Evaluation for effect of Gold nanoparticles on cancer cells

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Abstract

Nanotechnology is emerging eventually in many fields of application, especially the medical application. Gold nanoparticles one of these nanomaterials and due to its unique properties such as chemical, physical and biological properties, it used in diagnostic and treatment of cancer. The aim of the present study is evaluation the efficacy of GNPs on two cell lines, mammary adenocarcinoma (AMN3) and human cervical cancer cell line (HeLa), the cells were exposed to those particles at concentrations (4.5×10^{12}-6×10^{10}) for 24 hours.

The results revealed that GNPs can inhibit growth of cancer cells especially at higher concentrations more than low concentration, in the same time, the inhibition growth of mammary adenocarcinoma more than the cervical cells especially in the first and second concentrations, while in third and fourth concentration, the opposite occurred. We conclude from this study that Gold nanoparticles has inhibition effect on cancer cells and at different concentrations.

Key word: GNPs, cancer cells, cell line, concentration.

Introduction:

Recent uses of nanotechnology include the use of nanoparticles for the treatment of various diseases like cancer, diabetes, and HIV vaccination. Nanotechnology offers a unique way for managing a range of biological and medicinal processes at the nanoscale. A cytotoxic agent is used in traditional cancer treatment, which frequently has negative side effects (1).

Due to their versatility and distinctive qualities, gold nanoparticles (GNPs) have a variety of biomedical uses in the diagnosis and treatment of disease, including targeted chemotherapy and pharmaceutical medication delivery. For site-specific drug delivery applications, GNPs can be coupled with ligands, imaging labels, medicinal medicines, and other functional moieties (2).

In the EU, 1.27 million people died from cancer in 2020, while 2.7 million individuals received a new cancer diagnosis. After cardiovascular disorders, this places cancer as the second most common cause of death in the EU. By 2035, the number of instances of cancer is expected to rise by 24%, making it the EU's biggest cause of death (3).

The conventional cancer treatments (surgery, radiation and chemotherapy) are not effective at eradicating cancer from other body, These methods are also wrought with negative side effects, increased frequency and severity of patients' late problems (4). Hence, many research were done to find alternative treatment to cancer current treatment, One of these alternative treatment is nanotechnology.

Materials and methods:

Gold nanoparticles (GNPs) with a diameter of 10 nm, a spherical form, and a concentration of 6 1012 particles/ml were created by the Sigma Aldrich Company.

Cell culture

The Iraqi Centre for Cancer and Medical Genetics Research (ICCMGR) sold human cervical cancer (HeLa) and mammary adenocarcinoma (AMN3) cell lines. The cells were cultured in 50 cm2 tissue culture flasks with 10% fetal bovine serum (FBS), peniciline-streptomycin, and a humidified 5% CO2 atmosphere at 37°C for the duration of the experiment.

Cytotoxicity assay

Five concentrations (dilutions) of GNPs (4.51012, 1.51012, 5.41011, 1.81011 and 61010) particles/ml were made from a stock solution of GNPs using free serum media. Cell culture in microtiter plates (96 wells) were then exposed to the five concentrations of GNPs during the log phase of growth with four replicates at 200 l for each concentration, while the control wells were exposed to only free serum medium. After the cells had been incubated, they were stained with MTT dye and read using a micro-ELISA reader at 550 nm. The inhibition rate was then determined using the formula: IR% = A-B/A 100 IR=inhibitor rate, A=optical density of the control, and B=optical density of the treatment.

Statistical analysis

The impact of various factors on the research parameters was determined using the Statistical Analysis System, SAS (2012). In this study, the Least Significant Difference (LSD) test was utilized to compare means substantially**.**

Results and Discussion

After 24, the result of inhibition rate (IR%) for HeLa and AMN3 cancer cell line at the first concentration revealed higher significant inhibition in comparison with the fifth concentration which showed lower inhibition rate (Table 1), without significant variation between the cytotoxic effect for the other concentrations, with highly significant variation at level ($p<0.01$).

