Biochemical and Biophysical Research Communications 484 (2017) 774–780

Contents lists available at ScienceDirect

Biochemical and Biophysical Research Communications

journal homepage: www.elsevier.com/locate/ybbrc

Green synthesis of gold nanoparticles reduced and stabilized by sodium glutamate and sodium dodecyl sulfate

Gil Felicisimo S. Cabrera [a, 1], Michelle M. Balbin [b, 1], Paul John G. Eugenio [a], Charleo S. Zapanta [a], Juvy J. Monserate [a], Joel R. Salazar [a], Claro N. Mingala [b, c, *]

[a] Department of Chemistry, College of Arts and Sciences, Central Luzon State University, Science City of Muñoz 3120, Nueva Ecija, Philippines
[b] Biosafety and Environment Section, Philippine Carabao Center National Headquarters and Gene Pool, Science City of Muñoz 3120, Nueva Ecija, Philippines
[c] Affiliate Faculty, Department of Animal Science, College of Agriculture, Central Luzon State University, Science City of Muñoz 3120, Nueva Ecija, Philippines

ARTICLE INFO

Article history:
Received 20 January 2017
Accepted 29 January 2017
Available online 2 February 2017

Keywords:
AuNPs
Sodium glutamate
Sodium dodecyl sulfate
Synthesis
Characterization

ABSTRACT

The Turkevich method has been used for many years in the synthesis of gold nanoparticles. Lately, the use of plant extracts and amino acids has been reported, which is valuable in the field of biotechnology and biomedicine. The AuNPs was synthesized from the reduction of HAuCl4 3H2O by sodium glutamate and stabilized with sodium dodecyl sulfate. The optimum concentrations for sodium glutamate and sodium dodecyl sulfate in the synthesis process were determined. The characteristics of the synthesized AuNPs was analysed through UV–Vis Spectroscopy and SEM. The AuNPs have spherical shape with a mean diameter of approximately 21.62 ± 4.39 nm and is well dispersed. FTIR analysis of the AuNPs reflected that the sulfate head group of sodium dodecyl sulfate is adsorbed at the surface of the AuNPs. Thus, we report herein the synthesis of AuNPs using sodium glutamate and sodium dodecyl sulfate.

1. Introduction

The Gold nanoparticles (AuNPs) or colloidal gold has been used since the ancient times especially by the Romans in the field of glass staining [1]. Due to their biocompatibility and non-cytotoxicity, AuNPs have advantages over other metal nanoparticles (NPs) [2] for preparation of engineered nanoplatforms in smart sensing devices. Although AuNPs are defined by small size, substantial quantities are likely required in many commercial and industrial applications [3].

Noble metals, like AuNP-based biosensors provide a new horizon for novel functions with a variety of applications in clinical diagnostics and biological research. Noble metal NPs have already proven to be one of the most important groups of nanomaterials for biosensing approaches, as well as in other biomedical applications [4]. The NPs can act as the probe for the microscopic study of cancer cells, wherein theAuNPs accumulate in the tumor cells and show optical scattering. The AuNPs, has been used in detecting colon, head and neck cancer [5]. The AuNPs also emerged as promising carriers of bio molecules [2] such as drugs for the treatment of various diseases.

The AuNPs occur in various sizes ranges from 2 to 100 nm but 20–50 nm particles size range show the most efficient cellular uptake [2]. Depending on size, the AuNPs exhibit colors ranging from light yellow to ruby red upon synthesis. The color is due to the surface plasmon resonance of the NPs. The AuNPs are widely synthesized through chemical and physical methods [6]. The Turkevich method, which is most widely employed chemical method for the synthesis of AuNPs uses trisodium citrate in reducing and stabilizing the Au3+, in the form of tetrachloroauric (III) acid (HAuCl4 3H2O), to elemental gold [3,7]. Physical methods on the other hand includes deposition-precipitation method [8], electrosynthesis [9], ultrasonic-spray pyrolysis [10], and the use of molecular cage via template synthesis [11]. However, these methods were reported to be costly and employ use of toxic reagents and stabilizers which may not be suitable for biological applications [6,12].

The biocompatability of the synthesized AuNPs have gained attention, since the nanotechnology been widely applied in different research field in the recent years. A method called “green synthesis” uses cheap, easy available and eco-friendly reducing agents in the synthesis of AuNPs [6,13]. This method employs the use of amino acids [14,15], aromatic amines [16], glycerol [17], phenolic acids [18] and plant extracts [19–22] to generate AuNPs.

* Corresponding author. Philippine Carabao Center National Headquarters and Gene Pool, Science City of Munoz 3120, Nueva Ecija, Philippines.
E-mail address: cnmingala@hotmail.com (C.N. Mingala).
[1] Both authors contributed equally to this work.

http://dx.doi.org/10.1016/j.bbrc.2017.01.164
0006-291X/

However, the "green synthesis" method requires a reducing agent that satisfies the size range and morphology of AuNPs and stabilizer and capping agents to passivate the NPs surface [13].

L-glutamic sodium salt, sodium glutamate (SG) is a derivative of glutamic acid, one of the non-essential amino acids is reported to reduce gold ions to form AuNPs. Monosodium glutamate has been used as reducing agent in synthesizing AuNPs with poly (methylmethacrylate) as a stabilizing agent [23]. Surfactants such as sodium dodecyl sulfate (SDS) on the other hand, have been employed as a stabilizing agent in tryptophan reduced AuNPs [24]. Surfactants are known for its high effect on the dispersion of NPs [25] therefore prevent its aggregation, thus extends its shelf life. Some applications involving nanotechnology researches have used SDS as a temporary stabilizing agent in AuNPs, before DNA conjugation for the detection of genomic DNA [26,27].

