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Synthesis, characterization and evaluation cytotoxic activity of silver nanoparticles synthesized by Chinese herbal *Cornus officinalis via* environment friendly approach

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ABSTRACT

Cornus officinalis has been widely used as a precious herb and as the tonic food to improve kidney function in China. Its fruits have been used in many traditional Chinese medicine prescriptions to treat kidney diseases, diabetes, cancer and shock. In this study, a new eco-friendly approach for green synthesis of silver nanoparticles (AgNPs) by using the fruits of *Cornus officinalis* aqueous extract as a reducing and stabilizing agent. The so-synthesized AgNPs showed quasi-spherical in shape with uniform dispersal and an average mean size of 11.7 nm. Water soluble biomolecules such as flavonoids and/or anthocyanins from the extract played important roles in the nanoparticles formation. The AgNPs displayed distinctive cytotoxicity activities against human prostate cancer (PC-3) and human liver cancer (HepG2) cell lines. The results provided a low cost, nontoxic and eco-friendly approach for synthesizing metal nanoparticles to explore alternative anticancer agents on the way fighting against cancer in future.

1. Introduction

Cancer, as an increasingly prevalent health problem during the last two decades, is now ranked the second cause among the 10 top leading of death around the world. Fortunately, the mortality has been significantly inhibited by the rapid developments of different diagnostic devices and therapeutic strategies (Liu et al., 2012). However, among all the current clinical cancer treatments, there is none methodology can only selectively bind and target cancer cells to avoid the toxicity and unwanted side effects of the patients. A new contribution to conquer this problem is the emergence of nanoparticles synthesis, which opens a new interdisciplinary research area to explore potential alternative nano-sized materials for cancer diagnosis and treatment. A few clinically approved passively targeting bionanomaterials were reviewed by Mollick and co-workers (Mollick et al., 2014).

Silver, a noble metal commonly used for preparing jewelry over 200 years ago since discovered, has long been used as a potential antibacterial agent with lower toxicity and bacterial resistance properties (Loo et al., 2016; Dipankar and Murugan, 2012). In the last decade, the design and synthesis of silver nanoparticles (AgNPs) have attracted extensive interests due to their distinctive surface plasmon resonance, fluorescent properties, electrochemical activity (He et al., 2015), and broad range of bioactivities such as anti-fungal (Kvitek et al., 2009), antibacterial (Saxena et al., 2012; Shukla et al., 2012a), anti-inflammatory effect (Pugazhendhi et al., 2015). Many investigations have demonstrated that AgNPs are excellent sensors for probe single molecules with ultrahigh sensitivity (He et al., 2015; Shukla et al., 2012b). Interesting, recent studies strongly supported that using natural medicinal plants for synthesis of AgNPs could be a low-costing and eco-friendly green synthesis strategy to explore therapeutic agents for cancer treatments (Dipankar and Murugan, 2012; Jacob et al., 2012).

Cornus officinalis is a widely distributed tree native to China, Japan and Korea. Its fruits, commonly known as "Shanzhuyu" in Chinese, have been traditional used as a tonic and anti-inflammatory food to improve liver and kidney functions (Ma et al., 2014). In addition, it also used in Chinese herbal medicine for the treatment of diabetes, cancer and shock (Liu et al., 2011). The extract of Shanzhuyu has been reported to have anti-diabetic, anti-oxidant, immune regulation, anti-hyperglycemia, renal and neural protection effects (Ma et al., 2014; Lin et al., 2011; Jang et al., 2014). The phytochemical studies of *C. officinalis* have resulted in the isolations more than 150 compounds including structurally diverse iridoid glycosides, anthocyanins, flavonoids, saccharides and tannins (Lin et al., 2011). Some kinds of these compounds such as anthocyanins have roused a lot of interest because

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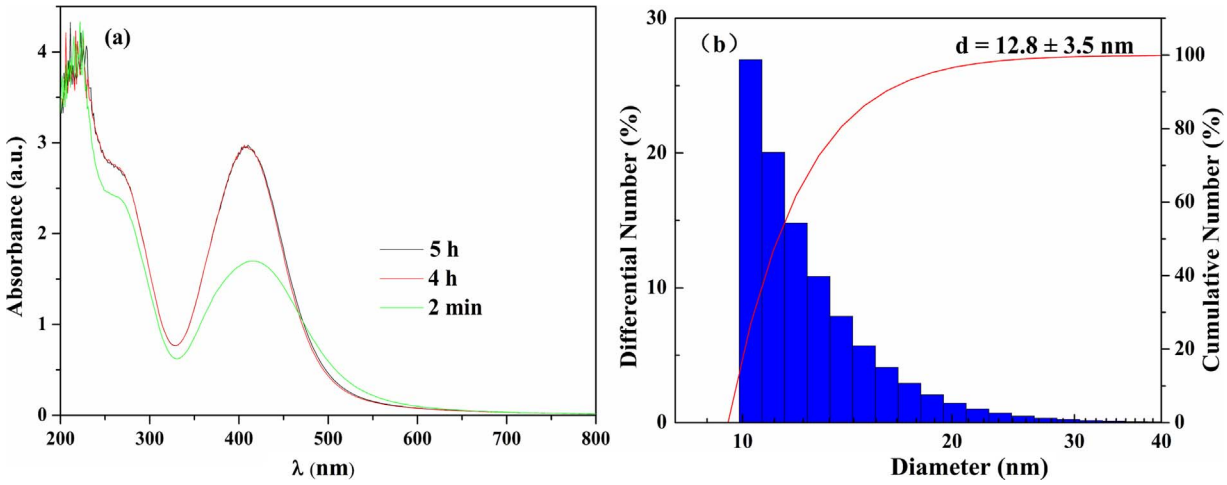

Fig. 1. (a) UV-vis spectra of AgNPs (1:5 diluted) prepared by 10 mL 10.0 mM $AgNO_3$ in 10 mL Shanzhuyu extract at 40 °C as a function of time; (b) DLS spectrum of AgNPs.

