GREEN SYNTHESIS OF SILVER NANOPARTICLES BY USING BLACKTEA EXTRACT

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ABSTRACT

The nanoparticles as compared to bulk materials, exhibit improved characteristics due to its size, distribution and morphology. Silver nanoparticles (AgNPs) have fascinated more attention in the recent years. It is mostly due to their availability, chemical stability, catalytic activity, conductivity, biocompatibility and biological activities. A major drawback of the chemical synthesis is that it involves the use of hazardous chemicals and toxic by-products are obtained after the synthesis. Therefore, there is a constant need for eco-friendly methods to synthesize Silver nanoparticles (AgNPs) through green approach with least toxicity and ease in its synthesis. In our project Silver nanoparticles were synthesised by the reduction of Ag^+ions through the action of black tea extract. The polyphenols are important reducing agent present in the black tea are not onlyable to reduce silver ions but also to stabilize the resulting nanoparticles acting as "capping agents". This research paper provides a useful and comprehensive demonstration about the green synthesis of silver nanoparticles using black tea extract, describing their main physical-chemical properties.

Keywords: *Silver, nanoparticles, green-synthesis, black tea powder; vegetables, polyphenols etc*

Introduction

The Silver nanoparticles (AgNPs) have shown extraordinary physicochemical properties and it has been effectively applied in numerous fields, including health care, synthetic biology, and cellular transportation[1]. In particularly AgNPs have received specific attention due to their unique morphologies, stability, and controlled geometry[2]. Silver have been used, for more than 2000 years, as a metal that exhibits good medical properties, silver-based compounds being used in numerous antimicrobial applications. Silver ions are extremely toxic to microorganisms therefore AgNPs have multiple roles in the medical field[3-4] as well largely used in various electronic and sensing devices, coating materials, molecular switches and data packing[5-7] . There are many methods were AgNPs are synthesized by various chemical and physical methods[8]. In case of physical methods[9]it includes ball milling, radiation, sonication, electric arc discharge, laser ablation, flame pyrolysis but physical methods often required very expensive instruments, high temperature, pressure and required very high energy demand[10]. In the past chemical methods particularly condensation, sol gel technique, reduction/decomposition of metal ions by chemical reducing reagents[11]viz sodium borohydride, lithium Aluminium hydride hydrazine and solvents which are having toxic and hazardous effects. In case of physical and chemical methods different types of stabilizers are also needed to avoid the aggregation of particles or to make it physiologically compatible[12]. There are two approaches to the synthesis of nano materials as bottom-up and top-down. The bottom-up approach is known as the self-assembly method where in this method AgNPs are fabricated primarily via the gathering of the atoms, molecules, or clusters. In the top-down approach, nanoscale devices are created by using larger, externally-controlled devices to direct their assembly. The top-down approach often uses the traditional workshop or microfabrication methods in which externally-controlled tools are used to cut, mill and shape materials into the desired shape and order. Subsequently, conventional physical and chemical methods have been fronting many challenges and have encouraged researchers to discover different methods. As we came a crossed the promising use of AgNPs for biological applications, the sustainable synthesis of NP is the great impotence in material science. In the recent years green chemistry and biosynthetic methods have become more attractive ways to obtain AgNPs. These unconventional methods use either biological microorganisms (e.g.: bacteria, fungi, marine algae, yeasts) or aqueous plant extracts. The Green synthesis has multiple advantages over classical methods as it is cost effective, eco-friendly and does not require high pressure, energy, temperature or the use of toxic chemical reagents[13].There are some reports of green synthesis of nanoparticles of FeNPs of various size and shapes using green tea[14], the leaf extract of Cynometra ramiflora, Citrus maxima peels, Punica granatum peel, different leaf extracts and coconut husk extract. The objective of this study was to prepare a simple and easy process to prepare green synthesis of AgNPs using Black Tea (BT) extract which is rich source of polyphenol as reducing agent.[15]

Materials and Methods

Silver nitrate ($AgNO_3$) was purchased from ALPHA CHEMIKA Pvt. Ltd., Mumbai, India and used without further purification. The purity was at least 99.5%. The solutions for the metal salts were prepared in the deionized water. The Black Tea (BT) was obtained from the local market as Red Label Tea package of 500gm.

Preparation of working stock solution of Black Tea (BT)

The polyphenol was extracted from dried Black Tea as 2.0g, 4.0g & 0.6g with 100 mlof double distilled deionized water at 60-70^{0C} by using magnetic stirrer in 250 ml beaker with 250 rpm stirring for 25 mins and extract was filtered by Whatman filter paper. The Collected exact of Black Tea (BT) powder which was used as capping as well as reducing agents in the method of AgNPs synthesis.

