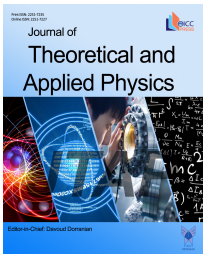

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Inhibition breast cancer by (Cu-Se) nanoparticles generated by plasma jet

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Original Research

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Abstract:

This work discusses the synthesis of (Cu-Se) core-shell nanoparticles using a plasma jet, using aqueous solutions of copper and selenium salts as a precursor. The structural properties of the resultant (Cu-Se) core-shell nanostructures were examined using UV, XRD, and SEM. The diameter of the granules with a concentration of 3:7 is 17 nm. Thus, utilising the designated diameter. Next, a comparison was made between the MDA cell line—which had been treated to Cu-Se NPs as an anti-cancer (breast cancer) agent—and the normal cell line REF. For every set, the following parameter was evaluated: (i) the proportion of breast cancer cells whose proliferation was inhibited after exposure for (24, 48) hours; (ii) the cytotoxicity of normal cells after (24, 48) hours. We diluted the nanomaterial five times and found that the cytotoxicity in normal cells does not exceed 22%, indicating that its effect is not detrimental to normal cells. Meanwhile, the nanomaterial's effects were observed on cancer cells after 24 hours, at roughly 63%, and after 48 hours, at roughly 93%, and the census was carried out with these cells.

Keywords: (Cu-Se) NPs; Plasma jet; MDA cells line; REF cells line; Growth inhibition; Cytotoxicity

1. Introduction

Cancer is the most common cause of mortality and the leading source of morbidity worldwide. Breast cancer is one of the most common cancers in women and has a high death rate. However, several variables, including environment, lifestyle, genetics, and demography, can impact the development of this illness and its impact on survival and mortality [1]. Unchecked cell division causes cancer, a deadly illness that spreads throughout the body. Because of these reasons, it is essential to identify and treat cancer as soon as possible to decrease its rate of spread and death. Nanotechnology is currently one of the techniques used in cancer research the most frequently. Numerous promising advancements, including medication delivery, have been made in the application of nanotechnology to cancer detection and therapy [2]. Conventional treatments including radiation, chemotherapy, and surgery are given to the majority of patients. Research indicates that over 50% of cancer patients experience agony and ultimately pass away due to inadequate or improper therapy [2, 3]. Breast cancer is the deadliest gynaecological cancer, a leading cause of cancer-related death in women, and a significant public health issue [3]. Novel techniques have been developed as a result of recent advances in medical research and emerging technologies, such as hormone treatment and the use of nanotechnology in the creation of nanomaterials [4]. Due to their biological nature, nanomaterials may pass right through cell membranes [5]. Before nanoparticles are widely used in cancer treatment clinics, much more research has to be done due to their possible toxicity [6]. Tools based on nanotechnology for treating cancer Nanotechnology cannot progress without drug delivery systems based on molecules and tiny molecular structures. Numerous nano carriers have been utilised in the therapy of cancer, including carbon nanotubes, liposomes, micelles, dendritic macromolecules, and quantum dots [7].

Nanoparticles may be targeted to certain areas and interact biochemically with target cell receptors by changing their surface [8, 9]. The capacity of nanoparticles to cross a variety of biological barriers, including as the blood-brain barrier, and deliver drugs to the intended area is another crucial function. When coated with polylobate, drug-loaded nanoparticles can cross the blood-brain barrier and selectively target the brain during intravenous administration

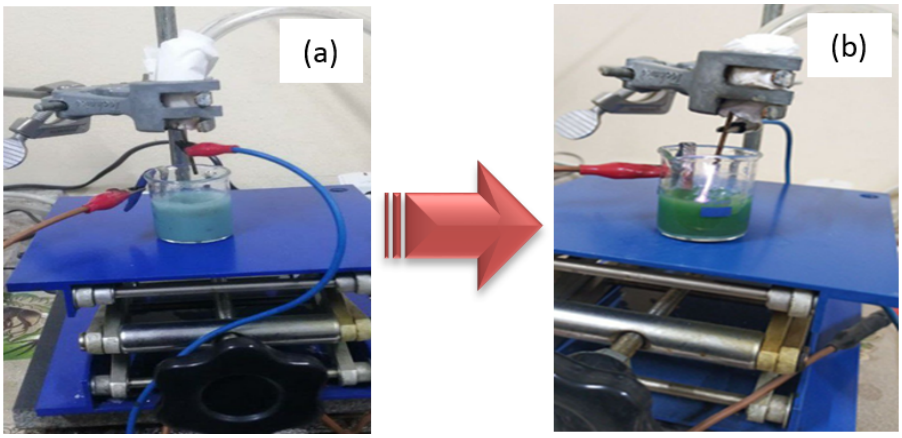

Figure 1. synthesis Cu-Se NPs (a) Chemical solution of copper carbonate $CuCO_3$ exposed plasma jet, (b) Cu-Se NPs after a 30 min exposure time.

