Controllable Fabrication and Characterization of Gold Nanoparticles: Enhanced Therapeutic Approaches in Cancer

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Abstract

Energy trans-ducing gold nano-particles, with well-being physical, chemical and optical properties for utilization in different types of cancer therapy can be prepared through chemical seed growth reduction method. Gold nano particle is a umbrella term have a variety of size and shape. More regular gold nano-particles can be obtained by reduction of HAuCl₄, selection of chemicals and parameters of growth medium are set in accordance with the required category of nano-particles. Nano-particles have longest dimension of 100 nm. Therapeutic treatments like photo-imaging, gene delivery, drug delivery, cell labeling and photo thermal therapy can be done by gold nano particles. They reduce the side effects of conventional therapy due to high target specificity and absorb and scatter specific wavelength of laser. Hyperthermia in cancerous cells is generated without damaging surrounding healthy tissues, cause the cell death by necrosis and apoptosis. The overall morphology of gold nano particles can be characterized by SEM and TEM.

Keywords: Controllable Fabrication, Gold Nanoparticles, Therapeutic Approaches, Cancer

ARTICLE INFORMATION

Received: 05 December 2018

Revised: 23 December 2018

Accepted: 25 January 2019

DOI: 10.31580/ojst.v2i1.934

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INTRODUCTION

Nanotechnology is a great research field including biology, chemistry. It contains vast ability for near the beginning discovery, correct detection and modified behavior towards tumor. Nano-particles are usually littler than a few 100 nm in size which are analogous with big biotic molecules, for example antibodies, enzymes. In size, it is 100 to 10000 times smaller besides from human cells, such nano-particles recommend unique relations accompanied by bio molecules both together inside and outside the cells which be able to develop tumor detection and behavior towards tumor. The important nano-particles are carbon nano-tubes, paramagnetic nano-particles, quantum dots, gold nano-particles, and several other.(Cai et al., 2008). In which, GNPs are usually utilized in therapeutic approach. GNPs separate themselves with a important light to heat transformation stuff may be used in tumor treatment methods, for example, photo thermal treatment (PTT) (Grabowska-Jadach et al., 2019). They contain extraordinary plasmonic effects because of collaboration of light with electrons conduction band. SPR (surface Plasmon resonance) occurs while occurrence of light to nano-particles equivalents to the SP occurrence and SP resonance depended on size and configuration of nano-particles. SP resonance of nano-particles has different optical properties.

We can analyze the interactivity of light with Au nano-particles with the help of Mie hypothesis. With the help of Mie hypothesis, we are able to find the situation of SP resonance in nano-particles (Ghaforyan et al., 2015). The excitation of surface Plasmon resonance in Au nano-particles exhibit better E.F (electric field). At a point, electric field is produced in the particle when a metal nano-particle is energized with an optical beam and the electrons are transported together with respect to the permanent positive charges (Srivastava et

al., 2012). Because of broad variety of applications in SEF, SERS, bio-chemical imaging and cancer treatment, , precious metal nano-particles cover consideration(Yeshchenko et al., 2013). To create the photo thermal treatment successful for cancer cells , one needs to promise the association between three critical variables: supreme transmission density of the Au nano-structures utilized like specific marks, laser wavelength, and phantom transmittance of the bio tissues treated by laser pulse (Maksimova et al., 2007). Under PPTT treatment, the delivery of high temperature can be find through absorption of light by thermal diffusion over nearby tissues. Laser warmth outcome on one as well as other cancer necrosis and possibly apoptosis. Laser heating speed up cancer development which depends on exactness of warmth and on increase in cancer temperature by laser light (Terentyuk et al., 2009). Hyper-thermia is a tonic strategy which is employed to lift up the temperature of the body influenced through tumor. It managed cooperatively as well as other tumor treatment. The temperature can be increased by different methods. The temperature can be increased through PDAR (power density absorption rate) (Wust et al., 2002).

To synthesize different shapes of gold nano-particles, different methods are used. In general, to synthesize the gold nano-particles, three methodologies are utilized: the seed mediated growth technique, ultraviolet irradiation photo reduction, and electrochemical (Ali et al., 2012). The seed growth technique for synthesis of Au-NP that has been utilized for over a century. The seed growth reduction technique increases the particles size in well ordered and simpler to hold the configuration and sizes of produced Au-NPs. Accordingly this technique is broadly utilized in controlled Au-NPs synthesis (Zhao et al., 2013). In seed growth method two phases involves, at initial phase, little-size Au-NP seeds ready, at another phase, the seeds added in HAuCl₄ at the presence of balancing and reducing agents

and after that Au⁰ get bigger at seed surface to make bulky size Au-NPs. Main objective of this technique is to concentrate on Au-NPs formation, also talk about strategies for Au-NP quality of being functionalized. It is useful preparation methods for Au-NPs.

