GREEN SYNTHESIS NANOPARTIKEL TEMBAGA MENGGUNAKAN REDUKTOR ALAMI EKSTRAK DAUN GAMBIR (*Uncaria gambir Roxb*.) DAN AKTIVITAS ANTIBAKTERINYA

DISERTASI

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SUMMARY

Nanotechnology and nanomaterials have become a focus of increasing interest to a number of researchers in recent years, because nanometer-sized materials have a number of chemical and physical properties that are superior to bulk materials. The main thing that makes nanoparticles different from similar materials in their large size is the surface properties that can be modified in terms of optical, magnetic, electronic and mechanical properties as well as their small size with a greater ratio between surface area and volume.

Many researches related to the synthesis of nanoparticles have been carried out. However, there are still some weaknesses that are found among them are the high production costs and the use of chemicals that are harmful to users and the environment. Therefore, it is necessary to develop a synthesis method that is more environmentally friendly by using natural reducing agents that are safe (non-toxic), cheap and easy to obtain. In addition, this method requires a relatively short contact time compared to other methods.

In this study, copper nanoparticles were synthesized using natural reducing agents from gambier leaf extract with variations in copper precursor anions and reaction times and antibacterial activity. Gambier leaf extract acts as a reducing agent and capping agent. The reason for choosing gambier leaves is that the availability is quite abundant and easy to obtain, considering that West Sumatra is the largest gambier producing area (80%) in Indonesia. The choice of copper as a precursor metal is due to its potential applications in various fields, including as a material for conductors, catalysts, detectors, optical sensors, and antimicrobial agents. In addition, the synthesis process is very easy, the costs used are relatively cheap and affordable and the availability is sufficient. The development of the copper metal synthesis method to produce nanoparticles is directed to produce NpCu in the size of 1-100 nm.

From previous literature studies, it has not been found that the use of gambier leaf extract as a copper metal reducer in the synthesis of NpCu and its characteristics and application as antibacterial. Starting from the literature search, the authors are interested in further researching the method of copper nanoparticle synthesis with gambier leaf extract and its antibacterial activity on gram-positive (Staphylococcus aureus) and gram-negative (Escherichia coli) bacteria.

In this study, three types of precursors were used, $CuSO_4$, $Cu(NO_3)_2$ and $CuCl_2$. Based on the research results obtained information on the potential of gambier leaf extract in reducing copper to NpCu. The formation of NpCu colloids is visually indicated by a color change from light brown to dark brown. The results of measurements with a UV-Vis spectrophotometer formed an absorption peak at a wavelength of 405-427 nm which is a specific wavelength of the formation of NpCu based on the Surface Plasmon Resonance (SPR) phenomenon. The results of the X-Ray Diffraction (XRD) analysis showed the results of NpCu with a Face Centered Cubic (FCC) crystal structure through the formation of 3 peaks in the 43.28 ° (111), 50.40 ° (200) and 74.81 ° (220) areas. The results of FTIR analysis showed that there

was a vibration of Cu-O bonds which assumed interaction between Cu ions and polyphenol compounds at wave numbers 623 cm^{-1} for $CuSO_4$, 615 cm^{-1} for $Cu(NO_3)_2$ and 610 cm-1 for CuCl2 precursors. Transmission Electron Microscope (TEM) shows the synthesized NpCu is spherical. The results obtained by using the $CuSO_4$ NpCu precursor formed tended to be more evenly distributed than the $Cu(NO_3)_2$ and $CuCl_2$ precursors with particle size diameters of 15 nm, 28 nm and 25 nm, respectively. The size and morphology of these copper nanoparticles are influenced by the type of precursor anions used. The higher the polarity, the solubility and the anion charge, the more stable and the smaller the NpCu particle size. Based on the characterization results, it can be concluded that with better NpCu produced from CuSO4 precursors compared to the other 2 precursors Cu $(NO_3)_2$ and $CuCl_2$. The precursors for $CuSO_4$, $Cu(NO_3)_2$ and $CuCl_2$ were 13.8 mm, 12.6 mm and 11.9 mm respectively and gram negative Escherichia coli with inhibition zone areas of 11.8 mm, 10.8 mm and 10.5 mm. This shows that NpCu has the potential as a strong category antibacterial agent. From the research conducted, the author has succeeded in discovering the potential of gambier leaf extract as a reducing agent and capping agent in synthesis. Copper nanoparticles are powdered with a size of 15 - 28 nm, a round and stable shape of the three precursors ($CuSO_4$, $Cu(NO_3)_2$ and $CuCl_2$). The resulting NpCu has been shown to act as a strong antibacterial agent with the formation of an inhibition zone of 11-13 mm. Advantages

Keywords: Green synthesis, copper nanoparticles, Uncaria gambir Roxb., Antibacteri