FUDMA Journal of Sciences (FJS)
ISSN Online: 2616-1370
ISSN Print: 2645-2944
Vol. 2 No.3, September, 2018, pp 116 - 121

USE OF BIOSYNTHESIZED SILVER NANOPARTICLES OBTAINED FROM *MORINGA OLEIFERA* EXTRACTS FOR WATER PURIFICATION

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ABSTRACT

Clean water is essential for human health. Lack of it leads to water borne diseases and environmental pollution. Several techniques that include chlorination, distillation and water sediment filters have been used to purify water however, some of these techniques are expensive, toxic and have many limitations. The use of silver nanoparticles (AgNPs) for water purification has been found to be easier, non-toxic and cost effective. Silver nanoparticles were biosynthesized from *Moringa oleifera* leaves, stem back, roots and seeds using biomass reaction of aqueous extracts from the different parts of the plants with aqueous solutions of silver nitrate ($AgNO_3$). Spectrometric results showed the presence of nanoparticles in all the extracts to be between the ranges of 350 to 450 wavelengths while the absorbance rate was seen to be within the standard range for silver nanoparticles (1nm – 100nm). This study reveals that Silver nano particles obtained from *Moringa oleifera* can be used in water purification even though further research on characterization of the particles needs to be done.

Keywords: *Biosynthesized, Silver nano particles, Moringa oleifera extracts.*

INTRODUCTION

The world is facing formidable challenges in meeting the rising demand for clean water as the available supplies of fresh water are depleting due to extended drought, population growth and competing demands from users (Dhermendra *et al.*, 2008). Physical and chemical techniques that include the use of chlorine and its derivatives, boiling, distillation, water sediment filter (fiber and ceramic) and activated carbon are employed in water treatment are currently being used. Nanotechnology offers the possibility of efficiently removing pollutants and germs (Perez, 2012), it has also proved to be a good technique in water treatment because of its high surface area to volume ratio (ref). Metal nanoparticles such as silver and gold are receiving great attention due to their application in diverse areas such as medicine, electronics, cosmetics, coatings, packaging and biotechnology (Geoprincy *et al.*, 2012) however, toxic chemicals are used in these processes which make them hazardous. For example, the syntheses of silver nanoparticles using organic and inorganic reducing agents such as sodium citrate, ascorbate, sodium borohydride, elemental hydrogen, palyol process, tollens reagent and poly (ethylene glycol) block copolymers that can reduce silver ions ($Ag+$) in aqueous or non-aqueous solutions (Wiley *et al.*, 2005; Merga *et al.*, 2007). Ultraviolet - initiated photo reduction and micro-emulsion techniques have been reported for synthesis of silver nanoparticles (Hassan and Siavash, 2012).

The potential use of various plants for the synthesis of silver nanoparticles was explored (Solgi and Taghizadeh, 2012). The results have significant advantages that include wide distribution, availability, safeness in handling and source of several metabolites (Dhermendra *et al.*, 2008; Geoprancy *et al.*, 2012). Plants in which their extracts have been used to synthesize silver nanoparticles include *camellia sinensis* (Vilchis-Nextor *et al*., 2008), alfalfa (*Medicago sativa*), lemon grass (*Cymbopogon flexosuss*) (Harris and Bali, 2008), aloe vera, *Oryza sativa*, *Saccharum officinarum*, Zea mays, *Moringa oleifera*, *nauclea latifolia* (Geoprincy *et al.*, 2012). The various constituents found in these plants such as alkaloids, proteins, enzymes, amino acids, alcoholic compounds, polysaccharides and heparin have been reported to be agents used to bio reduce, stabilize and biosynthesize silver nanoparticles (Hassan and Siavash, 2012). *Moringa oleifera* is the most widely cultivated species of *Moringa* which is the only genus in the family Moringaceae. The plant is a fast- growing, drought -resistant, native to the southern foothills of the Himalayas in northwestern India. It is widely cultivated in tropical and subtropical areas where its young seed pods and leaves are used as vegetables. It can also be used for water purification, hand washing and sometimes in herbal medicine (Olson, 2010). It may be used as forage for livestock, micronutrient liquid, natural anthelminthic and possible adjuvant (Mahajan, 2007). *Moringa oleifera* leaf powder is as effective as soap for hand washing when water which activates anti-septic and detergent properties from phytochemicals in the leaves is added (Mahajan, 2007). The seeds from this plant had been reported to contain active coagulating agents characterized as dimeric cationic proteins, having molecular weight of 13 kDa and an isoelectric point between 10 and 11which can be utilized for waste water treatment (Anwar and Rashid, 2007). However, in some developing countries, the powdered seeds of the plants are traditionally utilized as a natural coagulant for water purification because of their strong coagulating properties for sedimentation of suspended undesired particles (Kalogo *et al*., 2000; Anwar *et al*., 2007).