In photo thermal cancer treatment and optoelectronic technology, gold nano-particles showed potential. The surfaces of gold nano-shells can be functionalized through the adsorption of alkanethiols. Characterizations of Au nano-particles are done by TEM, FTIR spectroscopy, ultra violet visible spectroscopy, X-ray photoelectron spectroscopy.

MATERIAL AND METHOD

Material

Following materials was utilized for synthesis of Au nano-particles. Gold (III) chloride trihydrate (HAuCl₄), Na₃C₆H₅O₇ (trisodium citrate), NaBH₄ (sodium borohydrate), C₆H₈O₆ (ascorbic acid also known as Vitamin C), Cetrimonium bromide (CTAB), distilled water

Method

GOLD NANOPARTICLES PREPARATIONS THROUGH SEED GROWTH REDUCTION METHOD

In photo thermal cancer treatment and optoelectronic technology, gold nano-particles showed potential. To produce quietly small gold nano-rods with normal dimensions, seed growth synthesis technique is used. The seed-growth technique enlarges the particles 'size' slowly that's why chemical seed growth reduction technique is broadly utilized to control size and shape of Au-NPs. Chemical seed growth reduction technique occur through 2 phases. At initial phase little Au-NPs 'seeds' will be produce. At the next phase, the seeds will be inserted in a solution contain HAuCl₄ in the presence of stabilizing and reducing agents. The reducing agents 'reduce Au³⁺ to Au⁰' only in the company of catalysts which are Au⁰ seed. At the absence of catalyst, reducing agents will reduce Au^{III} to Au^I in sharp medium and the reducing agent slower the 2 phase. In this technique, by changing the nature and amount of reducing agent and stabilizer 'the size, shape, and surface properties' can be 'controlled'.

SYNTHESIS OF GOLD NANOPARTICLES

Take 3 conical flask which was in the order of A, B, C where flask A and B was 20 mL and flask C was 100 mL. In flask A and B, added 9 mL solution which contains 2.5×10^{-4} M HAuCl₄ and 0.1M CTAB and 45 mL in flask C. In flask A and B, 50 μ L of C₆H₈O₆ (ascorbic acid) was added and 250 μ L in flask C and stirred frequently. In CTAB solution, the orange color of Au salt was when ascorbic acid

added. The changed color showed that Au³⁺ to Au⁰. To reduce at Au⁰, 1.0 mL of seed solution added in flask A, solution color was in red. The red color indicates the creation of gold nano-particles. After 15s, 1.0 mL of sample A was added in B sample and the color of sample B was changed. In sample B, reduction was slower than in sample A. After 30s, 5.0 mL of B sample was added in C sample, the color of sample C was changed into purple and the solution was kept for 16 hours at 250C. Purification was necessary to obtain gold nano-particles.

CHARACTERIZATION

Characterizations of Au nanoparticles were done by TEM (Transmission electron microscopy), FTIR spectroscopy, ultra violet visible spectroscopy, X-ray photoelectron spectroscopy.

GOLD NANO PARTICLES USED IN BIOMEDICAL APPLICATIONS

The choice of gold nano-particles to get capable contrast for cell imaging and biological applications, also for photo thermal remedial applications are depend on the optical properties of the Au nano-particles. To calculate scattering and absorption, we use Mie theory efficiencies and also calculate optical resonance wavelengths with the help of Mie theory in which gold nano-particles are in different shapes: gold nano-spheres, silica-gold nano-shells, and gold nano-rods (Jain et al., 2006). Moreover, their optical resonances are positioned happily in the near infrared area. Gold nano-rods exhibit optical cross sections as compared to nano-spheres and nano-shells, which depend on size, where smaller size is much valuable. At near infrared area, their optical resonance can be changed by changing the size (Elahi et al., 2018). With the effective size, scattering donation increases quickly, though they are independent of the phase ratio, for real biomedical applications (Daraee et al., 2016). For real biomedical applications in which nano-particles of different sizes are much effective, size normalized optical cross sections are calculated. For imaging applications, the highest scattering is achieved from nano-rods of higher phase ratio with a larger radius.

