due to incredibly small size, nanoparticles exhibit unique properties like high reactivity, larger surface area, strength, sensitivity and stability as compared to their bulk counterpart.

The metallic nanoparticles have multitude applications in Nano-devices, Nanosensors, Nano-electronics, information storage, and as well as in catalysis mainly because of their high surface area and reactivity (Abbasi, Iqbal, Mahmood, Ahmad, Kanwal, & Afridi, 2019). Nanoparticles are widely used in food and agriculture. Lessen the use of pesticides in agriculture. In the food industry for packaging, nutrient delivery, and improving texture. In the environment, nanoparticles are widely used as pollution monitoring sensors, pollutant scavengers, and biodegradable polymers and in UV protection, and water purification and air

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filtration.

Copper-Nickle bimetallic nanoparticles have attracted more attention due to their fascinating physical and chemical properties. Nanoparticle have synthesized through various methods such as chemical reduction, precipitation, micro-emulsion, sol gel and green synthesis (Chung et. al., 2017).

Copper nanoparticles manifest potential bacterial properties by causing membrane damage and triggering reactive oxygen species production and are particularly effective against E-Coli and other bacterial strains (Kathiravan, 2018). Zinc particles can disrupt bacterial cell membrane leading to increase permeability and ultimately causing cell lysis. This study includes the synthesis of Cu-Ni bimetallic nanoparticles by using Tulsi extract as a natural reducing agent for metal atom (Cohen, 2014).

1. Experimental procedure

1.1. Synthesis of copper-nickel bimetallic nanoparticles

Copper sulfate ($CuSO_4.5H_2O$) and Nickle Sulphate- $NiSO_4(H_2O)_6$ were purchased from sigma Aldrich. All chemicals were used without purification. The synthesis of copper-nickel bimetallic nanoparticles commenced with the addition of 30 ml of Tulsi leaves extract to conical flask. Subsequently solutions of both metals (0.001M each) were taken in separate burettes. Gradually one drop of each metal solution was added consecutively with continuous shaking to prevent precipitation until the solution acquired the dirty green colour, indicating the end point. The resulting solution was then subjected to heating using Bunsen burner and evaporated. Upon reducing the volume to 5 ml, the solution was transferred into a china dish and further evaporated until all moisture removed. Following this process, the residue or powder remained in the china dis and was collected. The collected sample was stored in an airtight sample vial for characterizations.

2.2 Characterization of copper-nickel bimetallic nanoparticles

The UV–visible spectrum of copper-nickel bimetallic nanoparticles was recorded, by taking a sample and diluting it with deionized water, sample composition is 0.001M. Shimadzu 1601 spectrophotometer was used in the wavelength region 400 to800 nm operated at a resolution of 1 nm. A spectrum is obtained which gives information about the absorption of light at various wavelengths and we can find λ_{max} for the sample. These were the specific peaks of Cu-Ni bimetallic nanoparticles (NPs). While if the main projecting peak is achieved at 368nm shows the formation of Cu-Ni bimetallic nanoparticles (NPs). FTIR studies were conducted employing a JASCO 4100 spectrometer to identify the potential functional groups, facilitating the recognition of bonding pattern. Sem was utilized to examine the morphology of Cu-Ni bimetallic nanoparticles. The SEM (VEGA3 TESCAN) was operated at an accelerating voltage of 12.5 kV. Beam diffraction of X-RAY also called XRD which was implemented on the copper-nickel bimetallic nanoparticles using a 10% concentrate of tulsi leaves. To address this, a monochromatic diffractometer operating at 30 kV power and an electric charge of 15 mA was employed. The examination involved scanning across a range of two thetas, specifically from 2 to 60, with an increment of 2 per minute. The XRD analysis was performed on nanoparticle samples with a composition of 0.001 M.

2.2.1 Antibacterial activity

Synthesized Cu-Ni bimetallic nanoparticles (NP) antibacterial activity was investigated against *Escherichia coli* and *Staphylococcus aureus*. Antibacterial potential was evaluated by using Well diffusion method (Iornumbe, Yiase, Sha'Ato, R & Tor-Anyiin, 2015) Erythromycin was employed as a standard drug.

2. Results and discussion

2.1. UV-Visible spectrophotometric analysis

The result of UV-Visible spectroscopy is obtained in form of absorption spectra. This technique is applied for the determination of the absorption capacity of a sample in visible and ultraviolet regions. The analysis or scan is made from 400nm to 800nm range of wavelength.
A spectrum is acquired, providing details about the absorption of light across different wavelengths, and enables the determination of λmax for the given sample. In the process of environmentally friendly synthesis of Cu-Ni bimetallic nanoparticles, distinct peaks are observed at 368 nm and 206 nm. The presence of specific peaks at 368 nm strongly indicates the formation of Cu-Ni bimetallic nanoparticles during the green synthesis process. This prominent peak at 368 nm serves as a key indicator of the successful synthesis and presence of the desired Cu-Ni bimetallic nanoparticles.

2.2. FTIR analysis

The Fourier Transform Infrared spectrum of Cu-nickel bimetallic nanoparticles was noticeable in the 400-4000 cm range figure 3.1 specified the results attained from FTIR spectroscopy.

