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TOXICITY PROFILING OF GOLD AND IRON OXIDE NANOPARTICLES AS A RADIOGRAPHIC CONTRAST MEDIA

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AUTHOR'S DECLARATION

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the results of my own work, unless otherwise indicated or acknowledged as referenced work. This thesis has not been submitted to any other institution or non-academic institution for any degree or qualification.

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ABSTRACT

Exponential growth of nanotechnology has led to a tremendous research and development to exploit their novel properties in various fields including diagnostic imaging. To date, iodine has been clinically used as a radiographic contrast medium. However, raising concern of iodine threats lead to an exploration of new contrast media with lower toxic level. In animal modeling study, gold nanoparticles (GNPs) and iron oxide nanoparticles (IONPs) have been assessed for toxicity properties as compared to conventional iodine. Nanotoxicities were assessed in liver and kidney tissues by hematology and biochemical analyses, ROS and MDA production, histology and ultrastructural evaluation, and followed by apoptosis and DNA damage induction. The hematological and biochemical analyses revealed that most of the parameters were significantly increased in iodine-administered group compared to those in control group and NPs-administered groups ($p < 0.05$). ROS and MDA production were recorded as significantly reduced in NPs-administered group ($p < 0.05$). Histological and ultrastructural evaluations showed that there were significant alteration in liver and kidney tissues of iodine-administered rats ($p < 0.05$) compared to control and NPs groups. Apoptosis was not detected in both NPs-administered groups while it was observed in iodine-administered group. Induction of DNA damage by comet assay was significantly observed in iodine-administered group compared to other groups ($p < 0.05$). The present study documented that intravenous administration of GNPs and IONPs did not induce appreciable toxicity compared to iodine, hence postulated that GNPs and IONPs could be potentially utilized in radiographic imaging.

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CHAPTER ONE
INTRODUCTION

1.1 BACKGROUND OF STUDY

Nanotechnology was introduced by Nobel Laureate P. Feynman back in 1959 as an idea of exploiting matter or particle at extremely small size (Sanchez & Sobolev, 2010). Nanotechnology can be defined as a technology that concerned with the controlled design, characterization, production and application of nano-sized or nano-scale materials (Johnston et al., 2010). Sometimes, nanotechnology can also be referred as general purpose technology or revolutionary discipline because it advancement may contribute to a great impact on almost all fields (Bhattacharyya, Singh, & Satnalika, 2009). Multi-application of nanotechnology shows a great demand in various disciplines and it is anticipated that nanotechnology may provide great benefits for society in general as well as financial gains (Johnston et al., 2010). The nanotechnology has penetrated deep into human life in diverse areas including engineering, information technology and with significant impact on medical and health sciences (Roy, Kumar, Tripathi, Das, & Dwivedi, 2014). Recent developments of nanotechnology in reducing the size of materials have led to a generation of nanomaterials (Parveen, Misra, & Sahoo, 2012). Nanomaterials produced from nanotechnology exploitation consist of three main subjects which are nanoplates, nanofibers and nanoparticles (NPs) (Krug & Wick, 2011).

Schröfel et al., (2014) asserted that unique properties of nanoscale materials have given rise to enormous research process towards NPs fabrication, characterization and application. NPs are referred as particles with dimension of 100 nm or less and behave as a whole unit itself and becoming an interest in biomedical application (Fornaguera, Llinàs, Solans, & Calderó, 2015). It also defined as a particles with nano-scale in at least one dimension or all three dimensions (Krug & Wick, 2011). NPs may or may not exhibit similar properties as observed in fine and bulk particles, particularly due to the size-related differences (Shinde et al., 2012). Various products of NPs are being developed, or some are currently available that exploit the nano-sized properties with combining benefits for wide range fields