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Biomedical Assessment of Silver Nanoparticles Derived from L-Aspartic Acid Against Breast Cancer Cell Lines and Bacteria Strains

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Abstract
Biomolecules such as L-aspartic acid can be well-reducing and capping agents to produce metal nanoparticles with unique bioapplications. Silver nanoparticles (AgNPs) were synthesized using L-aspartic acid and evaluated as antibacterial and anticancer agents. The L-aspartic acid-AgNPs were characterized by utilizing spectroscopic instruments. Ultraviolet–visible (UV–Vis) spectroscopy gave peaks at 416 nm. Also, based on Fourier transform infrared spectroscopy (FTIR) analyses, it was determined that there are different functional groups of L-aspartic acid, namely, amino groups (-NH_2), carboxylic acids (-COOH), and R-groups (side chains), that are responsible for bioreduction of Ag salt and the production of AgNPs. According to transmission electron microscopy (TEM), AgNPs are almost spherical in shape and have a nanoscale size of 11.3 nm. X-ray diffraction (XRD) study revealed a distinctive diffraction peak indicating crystalline nanoparticle formation, which agrees with AgNPs' spherical structure. Field emission scanning electron microscopy (FE-SEM) was carried out with the energy-dispersive X-ray spectroscopy (EDX) analysis to determine the elemental composition of biosynthesized AgNPs, which included silver, oxygen, and carbon. Dynamic light scattering (DLS) was designated with a hydrodynamic radius of 109 nm, polydispersity (PdI) is good at 0.266, and a Z-potential of − 14.5 mV indicates good stability. AgNPs showed antibacterial activity against gram-positive (*Staphylococcus aureus*) and gram-negative (*Escherichia coli*). AgNPs have cytotoxicity 3-(4,5-dimethylthiazol-2-yl)-2,5-diphenyltetrazolium bromide (MTT) assay against breast cancer MCF-7 cell line, half-maximal inhibitory concentration (IC_{50}) of 1159.6 µg/mL, and genotoxicity by comet assay, emphasizing apoptosis cells through cell cycle flow cytometry. Biogenic nano-formulations of L-aspartic acid-AgNPs possess antibacterial and anticancer therapeutic applications because they are safe, cost-effective, and scalable.

Keywords Silver nanoparticles · L-Aspartic acid · MCF-7 breast cancer · Antibacterial · DNA fragmentation

1 Introduction

Nanotechnology has revolutionized over the past two decades; nanoparticles have become a fashion trend of the twenty-first century because of their distinctive characteristics [1]. Various applications can be made with NPs, such as medicine, cosmetics, environmental health, machine design, optics, and biomedical sciences [2, 3]. Nanoparticles are now made of metals such as zinc, silver, copper, iron, gold, titanium, platinum, and many more and are primarily used in nanomedicine applications [4].

Nanoparticles are often synthesized using either the top-down or bottom-up approaches. A top-down approach involves shrinking bulk materials gradually to achieve the best nanostructure. A bottom-up approach, on the other hand, requires aggregating atoms or molecules (agglomeration) interior of small regions. Synthesizing nanoparticles can be achieved in three ways: physically (top-down), chemically, and biologically (bottom-up) (Fig. 1) [5].

According to a recent study, traditional methods for creating silver nanoparticles are less as effective as they could be due to bad chemical reactions, energy consumption, and cost [6, 7]. Also, the limited lifetimes of the particles owing to aggregation are additional disadvantages, and the use of harmful reducing agents, such as sodium citrate or

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