The growth inhibition rate in nanoparticle tests is dependent on the type of cancer cell lines, the size and shape of the nanoparticles, and the surface chemistry. In cytotoxicity experiments, the growth inhibition rate is dependent on the type of cell line, exposure length, and concentration (5). AMN3 cell line more effect than HeLa cell line, this mean that GNPs has selective effect towards cell lines. Patra (6) suggested that cell death was selective induce by GNPs dependent on type of cell lines until in absence of any specific functionalization, they found that human carcinoma lung cell line would selectively absorb GNPs while the baby hamster kidney and human hepatocellular liver carcinoma showed no response to treatment with GNPs.

GNPs bind to cancer cells 600 more than with noncancerous cells because that cancer cells express different protein groups on their surface, such as breast cancer overexpress seprase and Her2 which have corresponding antibodies that can be bound to GNPs especially conjugated GNPs (7), this explained why two cell line were affected by nanoparticles.

In concentration dependent manner, the study shows that highly inhibition rate when the concentration was increased, Qu and his team(5) emphasized on the same thing, when they pointed to that low concentration after incubation 24hrs did not increase in cell viability and high concentration lead to high inhibition. As well as the spherical GNPs were lethal only at highly concentration(8).

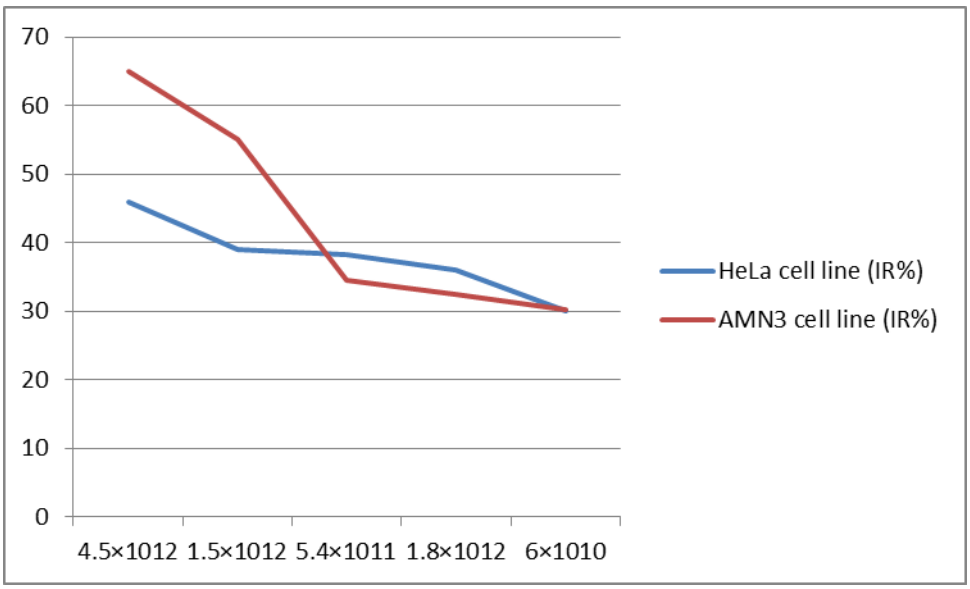
Due to GNPs' tiny size, they can diffuse around the center and edge of the culture wall or concentrate in the extracellular space between the basal plasma membrane for insertion into cells, but this happens infrequently in the nucleus. (9).

Conclusion:

According to this study, there is evidence that gold nanoparticles can slow the growth of cancer cells in several cancer cell lines. The inhibition varied depending on the cell line, the concentration, and the incubation period.

Table (1): Effect of GNPs concentrations on growth inhibition of AMN3 and HeLa cell lines at 24 h.

Concentration Particles/ml	AMN3 Mean of IR%	HeLa Mean of IR%
4.5×10^{12}	64.9	45.9
1.5×10^{12}	55.1	39
5.4×10^{11}	34.6	38.3
1.8×10^{12}	32.4	36
6×10^{10}	30.2	30
LSD	8.027**	5.612**



Figure(1) show Effect of GNPs concentrations on IR% of AMN3 and HeLa cell lines at 24h

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