There is documented work on the biosynthesis of Silver nano particles (AgNPs) from *Moringa oleifera* leaves (Shivashankar and Sisodia, 2012). However, there are scanty records on the biosynthesis of silver nano particles from the different parts of the plants. In this study, silver nanoparticles were synthesized by extraction of silver nitrate solution ($AgNO_3$) from *Moringa olifera* root, stem bark, leaves and seed extract to serve as a base line for further research on the different constituents of the plants.

MATERIALS AND METHODS

Study area

This study was carried out at the Sheda Science and Technology Complex (SHETSCO) in Kwali Area Council of FCT, Abuja.

Preparation of plant extracts

Moringa oleifera root, stem bark, leaves and seed were gotten from the Biological Garden in the Department of Biological Sciences, University of Abuja. The various parts were washed thoroughly with sterilized distilled water and air dried at room temperature thereafter, each part was cut into smaller pieces. Forty grams of each dried part was weighed and mixed with 200ml distilled water in separate beakers then boiled in water bath for 10 minutes and allowed to cool at room temperature. Watmann filter paper 1 (25μm pore spaces) was used to filter the various extracts.

Biosynthesis of silver nanoparticles from the extracts

Aqueous solution (1mM) of silver nitrate was prepared using distilled water in a dark bottle. The prepared solution (5ml) was added to 30ml of the various extracts in conical flasks. Aliquots were kept at room temperature. Reactions were observed immediately and after three hours later at room temperature (Shivashankar and Sisodia, 2012).

Formation of stable silver nano particles was determined by assessing the level of silver particles which was done by measuring the UV-Vis spectrum of the reaction medium after 3 hours by a spectrophotometer at a resolution of 1nm absorbance rate of 350 and 600 wavelengths.

Water sample collection and analysis

Water samples were collected from Gwagwalada river in three (3) sampling bottles. The water was collected from the part of the river with the highest human activity; for physical observation such as color, odor and visible particles.

RESULTS

Color changes observed in the various plant extracts on addition of Silver nitrate solution ($AgNo_3$) is as shown in table 1.

Table 1: Colour changes from *M. oleifera* extracts on addition of $AgNO_3$ solution.

Extracts	Initial	On addition of $AgNo_3$	After 3hrs of adding $AgNo_3$
Root	Yellow	Deep yellow	Deep brown
Stem bark	Yellow	Deep yellow	Deep brown
Leaves	Brown	Deep brown	Black
Seed	Pale yellow	Yellow	Deep yellow

Spectrophotometer readings of extracts.

Spectrophotometric readings of extracts that were used in determining the presence of nanoparticles are reported in Table 2 and Fig. 1-4. At 350 to 600 wavelength, the root extract reported an absorbance length that ranged from 0.204nm to 2.543nm followed by the stem bark extract with 0.610nm to 1.667nm while leaves and seed extracts had 0.556nm to 1.114nm and 0.609nm to 1.515nm respectively.

Table 2: Spectrophotometric readings of biosynthesized nanoparticles from *M. oleifera* extracts.