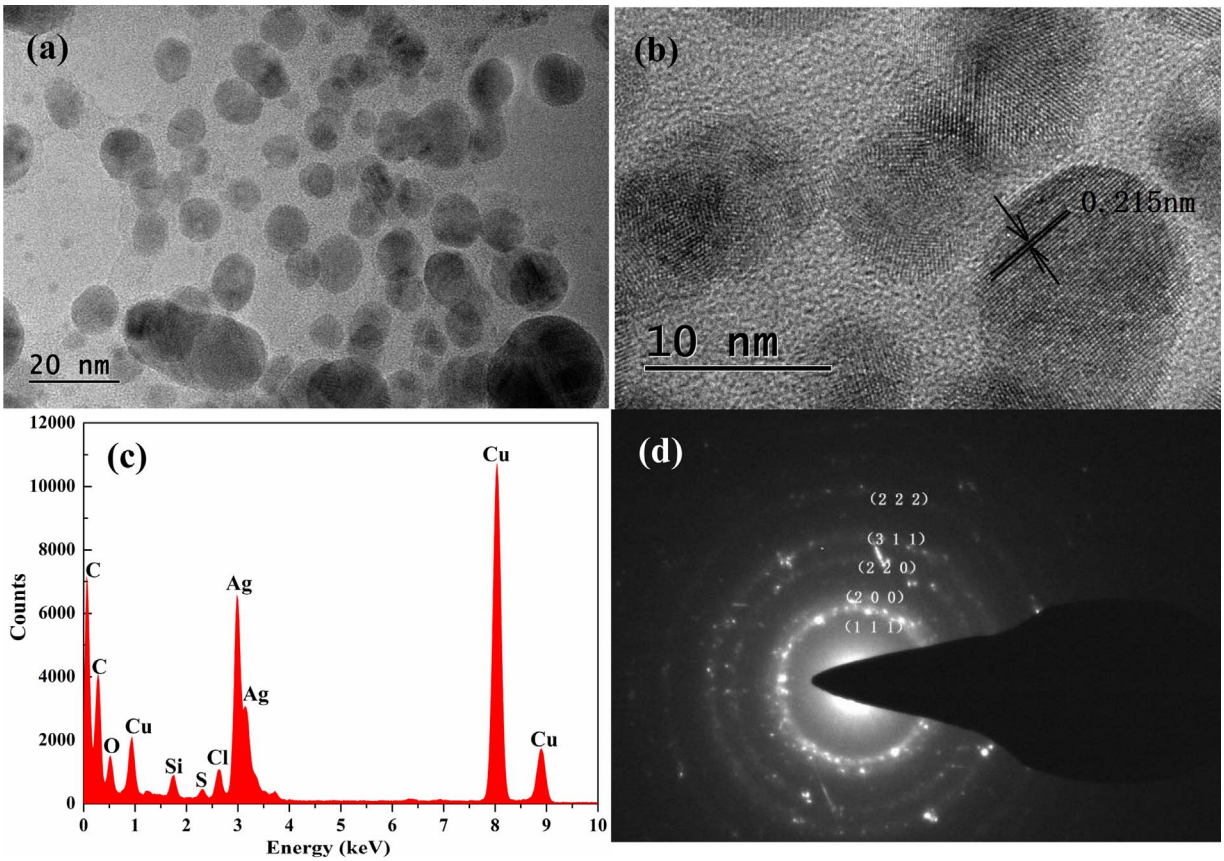

Fig. 2. FETEM images of the synthesized silver nanoparticles with different magnification (a and b), EDX spectrum (c) and SAED pattern (d).

of their wide range of fascinating bioactivities, including anti-inflammatory (Vareed et al., 2006; Seeram et al., 2002), anti-oxidative (Seeram et al., 2002), anti-neoplastic (Vareed et al., 2006) and anti-diabetic activities (Jayaprakasam et al., 2005). Based on the wide range of bioactivities of Shanzhuyu and its chemical composition mentioned above, we supposed that it might be a good natural resource to prepare AgNPs with potential pharmacological effects.

In this study, we reported a rapid, one-step and eco-friendly green synthesis of AgNPs using the extract of Shanzhuyu. So far, there is no report of the synthesis of AgNPs by using the aqueous extract of Shanzhuyu based on our knowledge. The AgNPs so prepared were characterized by UV–vis spectra analysis, field emission transmission electron microscopy (FETEM), energy dispersive X-ray spectrophotometer (EDX), X-ray diffraction (XRD) and fourier transform infrared spectroscopy (FT-IR). Furthermore, the cytotoxicity activity against the human gastric carcinoma (SGC-7901), human prostate cancer (PC-3) and human liver cancer (HepG2) cell lines was also evaluated.

2. Materials and methods

2.1. Chemicals and raw materials

Silver nitrate ($AgNO_3$) was ordered from Tianjin Kemiou Chemical Reagents Co. 3-(4,5-dimethyl-2-thiazolyl)-2,5-diphenyl-2H-tetrazolium bromine (MTT) supplied by sigma-aldrich (Shanghai, China) and other