GREEN SYNTHESIS AND CHARACTERIZATION OF SILVER NANOPARTICLES USING LEAF EXTRACTS OF *ALOE VERA*.

Omotoyosi Blessing Ojonukpe, Ibrahim Olakunle shoetan

Department of Chemistry, Federal University of Technology, Akure,Nigeria

ABSTRACT

For this research, a novel approach has been carried out for the green synthesis of silver Nano particle using leaf extract of *Aloe Vera* and silver nitrate solution. Stable silver nanoparticles were formed by treating aqueous solution of $AgNO_3$ with the plant leaf extracts as reducing agent of Ag^+ to Ag^0. UV-visible spectroscopy was used to monitor the quantitative formation of silver nanoparticles and this show a peak at 410 nm. The synthesized silver nanoparticles were characterized using scanning electron microscopy (SEM) and Fourier Transform Infra-red Spectroscopy (FTIR). The average particle size ranged from 300 to 410 nm. The particle size could be controlled by changing the reaction temperature, leaf broth concentration and $AgNO_3$ concentration. This eco-friendly method of synthesizing silver nanoparticles production provides rates of synthesis which is more efficient when compared to those of chemical methods and can applied in various human endeavours such as cosmetics, foods and medical applications.

Keywords: Silver Nanoparticles; *Aloe Vera* Leaves Extract; Characterization, green synthesis

INTRODUCTION

Nanoscience and nanotechnology is the attractive damsel increasingly winning researchers' interest in the last couple of decades; the sweetheart of various fields with diverse applications. (Baker and Satish, 2012). Nanotechnology has brought about great scientific advancement in the field of research and technology. Nanotechnology is the study and application of small object which can be used across all fields such as chemistry, biology, physics, material science and engineering. Nanoparticle is a core particle which performs as a whole unit in terms of transport and property (Nour *et al.,* 2010). As the name indicates nano means a billionth or 10^{-9} unit. Its size ranges usually from 1-100 nm (Nour *et al.,* 2010) due to these it occupies a position in various fields of nano science and nanotechnology. Nano sized particles have special features because of their increased surface to volume ratio and also their physical, chemical and biological properties are different from bulk material. Thus in recent years much research is going on on the metallic nanoparticle and its properties like catalyst, sensing optics, antibacterial activity, data storage capacity (Nour *et al.,* 2010 and Sharma *et al.*, 2009).

Nanotechnology is a fast growing area in the field on science which is a interdisciplinary field of both science and technology that increase the scope of investing and regulating at cell level between synthetic material and biological system (Sinha *et al*., 2009).

The biological synthesis of nanoparticle is a challenging concept which is widely known as green synthesis. Biological synthesis utilizes naturally occupying reducing agent such as plant extract, microorganism, enzyme, polysaccharide which are simple and viable which is the alternative to the complex and toxic chemical processes (Du *et al.*, 2009). These biosynthetic methods have a numbers of benefits. Green synthesis of nanoparticle are cost effective, readily available, eco

friendly, nontoxic, large scale production and act as reducing and capping agent as compared to the chemical method which is a very costly as well as it emits hazardous by-product which can have some deleterious effect on the environment (Yamini *et al.,* 2011*).*

Plant extracts have reportedly been used in the preparation of Silver nanoparticles (Sun *et al.,* 2014).

Aloe vera leaf extract is a medicinal agent with multiple properties including an antibacterial effect. Moreover the constituents of aloe vera leaves include lignin, hemicellulose, and pectins which can be used in the reduction of silver ions to produce Silver nanoparticles with antibacterial activity.(*Tippawayat et al* 2016)

Plants can be described as nano factories which provide potential pathway to bioaccumulation into food chain and environment. Among the different biological agents, plants provide safe, efficient and beneficial way to the synthesis of metallic nanoparticle as it is easily available so there is possibilities for large scale production. Also, the synthesis pathway is eco-friendly, the rate of production is faster as compared to other biological models such as bacteria, algae and fungi (Nour *et al.,* 2010).

