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Fabrication of CuONPs using Tridax Procumbens Leaf Extract as Material Antibacterial with Green Synthesis Method

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ABSTRACT

This experiment used the green synthesis method with Tridax procumbens as a capping and stabilizing agent to synthesize CuONPs. The application of Tridax procumbens-based on CuONPs as the antibacterial Escherichia Coli (E. Coli). The CuONPs synthesized were characterized using X-ray diffraction and scanning electron microscopy. The inhibition zones against Escherichia coli were found to be 9.10 and 10.15 mm with a concentration of 75mg/ml with extract Tridax procumbens with green synthesis method.

Keywords: antibacterial, CuONPs, green synthesis, Tridax procumbens

INTRODUCTION

CuO as a semiconductor with a narrow bandgap is extensively investigated due to its promising diversity of applications such as sensors, superconductors, solar cells, catalysis, lithium-ion batteries, and supercapacitors. In addition, the use of CuO Nanoparticles (CuONPs) in the prevention of bacterial infections in medical devices and increased antimicrobial activity against pathogenic microorganisms in nanoform displays have also been recorded. CuONPs are applied in fabrics, agriculture, paints and also in hospitals due to their desirable properties. Due to its low cost and toxicity, good chemical and thermal stability with high surface area, CuONPs have received considerable attention. Copper-based materials allow reactivity and undergo various reactions through several pathways due to the various oxidation states Cu available, such as Cu (III), Cu (I), Cu (II) and Cu (0). Compared to precious metals CuONPs are attractive from an economic as well as industrial point of view. Due to all the distinctive properties mentioned above, it is widely used as an antibacterial and also as a photocatalyst for environmental remediation.[1].

Tridax is a hairy, perennial, weak straggling, hispid, procumbent herb, with a woody base, sometimes rooting at the node widespread weed. In English, it is known as "coatbuttons" and "tridax daisy," in Hindi as "*Ghamra*," in Sanskrit as "Jayanti Veda," in Oriya as "Bishalyaaarani," in Marathi as "*Dagadi Pala*," in Telugu as "Gaddi Chamanthi," in Tamil as "Thatha poo," in Malayalam as "Cheeravanakk," in Spanish as "Cadillp Chisaca," in French as "Herbe Caille," and in Japanese as "Kotobukigiku". *T. procumbens* L. is native to tropical America and naturalized in tropical Africa, Asia, Australia, and India. Coatbuttons is found along roadsides, waste grounds, dikes, railroads, riverbanks, meadows, and dunes [2]. Tridax procumbens is a species of flowering plant in the daisy family. It is best known as a widespread weed and pest plant. It is native to the tropical

Americas but it has been introduced to tropical, subtropical, and mild temperate regions worldwide. Traditionally, Tridax procumbens has been in use in India for wound healing, as anticoagulant, antifungal and insect repellent. It is were known to treat infectious skin diseases in folk medicines [3].

Green synthesis indicates the utilization of biological routes, for example, those including microorganisms, plants and so on for the synthesis of nanoparticles. Green synthesis is regarded as a better alternative to physical and chemical methods as it is easy, efficient, eco-friendly, cost-effective and free of chemical contamination for medical and biological application where purity is a factor of serious concern. Green synthesis of NPs using leaf extract have been a developing area of research and is favorable over other environmentally benevolent biological processes as it eliminates the elaborate processes of maintaining cell culture and it can also meet large scale production.[4]

Hence, the usage of this plant extract for the preparation of copper oxide NPs could have great potential for various applications. Therefore, in the present study, leaf extract of Tridax procumbens was used for the preparation of copper oxide NPs for an antibacterial Escherichia coli.

The X-Ray Diffraction (XRD) characterization that was carried out and aimed to see the microstructure of CuNPs that is formed. XRD analysis provides information on the size of the crystals resulting from the synthesis. This crystal size supports information on whether the material is effectively be used as an antibacterial. To confirm the crystal size, a Scanning Electron Microscope (SEM) was run in observation. An antibacterial test was additionally carried out by looking at the activity of the bacteria in the sample.

LITERATURE REVIEW

Metal Nanoparticles (NPs) such as Silver, zinc, gold, etc. are materials with tremendous application in medical institutions during the last few years. Metal nanoparticles have various morphologies and sizes that can be synthesized using physical and chemical methods. Chemical-mediated synthesis of nanoparticles utilizes toxic chemicals such as reducing agents, non-biodegradable stabilizers and organic solvents. These chemicals are harmful to biology, aquatic systems and the environment[5]. Thus, the synthesis of NPs using biological methods is proved as environmental friendly and economical and is served as the best alternative method for synthesis of NPs. In biological NP synthesis methods, microbes and bioactive plant extracts are used as reducing agent.