GOLD NANO PARTICLES IN CANCER TREATMENT

Laser photo thermal light treatment of cancer has been exhibit a unique methodology to specially kill cancer cells by the help of gold nano-particles. It is done at great lower laser powers as compare to those require for normal organs. Photo thermal ruin 2 tumor organs. Heat transportation form was utilized for temperature evaluation which increases inside the organ because of fundamental laser falling on Au nano-particles. To attain a definite temperature rise, the organs are treated with nano-particle need lower laser power. Precise binding of anti-EGFR (epidermal growth factor receptor) with harmful organs displaying more anti-EGFR (epidermal growth factor receptor) specifically expand Au nano-particle pile inside tumor organ (Huang et al., 2006). As well, photo thermal treatment utilized gold nano-particles needs lower laser power limits as compare to treatments utilizing conventional dyes because of higher absorption coefficient of the gold nano-particles. Earlier data expose that Au nano-shells show optic stuff like other metal. By altering the core shell size, SPR of the nano-shells are change by applying laser. The work hard is continue to build up new techniques to control these nano-particles. The surfaces of gold nano-shells can be functionalizing through the adsorption of alkanethiols.

PHOTO THERMAL THERAPY

Photo thermal therapy works on hyperthmia principle, where tumor cells are damaged by applying the heat which increases the temperature of tumor cells cause the cell death. Temperature increase by ultrasound, microwave, radio frequency, this is the method for tumor treatment at macro scale, it is not appropriate for deep tumor cell and heat division is not in good manner (Vo-Dinh et al., 2018). With gold nano particles, cancerous cells can be target with great

efficiency. Different shapes and sizes increase the efficiency of conversion of light. We use gold nano particles in the range of 30nm to 60nm for photo-thermal conversion. Mostly gold nano-shells are used for cancerous cell through photo thermal treatment. By comparison, gold nanoparticles which are in the range of 30nm or 60nm have great balance temperature as compare to gold nano-shells. To destroy the cancer cells laser energy is needed where due to EPR (Enhanced permeation retention) effect. This research confirmed that GNS have great probable for use in photo-thermal cancer therapy.

CELL DEATH

Mostly cell death in an organ or tissue due to injury, failure of blood supply or disease, this is called necrosis. According to modern research, cell death occurs by two different manners: one is apoptosis, in which a planned and managed type of cell death. Apoptosis is a process in which cells death occurs like a normal and controlled fraction. Apoptosis is a energy requiring, natural single cell death, with precise morphologic and biochemical features .and second one is necrosis, in which an accidental and un-ordered form of cell disappearing(Kanduc et al., 2002). The wrong result is the covering of two pints. First is the procedure whereby cells death or cell die and second one is the changes which can happen when the tissues and cells experience behind the cells die. Properties of cancer causing agents, the agents may be radiations or chemical have capability to encourage the death of the cell. It is broadly utilized in anti-cancer radio-therapy and chemo therapy. On the other hand, the mechanisms have limited attention which is related to cell death and cancer generation. It is common, the death of the cell caused by waves and cancer causing materials. Given the vast advancement in essential research on cancer, it must be sensible on the way to re-examine the connection among cancer development and the death of the cell.

CONCLUSION AND SIGNIFICANCE

Nanotechnology can play an important part in biological applications which enhance the attraction of nanoparticle for tumor cells and intensify diagnostic and therapeutic both into cancerous cells with superior efficiency. The properties of the nano-particles powerfully depend on size and shape. In chemical seed growth reduction method, three methodologies are utilized: the seed mediated growth technique, ultraviolet irradiation photo reduction, and electrochemical. The seed growth reduction technique increases the particles size in well ordered and simpler to hold the configuration and sizes of produced Au NPs. Accordingly this technique is broadly utilized in controlled Au NPs synthesis (Zhao et al., 2013). In seed growth method two phases involves, at initial phase , little-size Au NP seeds ready, at another phase, the seeds added in HAuCl₄ at the presence of balancing and reducing agents Main objective of this technique is to concentrate on NPs formation, also talk about strategies for Au NP quality of being functionalized. It is useful preparation methods for NPs. Although need more research, Which may have a impact to understand biological terms via introducing unique advances towards various research fields includes bio-analysis to imaging. As system at 1-100nm scales show essentially innovative results due their small structure. New molecular structure be able to

developed among a high level of accuracy and flexibility. Nano particles can be adjusted to increase efficiency for various tumor cells which may provide the facility in advanced detection and treatment methods.

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