Characterization of Drug-Carrying Nanocomposite Spheres for Targeted Drug Delivery

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Abstract. Active targeted drug delivery occurs when a drug is associated with a biodegradable polymer and a bio-targeting compound and administered to the site of interest. In this study, these nanocomposite spheres are characterized using various techniques. In-vitro characterization of the nano-spheres containing therapeutic agent and fluorescence molecules are accomplished by culturing live cells in microscopic cells, and introducing the nano-spheres. In-vivo studies are conducted using immune-deficient mice. Other characteristics such as release rates, percent entrapment efficiency and size are studied with UV-Vis spectroscopy, TGA, and TEM.

1. Introduction

Targeted drug delivery, delivering therapeutic agents in a manner where the affected or injured part of the body has increased concentration of the medication, has increased the efficiency of treatments for various diseases by many folds. One of the most important uses of targeted drug delivery is for treating cancerous tumors. In this research, skin cancer is targeted to be treated using magnetic nanoparticles, therapeutic agents, and bio-targeting compound enveloped in a biodegradable polymer sphere measuring in micron scale. The nano-composite spheres are characterized for their rates of release, cytotoxicity, size and percent entrapment efficiency using UV-Vis spectroscopy, TGA, and cytotoxicity tests.

2. Materials and Methods

The nano-composite spheres are synthesized by oil-emulsification process. The bio-targeting compound functions to target specific cancerous cells in need of extra nourishment[1]. The magnetic nano-particle, in the presence of exterior magnetic field, helps in the propagation of the spheres towards the target site. Therapeutic agents functions to treat cancerous tumor cells. The polymer helps in holding all the above described ingredients together.
The Transmission Electron Microscope (TEM) is used to measure the size of the magnetic nano- particles, as shown in Figures 1 and 2. The TEM uses a focused beam of electron to measure the size. The average size is measured to be 18 nm in size.

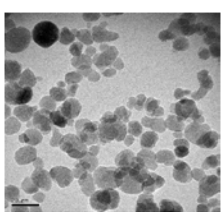

Fig. 1. TEM pictures of the magnetic nanoparticles

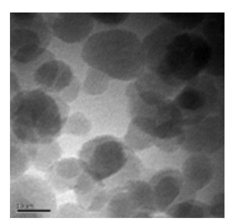

Fig. 2. Closer TEM pictures of the nanoparticles

The UV-Vis spectroscopy is used to analyze the amount of different compounds present in a solution. Thus the release rates of the nano-composite spheres are calculated. The UV spectra shown in Fig. 3 shows that as the days progress the absorption at 264 nm increases which relates back to the concentration. Figure 4 shows the individual concentration of various elements in the sphere.

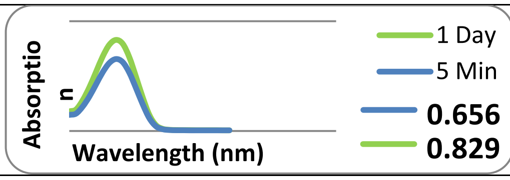

Fig. 3. UV spectra of therapeutic agent at day 1 and 5

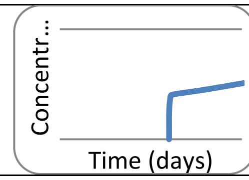

Fig. 4. The conc. of the therapeutic agent vs. time

Knowing the percent entrapment efficiency will allow medical treatments to be developed with the known amount of therapeutic agent retained in the drug carrier system. Thermal gravimetric analysis (TGA) can be used to find the percent entrapment efficiency. Fig. 55 shows the loss of one constituent between 35 and 23 percent. The total amount of that constituent was 20%, thus an entrapment efficiency of 60% is calculated.

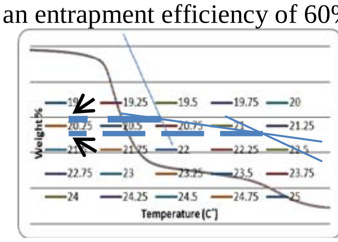

Fig. 5. TGA results used to find the entrapment efficiency

To better understand the passage of the nano-composite spheres in the in-vitro and in-vivo tests, they are added with fluorescent material. This enables the nano-composite spheres to be fluorescent in certain wavelength of light. Thus the path of the spheres and the location of the spheres can be easily observed.

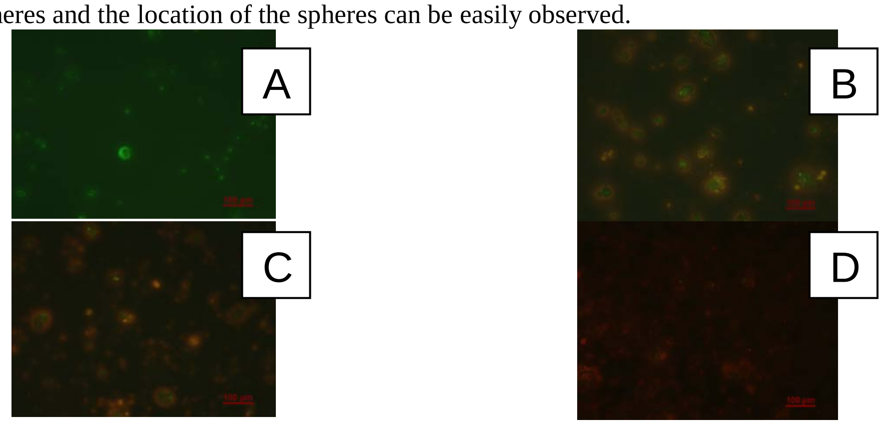

Fig. 6. In In-Vitro cytotoxicity test, cells fluoresce at the green wavelength while the drug carrier system fluoresces at red. The yellow is the result of both overlaid on top of each other

In-Vivo Tests: To better mimic real conditions of a human body, in-vivo tests are carried out in immune-deficient mice, as shown in Figure 6. These mice by genetic engineering are devoid of Thymus cells thus lacking an immune system and unable to reject foreign bodies [2]. Human skin cancer cells grown in certain spots on the mice are administered the nano-composite spheres and monitored at constant intervals.

3. Conclusion

The magnetic nano-composite spheres are characterized for important parameters using various techniques[3]. These characterizations will help understand the efficiency of the drug carrying spheres.

4. Acknowledgements

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5. References

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