The most widely used and known applications of silver and silver nanoparticles are in the medical industry. These include topical ointments and creams containing silver to prevent infection of burns and open wounds (Jiang *et al* 2004). Another widely used applications are medical devices and implants prepared with silver-impregnated polymers (Silver 2003). In addition, silver-containing consumer products such as colloidal silver gel and silver-embedded fabrics are now used in sporting equipment. (Song and Kim 2008)

This research will be based on the eco-friendly synthesis of silver nanoparticle from aloe vera in an ambient condition.

Materials

Materials used in research study were Silver Nitrate ($AgNO_3$), distilled water, What-man filter paper and *Aloe Vera* leaves, volumetric flask

Method

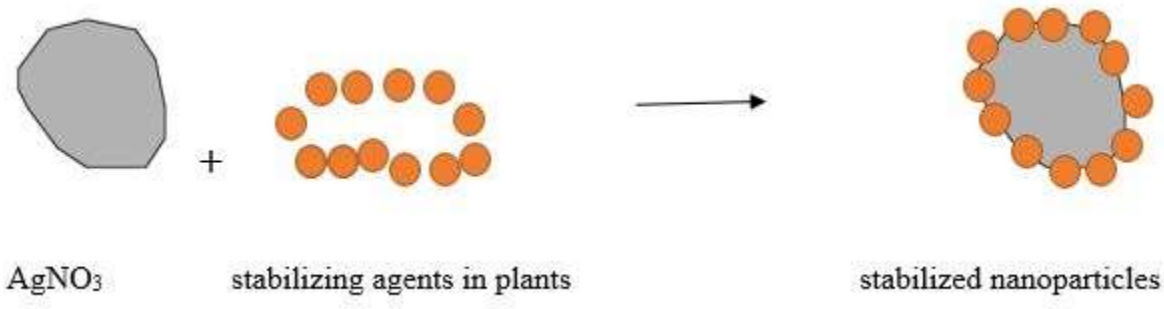
Fresh and healthy leaves were collected from a site at Federal University of Technology, Akure (FUTA). These were rinsed twice with distilled water and then with deionized water to remove adhering impurities and heavy biometals.

In this study, silver nitrate, analytical grade of $AgNO_3$ and aloe vera plant extract were used as the starting materials. The aloe vera extract solution was prepared by using 20g of aloe vera leaves that had been rinsed with deionized water and finely cut into small pieces. The chopped aloe vera leaves were boiled in a 100 ml of deionized water for 20 minutes and allowed to cool. The cooled leaf broth was filtered and stored in a refrigerator at 4°C. The resulting extract/ filtrate was used as an aloe vera extract solution.

Figure 1**.** *Aloe vera* plant

Equation of the reaction

$AgNO_3$ + phytochemicals in *M. oleifera* ⟶ Ag^0 (Silver nanoparticle)



Synthesis of silver nanoparticles using *Aloe vera*

50 grams of *Aloe vera* was boiled in 100 ml of water, the extract was cooled and filtered. 90 ml of 0.1 M $AgNO_3$ was added to 10 ml of the filtrate. This was heated using a magnetic stirrer and hot plate at 70°C. It was colourless initially but eventually changed to golden brown after 20 minutes which was stable till the end of the reaction set up. This confirms the reduction of Ag^+ to Ag^0 which was monitored by Uv- vis. Spectrophotometer at the range of 350 to 700 nm for confirmation of silver nanoparticles.

(a) **(b)**

Figure 2. Aqueous solution of 0.1 M AgNO3 with A. *vera* leaf extracts (a) before adding the leaf extract and (b) After addition of leaf extract at 20 min.

Recovery of synthesized nanoparticles was by centrifugation at 4000 rpm for 1 hour. The sediment then recovered. Centrifuged pellets were washed in deionized water to ensure the particle is concentrated. The sample stored for characterization.

