Investigate the Effectiveness of Carbon Nanotubes in Inhibiting Breast Cancer Cells in Vitro

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ABSTRACT

Background: Given their enormous potential in biomedical applications, nanomaterials have seen significant advancement in recent years. Due to their distinctive physicochemical characteristics, carbon nanotubes (CNTs) have gained popularity as a tool for cancer treatment and diagnosis. Breast cancer, the most common type in women, is one of these types of cancer. Breast cancer is extremely dangerous to one's health. Every year, the prevalence of BC spreads globally. **Methods**: MCF-7 cell line sub-cultured in vitro and exposed to different concentration of CNTs for 24 hours. Then measured by MTT test. **Results**: CNTs significantly inhibited the MCF-7 cell line proliferation after 24 hours particularly in 400 and 500µg/ml of CNTs **Conclusion**: CNTs have a highly toxicity against cancer cells.

Keywords: Carbon nanotube, Breast cancer cells, cancer, inhibition

Introduction

Globally, cancer has been classified as one of the leading causes of mortality as well as a serious public health issue (1). due to its abnormal growth in addition to the uncontrolled spread of cells inside the body. It has the ability to present in any part of the body, leading to the accumulation of cells, generally during various periods (2,3). Normal cells' growth-promoting genes are repeatedly reproduced in cancer cells, which frequently become unstable and develop fatal properties as they proliferate (4).

According to estimates from the World Health Organization (WHO), they recorded around 18.1 million cases of cancer worldwide in 2020. Furthermore, that number is likely to increase to 22 million years over the following twenty years (5). While In the United States in 2021, the American Cancer Society has reported 1.9 million new cancer cases and 608,570 cancer deaths (6).

Breast cancer is the first most common cancer in the world, accounting for 12.2% of all diagnosed cases (7). It is also the biggest cause of death for women, accounting for 450,000 fatalities each year and 1 million more cases (1). Every year, almost 2.09 million women in Iraq are diagnosed with breast cancer, and 627 000 of them pass away as a result of the illness. (8).

While breast cancer is a common cause of death in women, it only accounts for less than 1% of occurrences in men, which is an uncontrolled cell proliferation that begins in the breast tissues.

Breast cancer can be discovered in its early stages via image investigations (ultrasound, magnetic resonance imaging, and mammography) or, less frequently, clinicaltrials of tangible lesion. Breast cancer mitigation efforts have recently focused on prevention, earlydetection, also treatment. Breast cancer therapy is determined by the cancer type and itsgrade, which is determined by the size and extent of the tumor. The most common cancer therapies include surgery, radiation, chemotherapy, and hormone therapy (9, 10).

Although breast cancer patients have a greater survival percentage than other forms of cancer, current therapies are not completely efficient in preventing the spread and/or recurrence of the disease. They are also non-specific and can affect healthy tissues and cells. Finding a solution to this problem would have a significant impact on patients' lives, particularly those with metastatic breast cancer (11–12).

In latest years, it has been noticed that nanotechnology breakthroughs have made it feasible to increase the efficacy of traditional breast cancer therapies. One example is the use of nanomaterials in the release of chemotherapy medicines (13–14).

Nanotechnology is regarded as one of the most promising developing fields of science and technology, with the potential to create significant advancements in health. which identified the nanoscale as the scale included in the study, creation, design, synthesis,characterization, manipulation, and materials application, devices, and functional systems throughthe control of matter at nanoscale, thatis, at the scale of atomsand molecules (15).

Researchers have looked at the potential of nanomaterials to improve the effectiveness of breast cancer treatment today. The scientific community considers carbon nanomaterials, namely nanotubes, to be essential because of their distinctive physicochemical and biological characteristics. The interactions of carbon nanomaterials with biomolecules and cells can be strongly influenced by a variety of features, including size,shape,surface structure and charge, chemical assembly, aggregation and/or agglomeration, and solubility. For instance, using carbon nanomaterials, remarkable pictures of tumor locations have been produced (16, 17), outstanding potential as cell-specific medication and/or biomolecule delivery transporters (16, 18).

Therefore, our aim from current study wasto investigate the effectiveness of CNTs in inhibiting breast cancer cells in vitro.

Materials and methods

Our experimental procedures have been done in postgraduate research laboratories, the College of Medicine, and the University of Diyala. Scientific research ethics approvals were completed before starting the experiment from the Scientific Research Ethics Committee and the College of Medicine.

The breast cancer cell line MCF-7 was used. Initially, both cell line types were cultured in Petri dishes that contained DMEM/F12 medium containing 10% bovine serum (FBS) with 1% penicillin/streptomycin as well as, the plate consisted of six wells. After that, cells were split and sub-cultured for experimental repair.

Carbon nanotubes of various concentrations were obtained by Intessar K. Abe et al., 2022 (20). Where we communicated with the researcher, who gave us different concentrations of CNTs included (15.1, 31.2, 62.5, 125, 250, 400, and 500 g/ml).