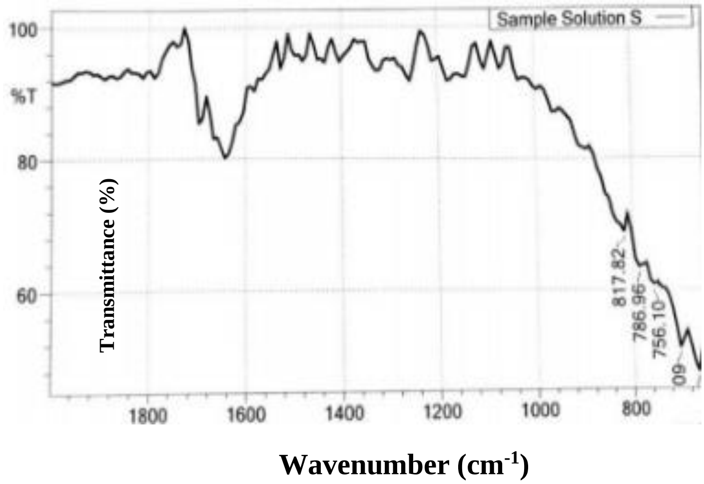

Figure 3.1 FTIR scan of Cu-Ni bimetallic nanoparticles

NPs functional group of amino acid, carboxyl group, and alkene family. The widespread peaks seem in a sort of 817cm^{-1} which forecast the existence of the =C-H group on the surface of NPs.

2.3. Scanning electron microscopy SEM analysis

The smallest size premediated from SEM demonstrations was 23.9nm. The size ranges from 23.9 nm to 46.3nm and the Shape of the particles is hexagonal cylindrical. While reforming-sized nanoparticles are accomplished but the least nanoparticles have this scope.

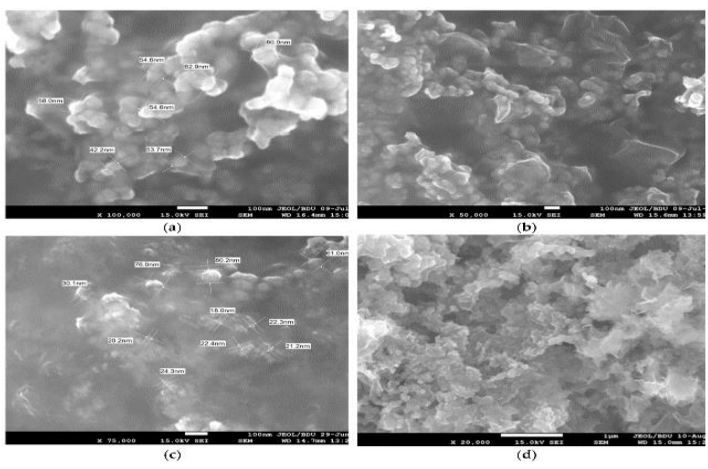

Figure 3.2 SEM images

2.4. XRD Analysis

Vellora Theka in 2013 studied the XRD pattern of CuO Nanoparticles using gum karaya as biotemplate peak splitting at 32. Results of XRD as presented in Figure 3.3 also showed peak splitting at 32 which confirms the presence of copper nanoparticles.

B Jyoti et al., (2013) studied the biological function of nickel and copper nanoparticles and the XRD pattern of copper nanoparticles Nanoparticles had been found that the average size of nanoparticles is 13.13nm a peak splitting at 42. Our results of XRD also showed peak splitting at 42 which confirms the presence of copper nanoparticles (Quaino et. al., 2017).

Myung-Gi studied the XRD pattern of Ni-Cu powdered electrodes peak splitting at 50 or 51. Our results of XRD also showed peak splitting at 51 which confirms Cu-Ni bimetallic nanoparticles formation. Similarly, another peak splitting also confirms copper-nickel bimetallic nanoparticles formation.

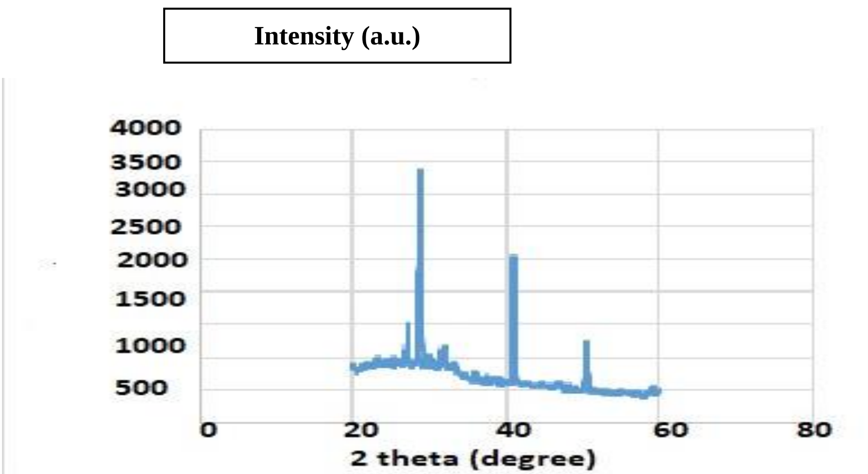

Figure3.3 XRD spectra

2.5. Antibacterial activity of Copper-nickle bimetallic nanoparticles

Cu-Ni bimetallic nanoparticles could not show any antibacterial activity against gram-positive and gram-negative bacteria by using well method (Subhankari & Nayak, 2013). At the nanoscale, these particles prepared from tulsi leaves do have not any antibacterial activity. So should not use these particles in antibiotics.

Figure 3.4 Antibacterial activity of Cu-Ni bimetallic NP

3. Conclusion

No hazardous chemicals was applied. Synthesized nanoparticles have scope in different fields. The size of the Cu-Ni bimetallic nanoparticle is below 100nm. SEM analysis gives information about the morphology of particles. The size of NPs was in the range of 23.9 to 46.3nm and the Shape of the particles was hexagonal cylindrical. Due to their smaller size nanoparticles have wider applications in the field of medicines such as drug carriers.

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