Results And Discussion

Colour Observation

For Silver nanoparticles from *Aloe vera* the colour on mixing of silver nitrate with aqueous extract was colourless, this changed to golden brown after 20 minutes as seen in figure 2

Uv-Visible Spectral Analysis

The reduction of Ag^+ ion in bio extract solution was monitored by periodic sampling of aliquots (0.5 ml) of the bio extract , then diluting the samples with 5 ml deionized water and subsequently measuring UV–Vis spectra of the resulting diluents. UV– Visible spectroscopy analyses of silver nanoparticles was recorded on Spectroscan 30 model spectrophotometer. The absorption spectrum is plotted against the range of wavelength, from 350 to 700 nm. A sharp peak was observed at 410 nm confirming the presence of silver nanoparticles.

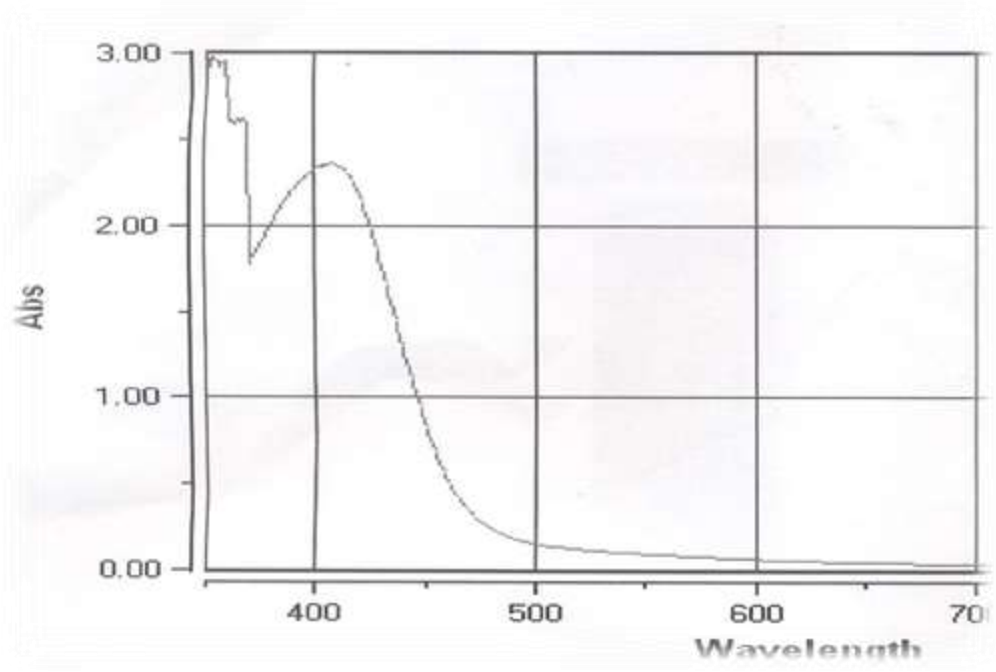


Figure 3. Uv- vis. Spectrum of silver nanoparticles

Fourier transform infrared spectroscopy (FTIR)

The characterization of functional groups on the surface of AgNPs by plant extracts were investigated by FTIR analysis (Shimadzu Model) and the spectra was scanned in the range of 4000 – 400 cm^{-1} . The samples were prepared by mixing the AgNPs uniformly in a matrix of dry KBr, compressed to form a disc. FTIR gives the information about functional groups present in the synthesised in order to understand their transformation from simple inorganic $AgNO_3$ to elemental silver by the action of the different phytochemicals which acted simultaneously as a reducing,stabilizing and capping agent

