CHAPTER 1

INTRODUCTION

1.0 CHAPTER OVERVIEW

This chapter describes the rationale of this research. The literature review shows that metallic nanoparticles synthesized from plant resources offer antibacterial and anticancer properties. In addition, the scope of the study presents the synthesis of metallic nanoparticles using biological route and their biomedical applications. Finally, the research objectives are also provided.

1.1 BACKGROUND OF THE STUDY

Nanoparticles (NP) are the building blocks in nanotechnology and they have diverse applications in different fields such as biomedical, engineering, energy and environmental sciences. In general, nanoparticles are synthesized by physical and chemical procedures, as these methods produce the desired sizes of the particles in large scale (Akamatsu et al., 2003, and Seigneuric et al., 2010). However, the physical methods have some limits such as expensive, involve time consuming steps and complicated vacuum techniques are necessary. Usually, the chemical processes have two main problems. Firstly, high surface energy of nanoparticles may enhance the interaction with materials and they often undergo aggregation. This aggregation can be prevented by using polymers, surfactants and DNA on the nanoparticle surface. Secondly, concentrated chemicals are used as reducing and stabilizing agents (sodium borohydride, citric acid etc.) which may exhibit biological hazards to humans and the environment (Bigall and Eychmuller, 2010, and Antony et al., 2011). Hence, the chemical and physical syntheses of nanoparticles have limited applications in the clinical fields. Therefore, the biological synthesis of nanoparticles is the alternative by using plants and microorganisms as substrates. Moreover, the biological mediated metallic nanoparticles are proven to be more biocompatible and have lower environmental toxicity. Thus, they can be useful for different biological applications including cancer treatments. The metallic NPs have been developed by using biological methods and evaluated in various preclinical or clinical studies, some of which have been approved for clinical cancer treatments (Chow, 2010; Reza Ghorbani et al., 2011). Moreover, the biosynthesized NPs also have the ability to reduce drug resistance and enhance therapeutic applications against chronic diseases. The biosynthesized metallic gold and silver nanoparticles are feasible drugs for treating cancer effectively due to the potent physico-chemical properties.

Cancer is the third leading cause of death worldwide after coronary diseases and diabetes. According to the World Cancer Report 2008 by WHO, the global cancer burden has doubled in the last four decades of the 19^{th} century (Chithrani et al., 2006). In Malaysia, cancer is the second most dangerous class of disease. Among cancer, the colon cancer shows the highest rate recorded in Chinese and Indian followed by Malay citizens (Lim et al., 2006). Colon cancer is one of the most dangerous class of cancer and an early detection is difficult to be made. The cancer cells in the colon or rectum divide fast and uncontrollably, ultimately forming a malignant tumor. The colon and rectum are parts of the digestive system, which take up nutrients from food and water in the colon. Colon cancer is common in both men and women. The preliminary colon polyps can develop into malignant tumors (Jain et al., 2007). The traditional strategies for cancer treatment are surgery, radiation, and chemotherapy. But, these specialized therapies can be applied only at the preliminary stage of cancers. The physical method of cancer treatment is surgery. It is a good way to cure, particularly those which have yet to metastasize to distinct parts of the body (Douglas-Kinghorn, 2001). Once it is metastasized, the multiplications of cancer cells are difficult to be controlled. Therefore, these stages need new and more effective therapies.

The nanoscience has proposed many fabrication methodologies including biological synthesis method. The biological synthesis method has developed unique and precise nanoparticles and it is possible to target cancer at different stages. On the other hand, the chemically synthesized nanomaterials also have specific sizes and shapes, but they are futile in clinical trials because of toxicity issues (Yoosaf et al., 2007). Therefore, the biosynthesis way is more effective, safe and may fulfill the following requirements: i) the drug concentration can be easily optimized which allows an effective dose at tumor cells without affecting normal cells, ii) could target tumor cells and prevent an uptake by normal cells, and iii) biological approach has a high biocompatibility.

Nanoparticle is defined as a sub-microscopic particle with the size that ranges between 1 to 100 nm. When the size of materials is reduced to the nano level, the properties change completely compared to bulk materials (Canizal, 2001, and Chaloupka et al., 2010). Gold nanoparticle (GNP) is a novel metal, has been utilized in many areas especially cancer diagnostics, coatings, thermal therapy, electronics and biotechnology (Gardea-Torresdey et al., 2003, and Kumar et al., 2007). GNPs can easilypass through the vasculature, be localized in targeted areas, and control the DNA transcription in cancer cells. The biological syntheses of gold nanoparticles are cheap, reliable and eco-friendly because of the naturally available plants acting as reducing and stabilizing agents and do not require any downstream process for purification of products. The plant extract contains various bioactive compounds which is able to reduce metal ions into metallic nanoparticles at room temperature (Sau et al., 2010).

On the other hand, silver nanoparticles also have unusual properties such as high antimicrobial activity, particle stability and surface chemistry (Krug et al., 1999, and Labouta and Schneider, 2010). Silver nanoparticles have specific surface plasmon resonance (SPR) peak wavelengths of between 450 nm (violet light) to 530 nm (green light). Different wavelengths express different particle sizes, shapes and surface properties (Jain et al., 2007). The AgNPs have been widely used as antimicrobial agents in healthcare, food industry, textile coatings and electronic devices (Reza-Ghorbani et al., 2011). Also, the AgNPs have been incorporated in many commercial products and approved by a range of accredited bodies, including the FDA (USA), SIAA (Japan) and KTR and FITI (Korea) (El-Nour et al., 2010).