Cysteine Capped Gold Nanoparticles for DNA Delivery

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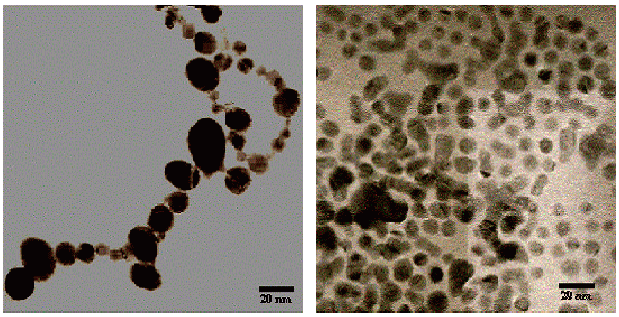
Introduction: In biology, most modern application, clinical studies with pure elemental gold are just getting underway which employ microscopic particles of this inert metal as a vehicle for gene delivery [1]. Pre-clinical studies have clearly established that naked DNA (including defined gene sequences) can be absorbed to the surface of minute metallic gold particles and efficiently delivered by a controlled helium pulse to cells of the inferior epidermis. This almost painless maneuver results in notably efficient gene expression. It has been undertaken largely to evaluate the potential technological risks attributable to gold itself and to anticipate any possible complexities which may arise from the application of this promising new approach to gene therapy. However, because of its instability due to their high surface energy, there is urgent need of suitable stabilizer for the prevention of aggregation effect of the gold in aqueous solution. Some functional groups such as cyano (-CN), mercapto (-SH), and amino ($-NH_2$) are known to have high affinity for gold[2]. L-cysteine (Cys) is a small, zwitterionic molecule, and well used in biochemical and electrochemical research. Here, we report the stabilization of gold nanoparticles by Cys in an aqueous medium and its characterization to identify S-Au interaction using different spectral studies. The engineering gold nanoparticles were used as gene delivery vectors

Methods: Raman, NMR, and FT-IR spectroscopy were used to characterize cysteine capped gold nanoparticles in aqueous medium. Morphology of the formulated nanoparticles was observed through TEM images. Furthermore, the formulation of plasmid DNA (pcDNA3.1His/Myc/LacZ) with the nanoparticles as a complex forming capacity on different pH was observed by gel electrophoresis. The trypan blue assay and β-galactosidage reporter gene assay were used on MCF-7 breast cancer cell and 3T3 mouse embryo cell to measure *in vitro* cytotoxicity and transfection efficiency of the nanoparticles, respectively.

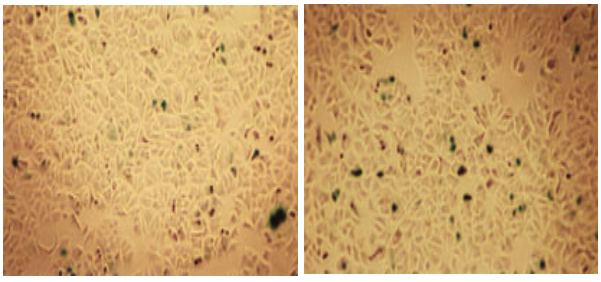
Results/Discussion: Results shows the existence of the S-Au interaction in cysteine capped gold nanoparticles and becomes stable in aqueous medium. The TEM images shows cysteine capped gold nanoparticles as distinct and spherical entities as compared to free colloidal gold nanoparticles, figure 1. Furthermore, results showed that no cytotoxicity at all and the transfection efficiency of the nanoparticles were dependent on the pH of the formulation media as well as cell type and higher β-galactosidage activity was observed on MCF-7 breast cancer cell. Typically, this activity was 4 times higher in the pH of 5 than that achieved by the nanoparticles of other pH (and/or control), figure 2.

Conclusions: Thiol moiety of cysteine is a very effective site to interact with gold. As a result, S-Au interaction, cysteine capped gold nanoparticles are very stable with an average size of 12 nm. Highly stable, nanoscopic, biocompatible and nontoxic cysteine capped gold nanoparticles interact with the plasmid DAN and also transfect MCF-7 breast cancer cell at low pH. From these results, cysteine capped gold nanoparticles could be an alternative vector in gene delivery/therapy.



(A) (B)

Figure 1. TEM images of (A) cysteine capped gold nanoparticles (B) gold nanoparticles in gold hydrosol.



(A) (B)

Figure 2. X-gal staining of MCF-7 breast cancer cell after transfection of cysteine capped gold nanoparticles at pH 7.5(A) and 5.0(B).

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References

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