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A Simple Aqueous Solution based Chemical Methodology for Synthesis of Ag-Nanoparticles using Sucrose

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Synthesis of silver nanoparticles by using sucrose in aqueous medium is reported. Current approach based on using sucrose sugar in silver nitrate reduction to silver nanoparticles. Appearing of dark brown color after addition of sucrose into silver nitrate solution is one of the most important characteristics for silver nanoparticles formation. The features reported in the literature, namely, a possible plasmon peak at about 420 nm, characterize absorption in the UV-visible region by these particles. This chemical route reported here offers a simple method for preparation of silver nanoparticles.

Key words: Silver Nanoparticles, sucrose, UV-Vis, green method.

Research on metal nanoparticles is now an area of intense scientific attention because of a wide variety of potential industrial and medical applications. Recently, Silver nanoparticles (AgNPs) have taken great interest as a result of the high-efficiency, low-cost, single optical and electronic characteristics. Research on metal nanoparticles is now an area of intense scientific attention because of a wide variety of potential industrial and medical applications. Recently, Silver nanoparticles (AgNPs) have taken great interest as a result of the high-efficiency, low-cost, single optical and electronic characteristics (Bhatte, Tambade *et al*. 2010), antimicrobial properties (Musarrat, Dwivedi *et al*. 2011), sensors (Kosmala, Wright *et al*. 2011). At present, there are a great number of physicochemical, biological approaches to prepare different metal nanoparticles (Mahdavi, Ahmad *et al*. 2013). One of disadvantages of chemical and physical methods for nanoparticle preparations is the use of toxic chemical. To overcome this problem of toxicity, eco-friendly safe green methods have been used for producing nanoparticles (Arockiya Aarthi Rajathi, Parthiban *et al*. 2012). Green methods for the synthesis of nanoparticles have numerous gains such as cost effectiveness, simplicity, and compatibility for biomedical application as well as for large-scale commercial production. (Shameli, Ahmad *et al*. 2012).

In a "green" synthetic strategy, it is important to use nontoxic chemicals, environmentally benign solvents, and renewable materials. To our knowledge few works in literature reportedthe totally green synthesis of metal

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nanoparticles using sugars as reducing agents; but in such works the reduction of metal saltsby sugars needed long reaction time or very high temperature under high intensity micro-wave irradiation or intermediate steps inthe nanoparticles formation process.

Therefore, the current study was intended to prepare silver nanoparticles using Simple Aqueous Solution based Chemical Methodology with sucrose as capping and reducing agent of Ag^+ to Ag to synthesize the silver nanoparticles. The formed silver nanoparticle swere characterized using UV spectroscopy. Understanding of the in situ particle stabilization mechanism are dedicated in current study.

MATERIALAND METHODS

All used chemicals used in the current study are of high purity Sigma and Merck chemicals.All glassware's were washed withnitric acidand distilled water and dried in oven.

In a typical one-step synthesis protocol, 1.0 g of sucrose was added to 100 mL of deionized water and gently heated with string on hotplate. The synthesis of nanoparticles was carried by adding 10 ml of soluble sucrose to 50 ml of1 mM silver nitrate solution and kept for 3 h on hotplate with string. Color change of silver nitrate solution from colorless to brownish yellow was observed by naked eye. The obtained silver nanoparticles were separated by centrifugation and washed with distilled water. Silver nanoparticles were collected and redispersed in deionized water for characterization by UV -visible spectroscopy.

RESULTS AND DISCUSSION

Silver nanoparticle preparation and characterization

Characterization of silver nanoparticle produced by this simple and green reduction method using sucrose is presented. The influence of the reaction time and mechanism of the formation of the silver nanoparticle was considered, and discussed in the following sections.

Silver nanoparticle formation from silver nitrate and sucrose was easily observed from change the color of the mixtures from colorless to brown. Yellowish brown color in aqueous solution is well known for silver nanoparticle formation. This color results from excitation of surface plasmon vibrations in silver nanoparticles (Kanipandian, Kannan *et al*. 2014) it is as collective oscillation of free electrons present in the reduced silver nanoparticle (Noginov, Zhu *et al*. 2006). Such visual observations on color change due to the synthesis of gold nanoparticles have been reported earlier (Ahmad, Mukherjee *et al*. 2003).