To determine how many of the MCF-7 cell lines could be alive in our laboratory environment, they were cultivated without the addition of any substance as control. We cultivated MCF-7 on ten distinct plates; each plate contained six wells. We then took measurements and averages from ten samples to determine how much might (on average) remain alive under the conditions of our lab. Control cell lines are the average number of MCF-7 cell lines that have survived.

Breast cancer cells were exposed to different concentrations for 24 hours. To perform the test, 10,000 MCF-7 cells were cultured from 96 cells per plate. After 12 hours of culture, the samples were added to the MTT solution at a concentration of 0.5mg/ml after 24 hours, they were then incubated for 3.5 hours at37 °C in the dark. The MTT solution was taken off the plate at the conclusion of the time period specified, and the resultant purple dye was dissolved in DMSO. At 570 nm, the purple dye's absorption rate was measured by ELISA.

Results

According to MTT measurements, which investigate the effect of drugs and nanomaterials on different cell lines to see if they can kill cancer cells or not. after 24 hours

of exposing MCF-7 cell line to different concentrations of CNT, We discovered that when the concentration of CNTs increased the MCF-7 cell line significantly inhibited particularly when exposed to 400, and 500 µg/ml of CNTs where CNTs can inhibit between 70 and 80 percent of cancer cells, as shown in Table 1

Table 1: Inhibition ratios in MCF-7 were determined by different concentrations of CNTs after a period of 24 hours at 37 °C.

Concentration µg/ml	Mean ± Std
*15.1	**1.7 ± 24.87 d**
*31.2	**2.2 ± 39.98 c**
*62.5	**2.5 ± 41.11 b**
*125	**2.6 ± 58.92 b**
*250	**3.1 ± 60.65 b**
*400	**3.2 ± 77.60 a**
*500	**3.4 ± 78.20 a**
The letters indicate that there are statistical differences at the level of 0.05. Signs * indicate a statistically significant difference between the average inhibition rate and the 0.05 level.	

Furthermore, the MCF-7 cell line culture plate were checked under microscope especially with 400, 500 µg/ml of CNTs. As in figure 1.

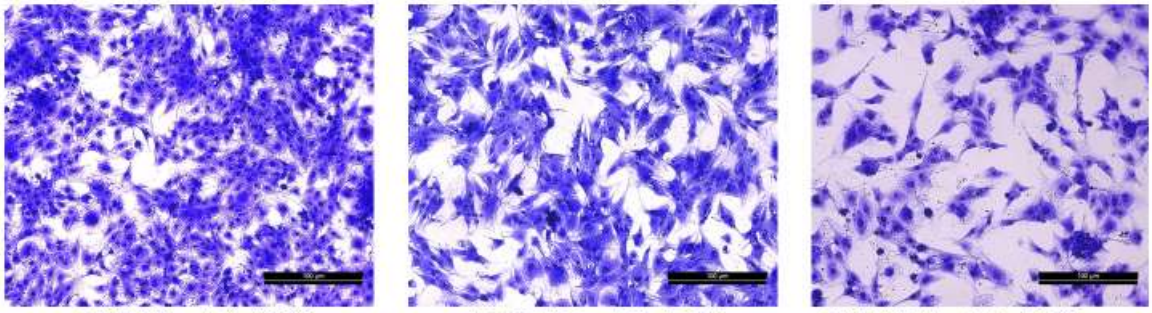

Figure1: MCF-7 inhibition with 0, 400, and 500 µg/ml of CNTs

Discussion

CNTs have piqued the interest of biomedical researchers due totheir unique structures also properties, such as high aspect ratios, large surface areas, a plethora of surfacechemical functionalities, and size stability on the nanoscale. CNTs in particular are desirable drug delivery carriers and noninvasive therapy mediators (21).

There are a number of restrictions on the clinical applications of these techniques, despite the fact that numerous studies have demonstrated promising outcomes for CNT-based therapies in vitro and in vivo. Human body safety concerns have not been sufficiently addressed. The majority of in vivo toxicity tests were carried out over a brief period of time, even though numerous in vitro tests demonstrated the safety of CNTs (21,22).

The topic of long-term safety is receiving more attention, furthermore in vivo research on the long-term-toxicity as well as exogenous excretion ofCNTs has made some headway. The surface functionalization and purification of CNTs have been used to.

The inhibitory rate of CNTs on MCF-7 cells increased in a time-dependent and concentration-dependent manner, according to our findings.

Moreover, the inhibitory rate increased with the increase in concentration in a dose-dependent manner. Therefore, it may be concluded that CNTs have a significant time- and dose-dependent inhibitory effect on the MCF-7 cell line. We can predict that CNTs have a high toxicity against cancerous cells at high concentrations. Where the high concentration of CNTs significantly inhibits MCF-7 cell proliferation (p-value 0.05). This is because CNTs are known to be cytotoxic and to inhibit growth, including cell cycle progression.

Conclusion

In conclusion, in order to enhance the targeted anti-tumor therapeutic effects of CNTs, the groups administered with CNTs inhibited Mcf-7, indicating the positive activity of these nanoparticles against cancer cells.

Simultaneously, we need to study the toxicity of CNTs on normal cells to determine whether it has a negative effect or not.

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