Green synthesis denotes the utilization of biological pathways, for example those including microorganisms, plants and so on for the synthesis of nanoparticles. The growth of microbial or microorganism cultures for a long time is very difficult and there is a possibility of contamination so that the use of plant bioactive compounds for the synthesis of NPs is very simple, economical and convenient. Recently many metal oxide syntheses have used this method. Copper oxide (CuO) NP has a wide range of applications in various fields and is used in catalytic, optical, superconducting and magnetic resistance materials as well as solar energy transformation applications. CuO NPs also have antimicrobial, antidiabetic, anticancer, and other properties. CuO NPs are non-toxic and have antimicrobial efficacy in controlling plant diseases, photocatalytic activity for dye waste treatment, and many other environmental applications[6]. Figure 1. shows the parts of the plant used that can be used as the plant extract. As for the parts used, among others, such as leaves, seeds, bark, fruits, skin, coir, roots, and gum. The leaves and roots are used in two ways. Firstly, fresh leaves and roots are used for the preparation of plant extracts, and secondly, dry leaves and roots in powder form are used. However, most of the synthesis generally uses direct extraction of plant leaves because it is easier to apply[7].

Figure 1. Parts of the plant used for the preparation of plant extract[7]

MATERIALS & METHODS

2.1 Material

Copper sulfate ($CuSO_4.5H_2O$) (Sigma-Aldrich made Germany with purification 99%) was used for the preparation of CuONPs. Copper sulfate was used without further purification. *Tridax procumbens* leaves were collected from in around Diponegoro University campus environment, Semarang, Indonesia. NaOH (sodium hydroxide) (Sigma-Aldrich made Germany with purification 99%) for neutral pH.

2.2 Preparation of Leaf Extract

Tridax procumbens leaves were washed thoroughly with deionized water to remove the dust particles. The preparation of leaf aqueous extract, taking of *Tridax procumbens*. The variation of *Tridax procumbens* chopped leaves in a 250 ml Erlenmeyer flask with 100 mL of deionized water. Then boiled at 60°C for 10 min. This extract was filtered and used for the experiments.

2.3 Preparation of CuONPs

The copper sulfate solution was prepared using 0.1 M of copper sulfate in 100 ml of deionized water. Leaf extract of *Tridax procumbens* (40 ml) was added to 90 ml of aqueous copper sulfate solution and was kept under vigorous stirring for 4 h at 80°C. This solution was added NaOH for neutral pH until became a pellet. The pellet was collected and calcined in a box furnace at temperature 400°C for 5 h. The overall experimental preparation stages can be seen in Figure 2. Pellet results that have been collected and calcined in the furnace can be seen in Figure 3.

Figure 2. Flowchart of CuONPs synthesis via *green synthesis* method

Figure 3. As prepared samples of CuONPs

RESULT AND DISCUSSION

3.1 X-Ray Diffraction (XRD) analysis

In **figure 4**, there are three different treatments of CuONPs and it can be seen different peaks between them. The X-Ray Diffraction (XRD) images show that all three materials have formed CuONPs at 2θ of 35.6, 38.37, 48.6 with hkl values (002), (111), and (202). The points were confirmed by adjusting the Joint Committee on Powder Diffraction Standards (JCPDS) data NO.89-1397 indicating that crystal CuONPs had been formed. Based on **figure 4**, adding of leaf Tridax procumbens have purity of CuONPs, similar as previous report[8]. Based on the Debbye-Scherrer equation, the crystal size of CuONPs with adding of extracts Tridax procumbens obtained 63.22 nm.

