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Gold Nanoparticles Conjugated to Encapsulated 5-Fluorouracil Cationic polymers and their Efficiency as Drug Delivery Vehicles

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Extended Abstract

Gold nanoparticles (AuNP's) have emerged as potential vehicles for the delivery of chemotherapeutic drugs due to favourable attributes such as their apparent low toxicity, high surface area, optical properties, biocompatibility, high loading capacity, ease of synthesis and surface modification. This study involved the chemical synthesis of AuNP's via a modified Turkevich method. Subsequently, AuNP's were functionalized with cationic polymers of chitosan and poly-l-lysine respectively, for delivery of the anticancer drug 5-fluorouracil (5-FU). All nanoparticles and their nanocomposites were fully characterized using UV-vis spectroscopy, ICP, FTIR, TEM and Nanoparticle Tracking Analysis (NTA). To maximize the efficacy of drug delivering capabilities the method of encapsulating the anticancer agent with the polymers was carried out followed by subsequent conjugation to the AuNP's. The ability of the nanocomplexes to enhance the activity of the drug towards HepG2 (Liver adenocarcinoma), a cancerous cell line and lower the cytotoxic effects of the drug towards HEK293 (embryonic kidney), a noncancerous cell line was investigated, through two *in vitro* cytotoxicity assays. AuNP's were selected as a delivery vehicle as it was hypothesized that it would result in improved anticancer activity towards cancerous cell lines, owing mainly to the ability of the nanoparticles in penetrating the leaky vasculature structure of cancerous tissue and acidic pH of cancerous cells which would result in the release of 5-Fluorouracil. Similarly decreasing the cytotoxic effects towards noncancerous cell lines. Drug binding and release studies conducted would illustrate which polymer would be more suitable towards delivering the anticancer agent.

Data from NTA analysis and TEM imaging correlated well with each other, indicating that the nanocomplexes were relatively small in size, uniform in shape, stable due to their high zeta potentials, furthermore methods involving UV-vis spectroscopy, FTIR and NTA confirmed the successful conjugation of drug and polymers to AuNP's. This study revealed that chitosan had a superior in drug binding efficiency when compared to Poly-l-lysine, while drug release studies over a 8-hour period showed that there was a steady and controlled release of the drug from the nanocomposite containing chitosan at a pH of 4 which is desirable for effective cancer treatment. *In vitro* cytotoxicity assays were carried out on the two human cell lines viz. Hep-G2 and HEK293, which showed the effectiveness of the nanocomposite towards the tumour cell lines with little or no significant toxicity towards the non-cancer cell line. More specifically the nanocomposites containing chitosan exhibited greater anticancer activity on the Hep-G2 cell line. Apoptosis assays were carried out to determine the mechanism of cell death, with the data correlating well with results from the MTT and SRB cytotoxicity assays This highlights the immense potential of these cationic polymers functionalized AuNP's in providing safe and efficient drug delivery with limited side effects, due to selective targeting of cancerous tissue. Further studies and optimizations are ongoing to ascertain the cellular uptake processes.

Keywords: Nanomedicine, Drug delivery, 5-fluorouracil, Gold nanoparticles.