Preparation of Silver nitrate ($AgNO_3$) solution

Different molarities (1, 2, 3, 4 and 5mM) of Silver nitrate ($AgNO_3$) aqueous solution were prepared in 100 ml standard measuring flask by using double distilled deionized water.All the solutions were mixed thoroughly and covered with black cardboard paper and Aluminum foil and stored in dark place to prevent auto oxidation of silver. The silver nitrate aqueous solutions of different concentration were used as precursor to synthesis AgNPs.

Result and Discussions

Synthesis of Silver Nanoparticles (AgNPs) using Black Tea (BT) powder extract

Silver nanoparticles (AgNPs) were synthesized by adding Black Tea aqueous extract to $AgNO_3$ aqueous solution at known molarities (1mM, 2mM, 3mM, 4mM and 5mM)and the mixture was kept stirring using magnetic stirrer and AgNPs was monitored at different time interval with UV-Visible spectroscopy. The mixed solutions were allowed to grow and matured by covering the flask with black cardboard paper and aluminium foil to prevent auto oxidation of silver and kept at room temperature for 12hrs to harvest the silver nanoparticles. The change in color intensity after the reduction of Ag^+ to Silver nanoparticles (AgNPs) by Black Tea aqueous extracts from brown to black for higher concentration of $AgNO_3$ solution and for low concentration of $AgNO_3$ solution color changes from brown to grey.

UV-Visible Spectrum of AgNPs

Silver nanoparticles (AgNPs) were successfully biosynthesized using Black Tea power aqueous extract. The aqueous solution of silver ions ($AgNO_3$)was reduced to silver nanoparticles when added the Black Tea extract without the use of any additional reductant or stabilizer. It was observed that the color of the solutions of AgNPs turned from red to reddish brown and then turned to dark brown to blackish when reaction mixture kept for longer time to 12hrs (Fig-5and 6), which indicated the formation of silver nanoparticles (AgNPs). The formation and stability of the reduced silver nanoparticles AgNPs) in the colloidal solution was monitored by UV–Visible spectrophotometer.The UV-Visible spectrum of AgNPs was found at 430nm which is due to the small size of the nanoparticles formed due to surface plasmon resonance of the AgNPs as shown in the fig.1.

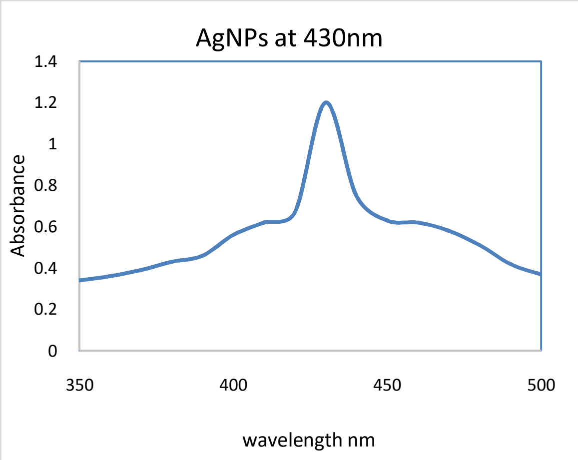


Fig.1-UV–Visible Spectrum of AgNPs reduced by Black Tea aqueous extract at 430nm.

The optimum $AgNO_3$ concentration was confirmed by using 1mM, 2mM, 3mM, 4mM and 5mM concentrations sets of $AgNO_3$ solution for the synthesis of AgNPs and was confirmed after 12hrs time by UV-Visible spectrum of AgNPs solutions as well it showed visible color change. The optimum concentration of $AgNO_3$for the synthesis of AgNPs was found to be 5mM solution of Ag^+ ions by UV-Visible spectrum of AgNPs as shown in fig.-2. The biosynthesized of AgNPs using polyphenols of Black Tea (BT) aqueous extract have different crystallite shapes which are dependent on the concentration of the Ag^+ ion in solution. It should be noted that the crystallite shape is not the only important factor influencing the properties of metal nanoparticles, but the particle size is also a crucial factor for optoelectronics and other applications of the nanomaterial[16]. Hence, silver ion concentration was varied in order to get desired sized AgNPs. As observed in figure-2, 5mM concentration of AgNO3 was found to be the most influential concentration which gave a SPR band at 430nm for AgNPs synthesized from tea extract. Other concentrations viz. 1mM, 2Mm, and 4mM also gave SPR bands around similar area but absorbance is not that prominent and concentration 4mM gave SPR band at 445 nm.