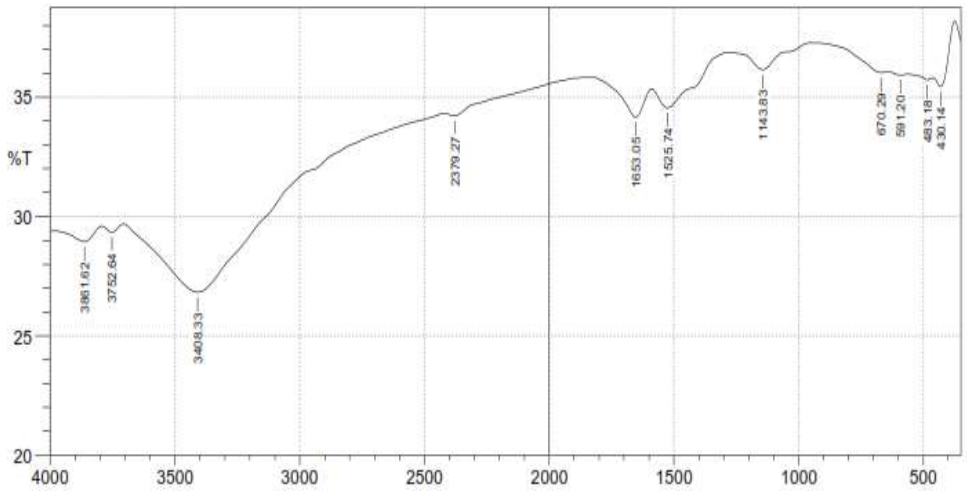


Figure 4. FTIR spectrum of silver nanoparticles

SCANNING ELECTRON MICROSCOPE

To further characterize the synthesized nanoparticles, SEM (Tshwane model) was used to determine the size, shape and morphology of silver and selenium nanoparticles. SEM micrographs provided further information regarding the morphology of the synthesised AgNPs. It clearly confirms the roughness of spherically shaped synthesised AgNPs capped with active compound in the plant extracts (phytochemicals).

Figure 5 shows the *Aloe* mediated AgNPs which is densely packed at the centre, with quasi-linear, hexagonal, and cubic structures and has an average diameter of 300 nm

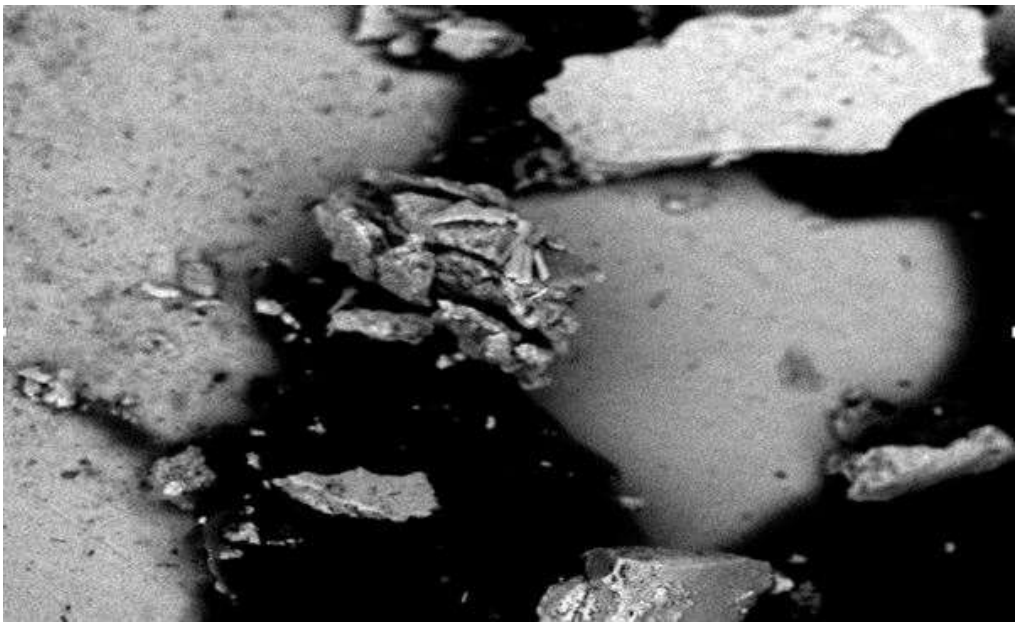


Figure 5. SEM micrograph of silver nanoparticle

Conclusion

In this study, AgNPs were synthesized by reacting 0.1 M $AgNO_3$ with aqueous extract of *Aloe vera*. The nanoparticles formed was characterized by physical data such as colour, UV–vis spectroscopy, FTIR and SEM.