	Absorbance Length (nm)			
Wavelength	**Roots**	**Stem bark**	**Leaves**	**Seeds**
350	2.543	1.667	0.556	0.810
400	1.441	1.324	0.912	0.743
450	0.562	0.826	1.114	1.246
500	0.343	1.213	0.856	1.515
550	0.331	0.739	0.701	0.964
600	0.204	0.610	0.412	0.609

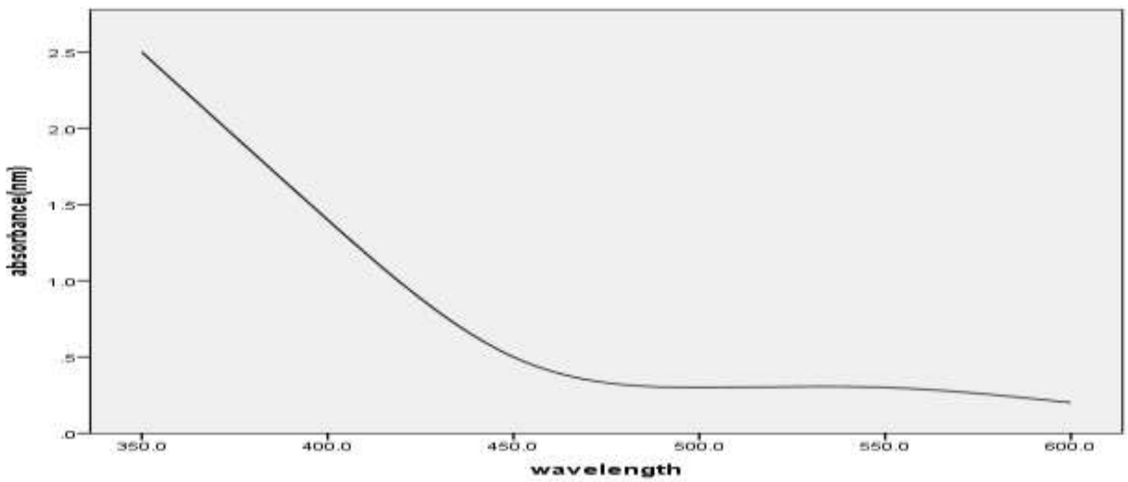

Fig 1: Spectrophotometric reading showing the presence of AgNPs in root extract

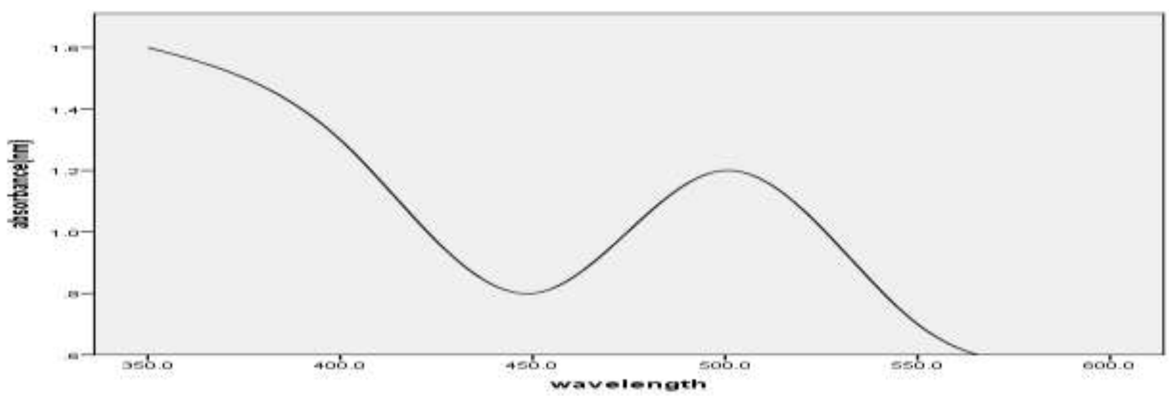

Fig 2. Spectrophotometric reading showing the presence of AgNPs in stem bark extract.

