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Antioxidant and Antibacterial Activities of Biosynthesized Silver Nanoparticles using Aqueous *Terminalia catappa* Leaf Extracts as Novel Reducing Agent

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In this study, silver nanoparticles (AgNPs) were successfully synthesized from aqueous *Terminalia catappa* leaf extract that acts as a novel reducing agent. Various parameters, including pH, temperature and reaction time, were determined. The UV-visible spectra showed the main peak at 416 nm, which was the characteristic surface plasmon resonance of AgNPs. The spherical shape and particle size of 49 ± 0.01 nm were observed from SEM, TEM and laser particle size analysis (LPSA). FTIR spectra of the leaf extract exhibited the characteristic functional groups that should be responsible for Ag^+ ion reduction. The EDX spectrum proved that the obtained sample is silver. The antioxidant activity of AgNPs treated with the leaf extract as determined by the DPPH assay was higher compared to that of *Terminalia catappa* leaf extract, and the treated AgNP sample exhibited high antibacterial potential against both Gram-positive and Gram-negative bacteria.

Keywords: Antioxidant activity, Antibacterial activity, Silver nanoparticles, *Terminalia catappa*.

INTRODUCTION

Silver nanoparticles (AgNPs) have numerous applications in several industries, such as pharmaceuticals, electronics and biosensor development [1-3]. Till date, several chemical, physical and biological methods have been adopted for nanoparticle synthesis [4-7]. Biological synthesis is eco-friendly because nontoxic reducing and capping agents are used. Usually, plants containing flavonoids, alkaloids, and polyphenolic compounds are ideal for preparing nanoparticles, wherein these compounds reduce silver ions (Ag^+) to silver nanoparticles (Ag^0) and act as capping agents [8]. One such plant *Terminalia catappa* L. that has been used for AgNPs synthesis has garnered considerable attention due to its low cost and easy availability. *Terminalia catappa* L. is commonly used as a popular medicine in Southeast Asia and has been claimed to have therapeutic effects for liver-related diseases [9].

Commonly, *Terminalia catappa* L. is found in coastal areas and along the roadsides in various Southeast Asian countries [10]. Various forms of hydrolyzable tannins have been isolated from the leaves of this plant, including punicalagin, punicalin, terflavins A and B, tergallagin, tercatain, geranin, chebulagic acid, geranin, granatin B and corilagin but no caffeine has been found in it [11]. In present study, we propose the possible mechanism for the reduction process of Ag^+ by important functional groups in tannins (Fig. 1). In this mechanism, Ag^+ ions form transitional complexes with the phenolic hydroxyl groups of tannic acid that loses one hydrogen radical and one electron, and then successively undergo oxidation to quinone, followed by the reduction of Ag^+ ions to form AgNPs [12,13].

This study aimed to synthesize and characterize AgNPs synthesized using *Terminalia catappa* leaf extract as a reducing agent and determined the optimal parameters including temperature, pH and reaction time because the size and shape of silver nanoparticles are dependent on the physical and chemical factors; in present study, nanoparticle synthesis was controlled by the pH and temperature of the reaction mixture [14]. Moreover, the potential of the synthesized AgNPs as an antioxidant and antibacterial agent was investigated.