Surface plasmon resonance phenomenon do UV-visible spectroscopy as unique approach in metallic nanoparticles characterization (Smitha, Philip *et al*. 2009). Fig. 1 displays the UV–vis absorption spectra of the prepared silver nanoparticles. Typical silver nanoparticles having

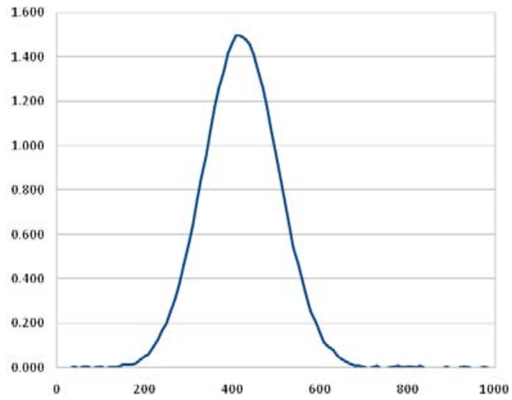

Fig. 1. UV- Vis spectra of AgNPssynthesized by sucrose

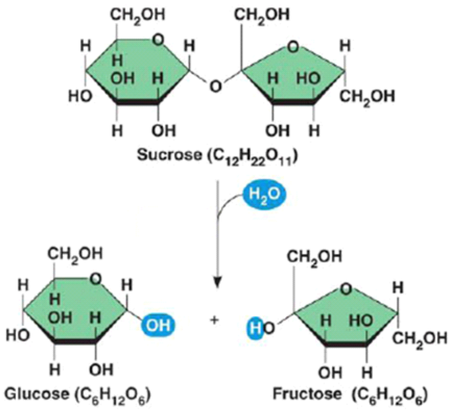

Fig. 2. Sucrose hydrolysis to glucose and fructose.

λmax values in the visible range of 400–500 nm (Sastry, Mayyaa *et al*. 1997). The obtained absorption peak is at about 420 nm, which indicate the successful reduction of silver using sucrose. Surface Plasmon peak observed confirms the influence of sucrose in reducing Ag+ ions to silver nanoparticles from aqueous of $AgNO_3$ solution.

Mechanism of the formation of silver nanoparticle

In order to explain the reaction mechanism it is indispensable to consider the structure and the reducing properties sucrose sugars.

Sucrose is a disaccharide consisting of one unit of α-glucose and one unit of β-fructose linked by β-glycosidic bond, which is a covalent bond between two monosaccharides that involves carbon C1 (anomeric) of the glucose and carbon C_2 of the fructose (Daniel 2005). Sucrose is well-known to be a non-reducing disaccharide because the carbonyl carbon of both monosaccharides (C1 carbon of glucose and C_2 carbon of fructose), are involved in glycosidic bond formation and they are not free for the reduction. So, in our experiment, it could not directly reduce AgNO3 to metallic Ag. The reducing agent involved in the present approach resulted from the hydrolysis of sucrose in the solution to equimolar mixture of a-glucose and bfructose (Fig. 2). The reducing group of a-glucose is aldehyde and that of b-fructose is ketone (Qi, Zhou *et al*. 2004). Then the hydrolyzed products reduced the metal salt. The hydrolysis of sucrose usually needs acidic conditions. Nevertheless, it is known that when sucrose is in very concentrated solutions, at neutral pH and in the absence of impurities and it is heated at high temperatures (range between 100 and 180°C) (all experimental conditions satisfied in our work), the effect of heat is similar to the effect of using lower temperatures in acidic conditions and the hydrolysis mechanism can be considered to be identical (Quintas, Guimaraes *et al*. 2007).

CONCLUSION

We introduce a simple, fast, and economical method to synthesize silver nanoparticles using sucrose. Sugar used as a reducing and capping agents. The characterization of Ag^+ ions exposed to sucrose by change to yellowish brown color and UV-Vis techniques that confirm the reduction of silver ions to silver nanoparticles. The reducing agent involved in the present approach resulted from the hydrolysis of sucrose in the solution to equimolar mixture of α-glucose and β-fructose.

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