[10].

Making and modifying nanomaterials using plasma The fourth state of matter is plasma, a quasineutral gas composed of neutral and charged particles that interact together. Plasma is the fragmented positive ions and negative electrons of atoms that make up around 99% of all matter in the universe. Examples of plasma include interstellar hydrogen, atmospheres, gaseous nebulae, and the interiors of stars [11]. Plasma can be totally ionised, as in the sun, or partly ionised, such in fluorescent lightbulbs [12]. A gaseous combination of ions, either positive or negative, and electrons is called plasma.

Thermal and nonthermal (ions and neutral particles) plasmas are distinguished by the temperature of the electrons in relation to the temperatures of the other particles. In a thermal plasma, the heavy particles and electrons are almost at the same temperature (they are in thermal equilibrium), whereas in a nonthermal plasma, the heavy particles are much warmer than the electrons [13]. The objective of the project is to create a copper-selenium nanomaterial utilising core-shell technology, which will increase the material's ability to suppress cancer cells and lessen its toxicity to healthy cells.

2. Synthesized core-shell

2.1 Synthesized core-shell (Cu-Se) NPs

In the beginning, core-shell (Cu-Se) NPs were produced in a metal pipe with a diameter of 1 mm and were secured vertically by the catcher. Proceed as previously instructed after preparing the copper carbonate solution and achieving the necessary weight and concentration. The prepared model will be placed on a platform within the metal tube. From the metal tube to a point one millimetre from the liquid's surface to the tube's nozzle, the edges of the beaker were rounded. In addition, the metal tube that carried the Argon gas was used to control the flow of Sanpur gas, which was also under control. The value corresponding to the voltage supplied by the system increased progressively until plasms formed between the tube and the liquid's surface [14].

Copper carbonate ($CuCO_3$) was initially dissolved in an aqueous solution at a concentration of 5 mM in order to create shell-core (Cu-Se) NPs. The solution was subsequently subjected to a plasma jet for 30 minutes, as seen in figure (b). To 3 millilitres of the previously made nano-copper,

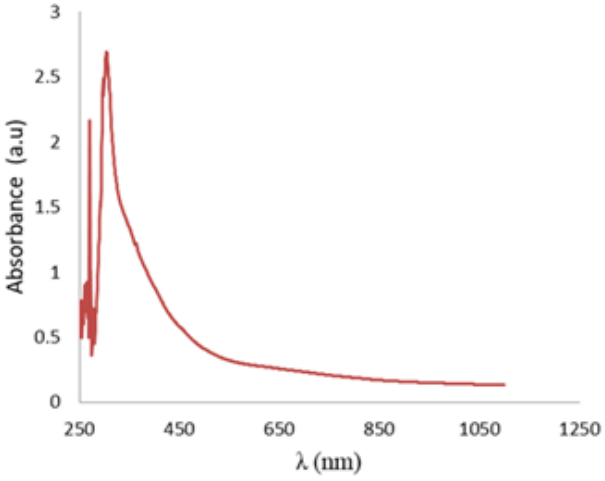

Figure 2. UV-Visible absorption spectra of Cu:Se core-shell NPs.

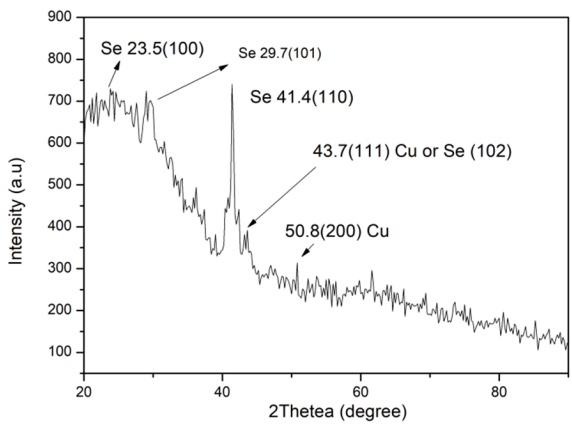

Figure 3. X-ray pattern of Cu nanoparticles prepared with jet plasma.

