Development of Gold Nanoparticles of Various Morphologies for Targeted Drug Delivery

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Combining advantages of nanotechnology with anticancer drugs represents an efficient, logical and alternative approach for cancer treatment [1]. Targeted drug delivery is already an emerging topic and it's all set to be the next generation of drug delivery agents. Meanwhile it has been recently discovered that natural molecules like curcumin, etc. have anti-cancer properties [2]. In this aspect we have combined the advantages of both nanotechnology and drug molecules to develop novel nanodrug delivery systems where ultrasound waves will trigger the drug release from the surface of nanoparticles. As a carrier we have chosen gold nanoparticles which have properties like inertness, high surface to volume ratio and low toxicity. We have developed a one pot green method for the synthesis of gold nanocrystals in presence of trisodium citrate which does not require mechanical stirring, organic solvents or high temperatures. The process involves reducing gold salt by trisodium citrate at room temperature in presence of a third molecule like L-tyrosine, drug molecules, polymers like polyvinylpyrrolidone (PVP) or dyes like fluorescein isothiocyanate (FITC) which resulted in a colloidal sol after few hours of reaction[3,4]. The morphology of final nanoparticles depends on the type and amount of additional molecule added with citrate. For example, with L-tyrosine the final colloidal sol is either blue or red in colour depending on the sequence of addition of reagents. The blue colour was due to formation of nanoflowers while red colour was due to formation of quasi spherical shape. In presence of PVP or FITC a bright red colour was developed indicating spherical shape. Electron microscopy images of nanoparticles synthesized in presence of PVP indicated ultra-small spherical particles with size of less than 5 nm. Additionally, this sol was extremely stable and did not precipitate even at high salt concentration or cell culture medium. Another additional feature of this method is that the citrate molecules also act as a base for the attachment of additional molecules like 11-mercaptoundecanoid acid (MUA) and enzymes like glucose oxidase (GOx) [4]. The particles are purified by centrifugation to remove any free unreacted reactants.

Moreover, as part of this project, the release of anti-cancer drugs from the surface of gold nanoparticles by ultrasonic waves are investigated. The developed gold nano-delivery system will be tested in targeted treatment of cancer tumours.

References

[1] O.C. Farokhzad, R. Langer, ACS Nano. 3, 2009,16.
[2] M.M. Yallapu, M. Jaggi, S.C. Chauhan, Drug Discov. Today. 17,2012,71.
[3] A. Jakhmola, R. Vecchione, *et al.*, Mater. Today Chem. 14, 2019, 100203.
[4] M. Celentano, A. Jakhmola, R. Vecchione *et al.*, Colloids Surfaces A Physicochem. Eng. Asp. 558, 2018, 548.

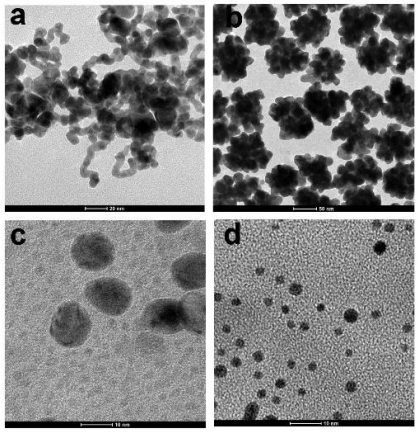

Figure 1: Gold nanoparticles synthesized at room temperature in presence of (a) Citrate, (b, c)citrate & L-tyrosine (d)Citrate & PVP.