From observation of colour, it could be induced that nanoparticles were formed as noticeable colour changes were observed from colourless to reddish brown in respect of *A. vera* mediated AgNPs. The absorption peaks as shown by Uv-vis. Spectrum was 410 nm. FTIR results showed the functional groups present in the synthesized nanoparticles which were O-H bonds and N-H stretching

SEM results showed the sizes of the synthesized nanoparticles to be 300 nm which confirms that fine spherically shaped nanoparticles were obtained. Thus, the biological route of green synthesis method offers a potential, economic and non-hazardous alternative to chemical and physical methods of AgNPs and SeNPs synthesis.

References

Baker S. and Satish S., (2012) Endophytes; toward a vision in synthesis of Nanoparticles for futuretherapeutic Agents. *Int. journal bio-inorganic Hybd. Nanomaterial* 50: 1-11.

Debasis Nayak, Sarbani Ashe, Pradipta Ranjan Rauta, Bismita Nayak (2015):Biosynthesis,characterisation and antimicrobial activity of silver nanoparticles using Hibiscus rosa sinensis petals extracts. *IET Nanoboitecnology* 15 pp 1-6

Du L, Jiang H, Liu X, Wang E, (2007). Biosynthesis of gold nanoparticles assisted by *Escherichia coli* DH5a and its application on direct electrochemistry of haemoglobin. *Electrochemistry Communications* 9:1165-1170.

Nour A E, Kholoud M M, Eftatha A, Abdulrahman Al-warthan, Reda A.A Ammar, (2010). Synthesis and application of . *Arabian journal of Chemistry* 3, 135-140.

Patcharaporn Tippayawat, Nutthakritta Phromviyo, Parichart Boueroy and Apiwat Chompoosor 2016. Green synthesis of silver nanoparticles in aloe vera plant extract prepared by a hydrothermal method and their synergistic antibacterial activity. PeerJ 4:e2589; DOI 10.7717/peerj.2589

Sharma KV, Yngard AR, Lin Y, (2009). Silver nanoparticle: Green synthesis and their antimicrobial activities, *Advances in Colloid and Interface Science* 145 83-96

Sinha S, Pan I, Chanda p, Sen S K, (2009). Nanoparticle fabrication using ambient biological resources, *Journal of Applied Biosciences* 19; 1113-1130.

Sun Q, Cai X, Li J, Zheng M, Chen Z, Yu C-P. 2014. Green synthesis of silver nanoparti- cles using tea leaf extract and evaluation of their stability and antibacterial activity. Colloids and Surfaces A: Physicochemical and Engineering Aspects 444:226_231 DOI 10.1016/j.colsurfa.2013.12.065.

Yamini GS, Fouzia B, Ezhilarasan, Arumugam S, (2011). Green Synthesis of Silver Nanoparticles from *Cleome Viscosa*: Synthesis and Antimicrobial Activity 2011 International Conference on Bioscience, Biochemistry and Bioinformatics IPCBEE vol.5.

Zhang Y, Cheng X, Zhang Y, Xue X, Fu Y. 2013. Biosynthesis of silver nanoparticles at room temperature using aqueous aloe leaf extract and antibacterial properties. Colloids and Surfaces A: Physicochemical and Engineering Aspects 423:63_68 DOI 10.1016/j.colsurfa.2013.01.059.

Jiang H, Manolache S, Wong ACL, Denes FS (2004) Plasmaenhanced deposition of silver nanoparticles onto polymer and metal surfaces for the generation of antimicrobial characteristics. J Appl Polym Sci 93:1411–1422

Becker RO (1999) Silver ions in the treatment of local infections. Met Based Drugs 6:297–300

Silver S (2003) Bacterial silver resistance: molecular biology and uses and misuses of silver compounds. FEMS Microbiol Rev 27:341–353

Jae Yong Song Æ Beom Soo Kim(2008). Rapid biological synthesis of silver nanoparticles using plant leaf extracts. Bioprocess Biosyst Eng (2009) 32:79–84 DOI 10.1007/s00449-008-0224-6