



Synthesis and Anticancerogenic Effect of New Generation Ruthenium-Based Nanoparticle from *Homalothecium sericeum* with Eco-Friendly Method

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Accepted: 14 March 2023

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Abstract

Background Green synthesis is a simple, inexpensive, and highly efficient method for the preparation of nanoparticles. In this study, ethanol extracts of *Homalothecium sericeum* (HOM) moss were used as reducing agents for the synthesis of bio-compatible ruthenium nanoparticles (RuNPs). The ruthenium-based green synthesis method has not been used in any other work in the literature. UV–visible spectrophotometer (UV–Vis), Zetasizer, FTIR, and EDX–SEM were used to characterize the RuNPs synthesized by the green synthesis method, and their efficacy on cell viability was tested on HCT116 human colon cancer cells.

Methods UV spectroscopic measurements were used to study the release of HOM–RuNPs. Apoptosis was assessed by measuring protein expression of p53, Bax, and Bcl-2 by Western blotting. The presence of apoptosis was confirmed by double staining with Hoechst dye/propidium iodide under a fluorescence microscope. HOM–RuNPs were also tested for BCRP/ABC2 expression to check for drug resistance.

Results HOM–RuNPs with a size of 70–80 nm were found to be most effective at a dosage of 5.71 µg/ml and induced cell death by increasing the ratio of Bax/Bcl-2 and p53 expression. It was also shown to reduce multidrug resistance protein (ABC2), suggesting that it may be useful against multidrug resistance.

Conclusion Ruthenium-based nanoparticles synthesized by a green synthesis technique may be a candidate for anticancer drugs in the pharmaceutical industry and deserve further attention for proof-of-concept studies.

Keywords Ruthenium nanoparticles · Green synthesis · Apoptosis · *Homalothecium sericeum*

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Introduction

The fourth leading cause of death in the world and the third most common cancer is colorectal carcinoma (CRC), a malignant tumor of the epithelium of the colon or rectum [1]. According to statistics, colorectal cancer is the second and third most common cancer in both men and women, respectively [2]. Surgical resection, radiation, and chemotherapy are the mainstays of conventional colorectal cancer treatment, and they can increase the survival rate from 90% of stage I patients to 10% of stage IV patients by only 5 years [3]. Although surgery is a necessary component of CRC treatment, it can lead to postoperative problems such as tumor cell recurrence and/or liver metastases. Peripheral neuropathy and bowel dysfunction are long-term side effects of chemotherapy and radiotherapy that are becoming more common and urgent [4]. Most of the genetic instability in