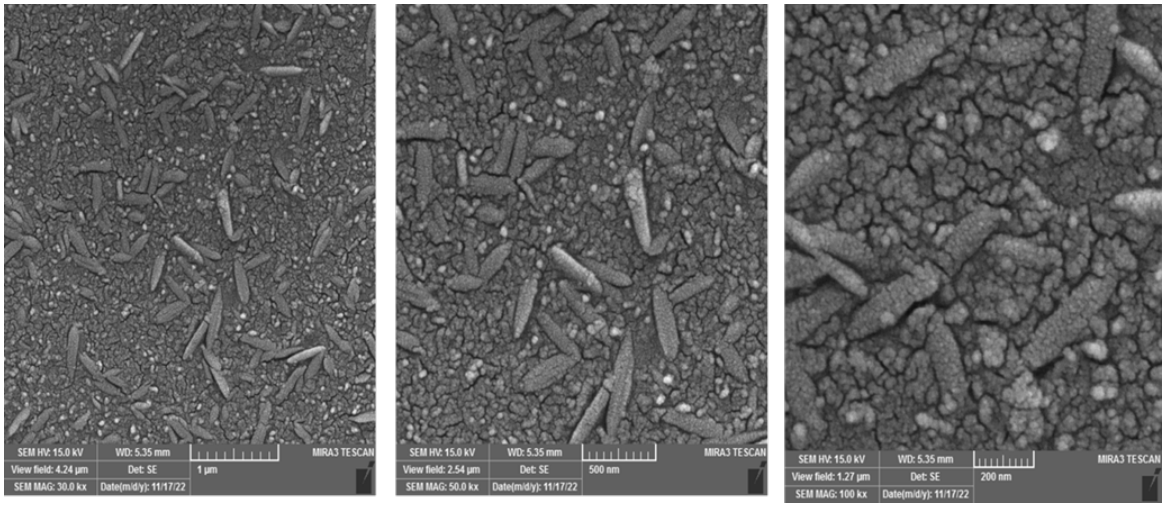

Figure 4. Images of FESEM Cu-Se nanoparticles prepared using plasma jet.

add 7 millilitres of 0.5 millimeter-strong selenium nitrate [15]. The necessary weight is found using the following Equation (1) [16]:

$$\text{Concentration(mole)} = \text{(mass(g))/(Molecular weight(g/mol)} \times \text{volume(Liter))...} \quad (1)$$

2.2 Impact of synthesised nanomaterials on the suppression of normal (REF) and breast cancer (MDA) cell lines

MDA and REF, two cell lines, were used to culture both normal and breast cancer cells. For my organisations, the Al-Nahrain University Biotechnology Centre donated cells. Trypsin EDTA was used in this instance to extract the cells, followed by the addition of PRMI 10% culture media and the distribution of 10,000 cells per well using a microplate 96 well. Following a 24-hour incubation period at 37 degrees Celsius, the cells were examined to see whether a monolayer had developed.

There were groups created on the 96-well Lear microplate. groups were given diluted concentrations in the following order: 100%, 50%, 25%, 12.5%, and 6.25%. The cells were exposed for twenty minutes to an inspection at 37° C for 24 and 48 hours after being dyed with 50 μg of Crystal Violet dye and put in an incubator.

As the outcomes of the nanomaterial manifested on cancer cells after 24 hours, roughly 63%, we observed that the cytotoxicity does not surpass 22% in normal cells, indicating that its influence is not negative on normal cells. Approximately 93% of cells had grown after 48 hours, and the cell growth rate was estimated using Equation (2) [17–20].

$$\text{Growth inhibition} = \frac{\text{control} - \text{treatment}}{\text{control}} \times 100\%..., \quad (2)$$

3. Results and discussion

3.1 Results of nanomaterial tests

In the present work, Ar gas and a plasma jet were used to create nanoparticles (Cu-Se) core-shell NPs. The solutions can be made from blue to olive in colour to indicate the presence of emerging nanoparticles (Figure 1). When present, (Cu-Se) NPs molecules have a colour that is different from water tetrachloride. Surface plasmon resonance produces salts. Consequently, spectroscopy at visible wavelengths was employed to display the nanoparticle composition. The produced nanoparticle solutions' optical properties were investigated. Of special significance is a deviation at the

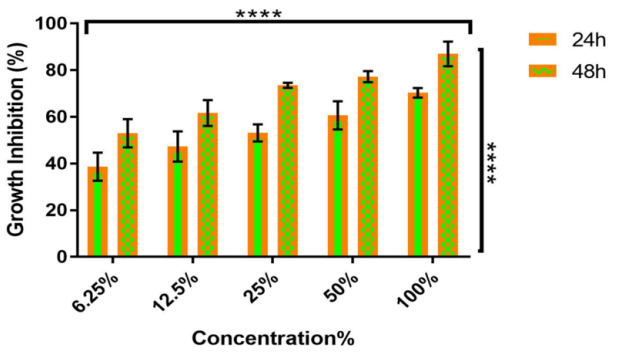

Figure 5. Growth inhibition of Cu-Se NPs on cancer MDA cell line.

