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Green fabrication of biologically active magnetic core-shell Fe_3O_4/Au nanoparticles and their potential anticancer effect

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ABSTRACT

Core-shell Fe_3O_4/Au nanostructures were constructed using an advanced method of two-step synthesis from *Juglans regia* (walnut) green husk extract. Several complementary methods were applied to investigate structural and magnetic properties of the samples. X-ray diffraction (XRD), high-resolution transmission electron microscopy (HR-TEM), electron diffraction, optical, thermogravimetric analysis (TGA), and vibrating sample magnetometer (VSM) were used for nanoparticle characterizations. As shown by HR-TEM, the mean diameter of core-shell Fe_3O_4/Au nanoparticles synthesized using co-precipitation method was 6.08 ± 1.06 nm. This study shows that the physical and structural properties of core-shell Fe_3O_4/Au nanoparticles possess intrinsic properties of gold and magnetite. VSM revealed that the core-shell Fe_3O_4/Au have high saturation magnetization and low coercivity due to the magnetic properties. The core-shell nanoparticles show the inhibitory concentration $(IC)_{50}$ of 235 μg/ml against a colorectal cancer cell line, HT-29. When tested against non-cancer cells, IC_{50} was not achieved even up to 500 μg/ml. This study highlights the magnetic properties and anticancer action of core-shell Fe_3O_4/Au nanoparticles. This compound can be ideal candidate for cancer treatment and other biomedical applications.

1. Introduction

The necessity of modern science and technology in novel materials with specific properties increases the interest of the global scientific community in nanophysics researchers [1,2]. In recent decades, a large number of successes and scientific data in nanotechnology allow a creation of nanomaterials with required structural, physical and chemical properties [3–5]. The ability to control structure of nanocomposite can lead to the development of new technologies in the fields of chemistry, physics and material science [6]. At present, the nanomaterials with multiple functions which can be used for various applications are of growing interest.

In recent years, inorganic nanoparticles with various compositions, physical features, and functionalities have been widely synthesized and used as drug vehicles in order to overcome multidrug-resistant cancer cells. In recent years, inorganic nanoparticles with various compositions, physical features, and functionalities have been widely synthesized and used as drug vehicles in order to overcome multidrug-resistant cancer cells [7].

In particular, core-shell nanostructures are attracting more interests due to their universal compositions and structures [8–10]. The interaction between the core and shell in a nanostructure can lead to new properties and functions [11,12]. In order to achieve different effects and physical properties, various organic and inorganic compounds can be used as materials for core and shell nanostructure constructions [13]. Materials used in core-shell nanostructures and consequently, their physical properties can make a new class of nanomaterials useful in a wide range of applications (e.g. nanomedicine, nanooptics, magnetic devices, bionanotechnology and others) [14–16].

Core-shell nanostructures can be generated by a sequential two-step synthesis, in which the core is first created and then the shell is built up [17]. In such process, the uniform coating of the core and the regulation of the shell thickness are crucial. To achieve this, the charge and selectivity of the core can be modified by polymers and surfactants,

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