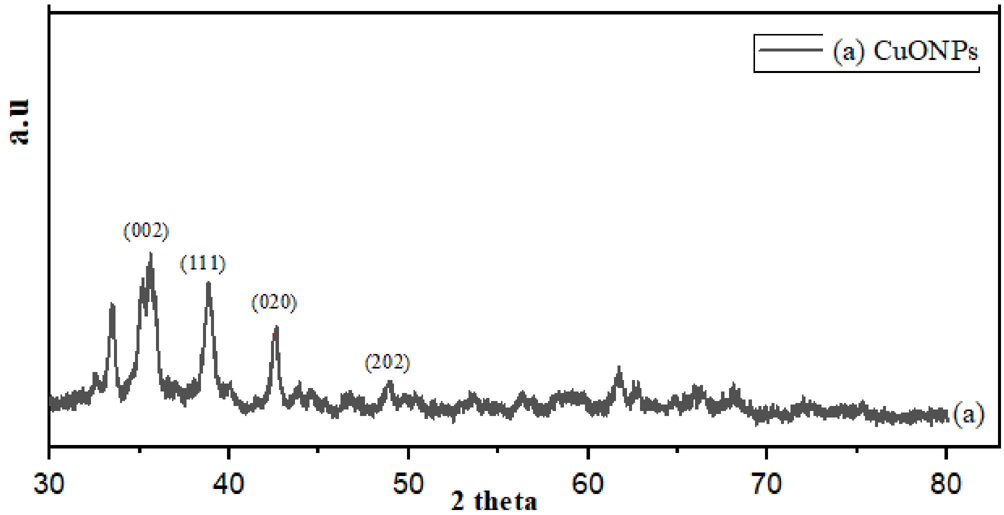

Figure 4. X-Ray Diffraction (XRD) pattern CuONPs

3.2 Scanning Electron Microscope (SEM)

The Scanning Electron Microscope (SEM) images showed the morphology of fabricated CuONPs different temperatures. Revealed that image of them showed the copper oxide nanoparticles agglomerated and formed larger granules (**Figure 5**). From the figure showed, most of CuONPs were spherical particles[1]. Some of the nanoparticles are quite separated from each other and most of them are agglomerated due to the oxidation of metal nanoparticles. [9].

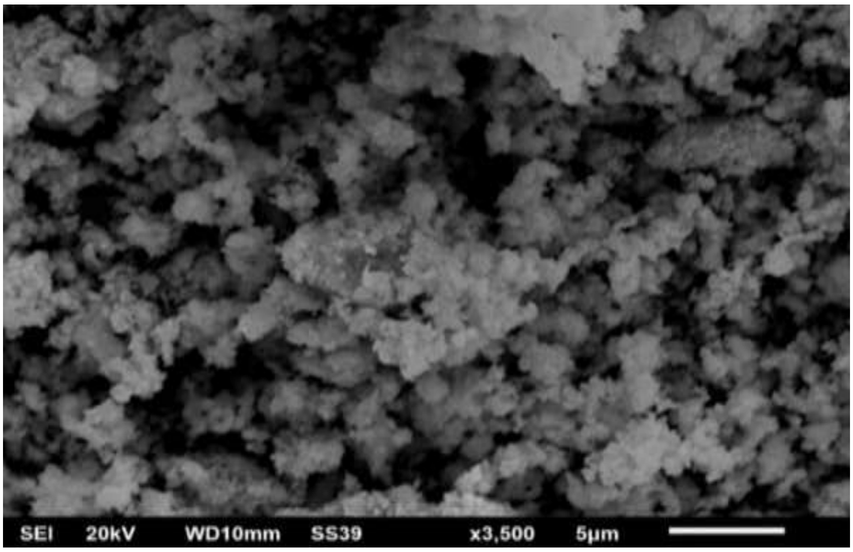

Figure 5. Scanning Electron Microscope (SEM) showed Morphology of CuONPs

3.3. Antibacterial Activity

Figure 6 shows of antibacterial activity of CuONPs calcined at different temperatures against pathogens Escherichia Coli (E. Coli). The variation concentration stretched from 75 mg⁄mL to 100 mg⁄mL with the control parameter amoxicillin as an antibiotic commercial. CuONPs showed maximum inhibition of the zone against E. Coli at a concentration of 100 mg/mL. It explained in **Table 1**, as a follow-up of this study, it was intended to explore the possibility of controlling their micrograph and crystallite for toxicity of bacterial life. Based on the research conducted on this bacterial test, it was proven that the effect of extract and temperature in the synthesis of CuONPs plays a role in the effectiveness of the antibacterial because low concentration shows more effectiveness.

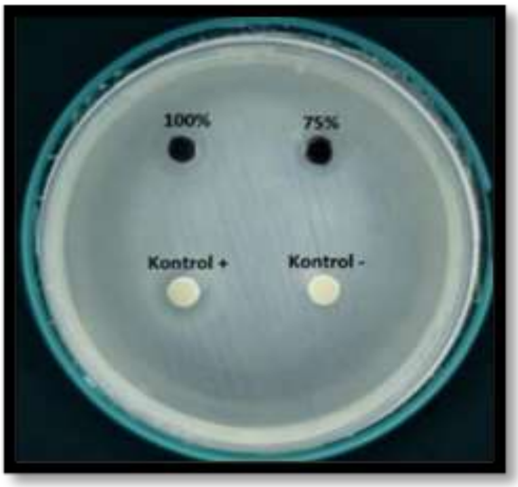

Figure 6. Antibacterial efficiency of CuONPs

Table 1 Zone of inhibition by CuONPs samples through Control with different concentration

Concentration mg/ml	Zone of inhibition diameter E. coli (mm)	
	CuONPs	Control
75	9.15	10.15
100	10.10	10.15

CONCLUSION

Tridax procumbens leave extract was used as reducing and capping agent for the facile, simple and eco-friendly fabrication of CuONPs. The XRD spectroscopy crystal structure of CuONPs nanoparticle's monoclinic single-phase structure. To the best of our knowledge, the synthesized CuONPs with green synthesis greatly affected the antibacterial effectiveness.

Declaration by Authors

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