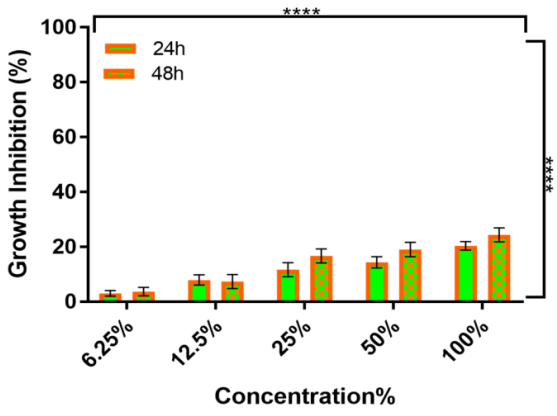

Figure 6. Cytotoxicity of Cu-Se NPs on normal cell line REF.

absorption edge that is skewed in wavelength from 400 to 800 nm (Figure 2) [17]. The peak at 580 nm is caused by the interband transition of copper electrons from the higher level of the valence band [18].
Using a plasma jet produced core-shell Cu-Se XRD patterns with a ratio of 3:7. According to PDF card stander 00-004-0784, the data indicated that all of the peaks seemed to be funnelled to copper and selenium. The sample including a well-crystallized camper with other features was generated by exposing it for 30 minutes to Cu and 10 minutes to Se. The two peaks at 2θ (43.7, 50.8) depict the planes (111), (200), and so on. The four peaks at 2θ (23.5, 29.7, 41.4, and 43.7) that, in turn, correspond to the planes (100), (101), (110), and (102) in the pattern of Cu NPs As can be shown in (Figure 3), the pattern for Se NPs offers compelling evidence for good quality.

3.2 Field emission scanning electron microscopy study

FESEM was used to examine the morphology of Cu:Se NPs produced by atmospheric plasma. The FESEM image, shown in Figure 4, demonstrated that nanoparticles have spherical and tube-shaped forms with another particle that resembles a spot light. The diameters of the particles were found to range from 15 to 50 nm. It is well known that a nanoparticle's form has a significant impact on its optical and electrical capabilities.

3.3 Results of effect Cu-Se nanoparticles on the inhibition of Breast cancer tissues (MDA)

The growth inhibition rate of cancer cells was assessed during incubation durations of 24 and 48 hours in order to assess the most successful evaluation of therapy. Figure 4 shows that when the concentration of core-shell nanoparticles was 100%, the maximum rate of cancer cell elimination was 63% after 24 hours, and the greatest rate was 93% after 48 hours. This data shows that the growth inhibition rate increases along with the length of time the cells are exposed to Figure 5.
Since the human body needs selenium, nanomaterials containing this element have high biocompatibility. When thoughtfully engineered, selenium-containing nanoparticles show potent anticancer action and remarkable sensitivity to redox stimuli. This article discusses the creation of selenium-containing nanoparticles as drug delivery vehicles and anticancer drugs for the treatment of cancer [20–22].
Figure 6 shows that the cytotoxicity in normal cells does not surpass 22%, indicating that normal cells are not adversely affected by it.

4. Conclusion

This work has shown that Cu-Se core-shell NPs created by plasma jets kill cancer cells.The synthesis of core-shell approaches in recent years has proved the production of these core-shell catalysts. Plasmonic-magnetic nanoparticles (NPs) are preferred because of their capacity to modify core size and their robust metal shells. NPs' ability to treat cancer cells depends on whether they are found within or outside of cells. The results of this investigation demonstrate that modest concentrations of NPs combined with extended exposure durations lead to minimal cytotoxicity for normal cells, but they severely restrict the growth of cancer cells.
The fact that these newly developed NPs show less toxicity in normal cells suggests that they may have a selective killing effect, which might lead to their application in the treatment of cancer.

Ethical approval
This manuscript does not report on or involve the use of any animal or human data or tissue. So the ethical approval is not applicable.

Authors Contributions
All the authors have participated sufficiently in the intellectual content, conception and design of this work or the analysis and interpretation of the data (when applicable), as well as the writing of the manuscript.

Availability of data and materials
Data presented in the manuscript are available via request.

Conflict of Interests
The author declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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