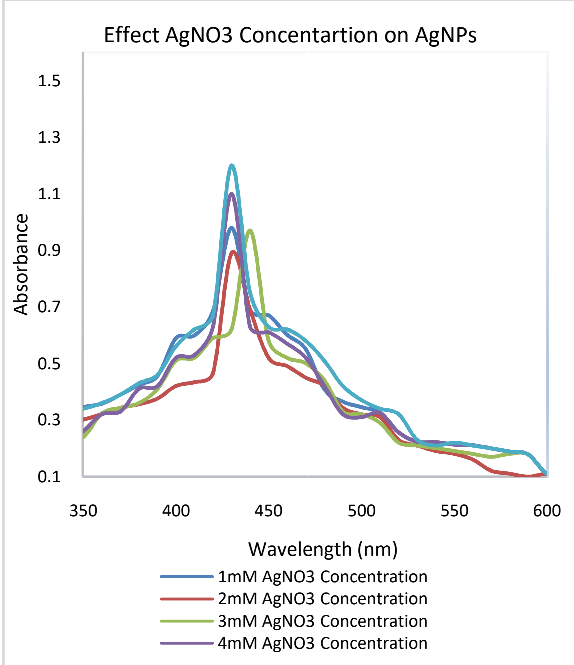


Fig.2-UV–Absorbance peak of AgNPs at different concentrations.

The kinetics of the reaction monitored by UV–Vis analysis revealed that the reaction was slow in the beginning; indeed, up to 20 min from the start of the reaction, no indication of the formation of NPs was observed (no Ag peak). After 30 min, the nucleation was initiated very rapidly and the formation of AgNPs occurred very fast until around 60 min had passed. This is clearly reflected by the sudden appearance of the characteristic band of AgNPs at ~430 nm after 30 min of reaction time (blue line in Figure 3). The reaction was allowed to continue further 60min and slight change observed in the intensity of the AgNPs peak that showed the progression of the reaction. The progress of the reaction between metal ions and the Black Tea extract were monitored by UV-visible spectra of AgNP'S in aqueous solution with different reaction times as shown in (Figure 3). It was observed that after 5hrs time there was very intense change in peak and we kept reaction mixture for further longer time for 12 hrs. The reduction of silver ions and for the formation of stable nanoparticles to occurred. The nanoparticles suspensions are stable for long time when there are negative surface charges and prevents two particles from aggregating due to strong coulombic repulsion leading to a metastable solution of single particles.

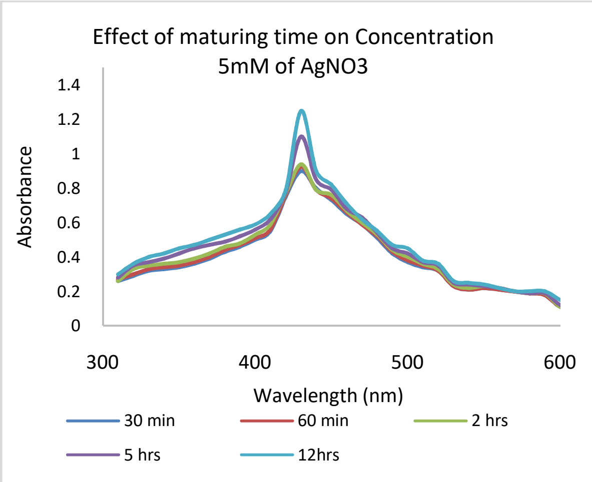
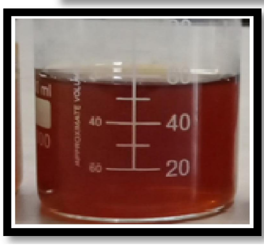


Fig.3-UV–The effect of maturing time at 5mM concentration for AgNPs synthesis.



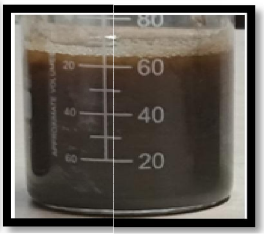


Fig:4-AgNPs after centrifugation **Fig:5-**Black Tea Extract **Fig:6-** AgNPs for 1 mM

Conclusions

In this study, silver nanoparticles were synthesized using a black tea extract. The method is considered to be green because the synthesis is carried out at ambient temperature, using easily available material as tea power as reductant and capping agent in the synthesis of AgNPs and without the addition of any chemical reductant, therefore it does not generate any environmental pollution. Characterization results obtained from UV-Spectroscopic analysis prove that the particles synthesized are in nanoscale range and crystalline in nature. The small size and stability of the particles can be attributed to room temperature during preparation of the extract and the concentration of AgNO3. The AgNPs were successfully synthesised by green method using black tea extract containing polyphenols.

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