The use of amino acid and other polypeptides is ideal in the synthesis of AuNPs and offers a wide application for biomedical, biosensing, imaging or drug delivery researches. In light of this, this study focused on the synthesis of AuNPs using SG and SDS as reducing and stabilizing agent, respectively. The surface morphology of the NPs was evaluated by Scanning Electron Microscope (SEM). The absorption peak and the influence of the SDS as a stabilizing agent were analyzed by Ultraviolet–visible (UV–vis) and Fourier Transform Infrared (FTIR) spectroscopy, respectively.

2. Materials and methods

2.1. Chemical and reagents

The following analytical grade chemicals were used: sodium hydroxide (Lab-Scan Analytical Sciences), L-glutamic acid (J.T. Baker), sodium dodecyl sulfate (Spectrum Chemical Mfg. Corp.) and tetrachloroauric (III) acid salt (HAuCl4 3H2O) was purchased from Sigma Aldrich. All glass wares used in this study was cleaned with aqua regia (3 HCl: 1 HNO_3) followed by washing with distilled water. All glasswares, along with micro centrifuge tubes and pipettes were sterile to avoid contamination.

2.2. AuNP synthesis

Synthesis of AuNPs was adapted from the study of Verma et al. [3] and was modified by using SG and SDS as reducing and stabilizing agents, respectively. A mixture of 1:1 M solutions of sodium hydroxide and L-glutamic acid was used to prepare 250 mM SG. The 1 mM HAuCl4 3H2O salt solution was boiled and added with 1.5 mL of 250 mM SG. After addition of SG, stirring was continued until ruby-red coloured solution was observed. To stabilize the synthesized AuNPs, 5 mL of 0.025 mMSDS was added to the solution after it cooled down to room temperature.

2.3. Optimization of SG and SDS concentration

The influence of the concentration of the reducing agent SG was further optimized. Different concentrations of SG ranging from 150 mM, 200 mM and 250 mM were evaluated. Constant concentration of SDS at 0.025 mM and HAuCl4 3H2Osalt solution at 1 mM was used in the optimization.

The effect of different concentration of SDS as the stabilizing agent wasalso investigated. Concentration of SDS was varied from 0.015 mM, 0.02 mM and 0.025 mM. The concentration of HAuCl4 3H2Osalt solution and SG was at 1 mM and at the optimum condition achieved for SG, respectively.

2.4. Characterization of synthesized AuNPs

The UV–Vis absorption peak of the synthesized AuNPs was recorded using UV–Vis spectroscopy (Thermo Scientific Nanodrop 2000). The scanning range of the samples was from 200 to 700 nm. All UV–Vis absorption spectra were read against distilled water.

The surface morphology of the synthesized AuNPs was analyzed using SEM apparatus (Helios Nanolab 600i). A 200 mL of the synthesized AuNPs were dried overnight in an aluminium foil. Each dried sample was transferred in a small holder with copper tape

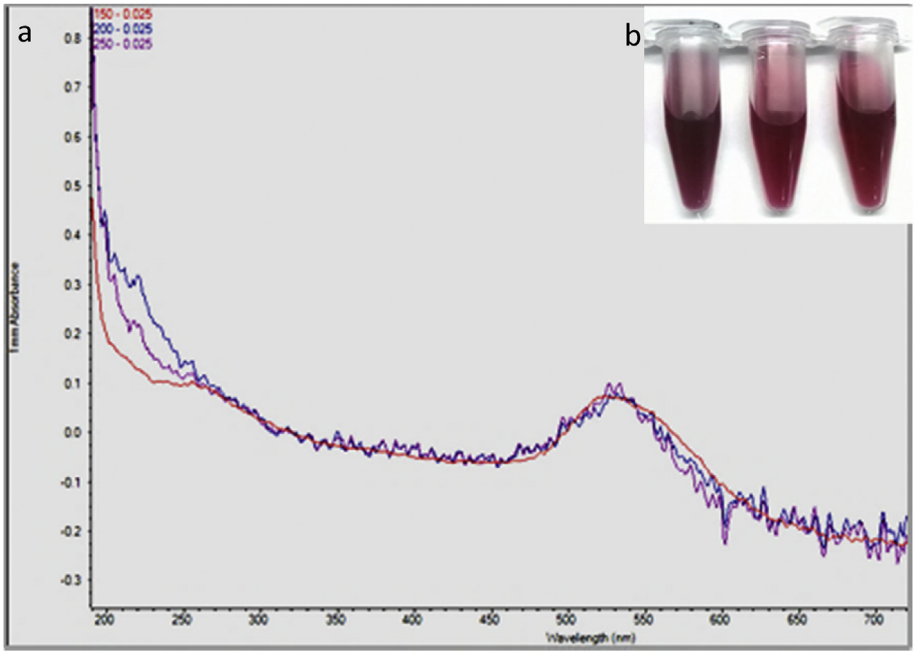

Fig. 1. Gold nanoparticles formed at different concentrations of SG (from left to right): 150 mM, 200 mM& 250 mM (a) shows the spectra of the respective solutions and (b) shows the color of the solutions. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)