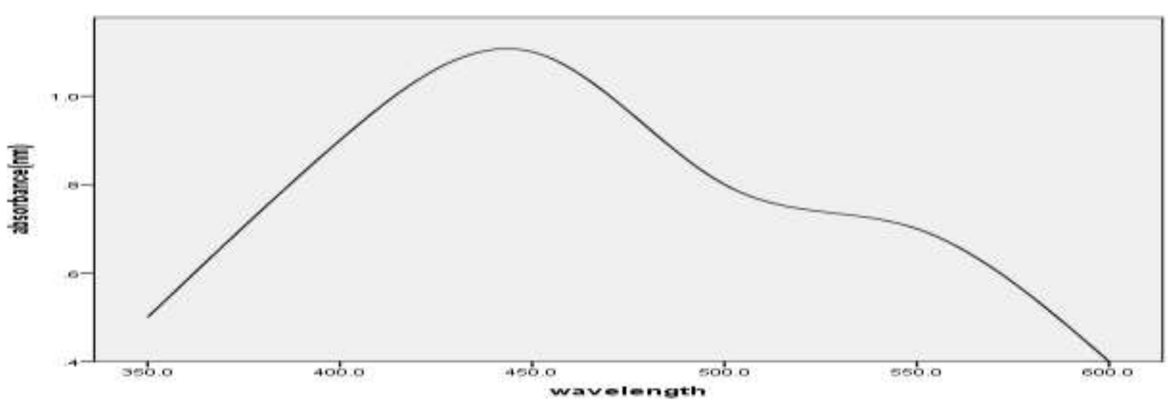

Fig 3. Spectrophotometric reading showing the presence of AgNPs in leaves extract.

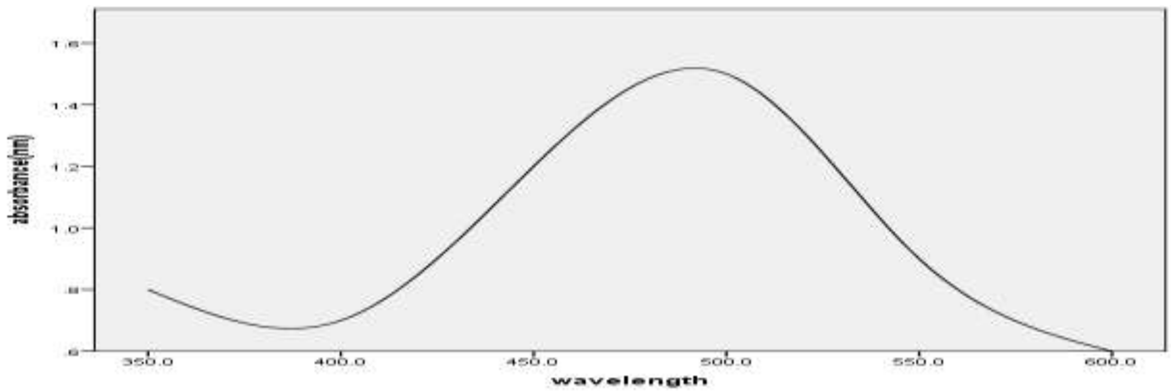

Fig 4. Spectrophotometric reading showing the presence of AgNPs in seed extract.

Water treatment

Physical analysis of all water samples collected reported turbidity and brownish coloration. Bad odour and small particles were also observed in the three samples (Plate 1). The biosynthesized silver nanoparticles were sterilized and 2ml was added to 100ml of each water sample.

Plate 1: Water samples from several points of Gwagwalada river.

Plate 2: Collected water samples before the introduction of biosynthesized AgNP from several parts of *Moringa oleifera*.

After 24 hours of adding biosynthesized AgNP, the water samples became colourless and the odor changed to a nice scent acquired from Moringa oleifera plant. All suspended particles formed coagulant beneath the collection bottles (Plate 3).

Plate 3: Water samples purified with biosynthesized AgNP from various parts of *Moringa oleifera*.

DISCUSSION

UV-Vis spectroscopy has been shown to be an important technique in establishing the formation and stability of metal nanoparticles in aqueous solutions (Philip, 2011) as reported by Ghosh *et al*. (2014). In the present study, there is reduction of silver ions present in the aqueous solution of silver complex during the reaction with the ingredients present in the *Moringa oleifera* extracts. This reaction have been seen by the UV-Vis spectrograph and has been recorded as a function of time as also reported by Ghosh *et al.* (2014). The spectrometric results showed the presence of nanoparticles in all the extracts; to be between the ranges of 350 to 450 wavelengths at an absorbance rate which is within the standard range for silver nanoparticles (1nm – 100nm). Similar characteristic absorption band has been reported (Ghosh *et al*., 2014). Also, the presence of silver nanoparticles indicated by color changes in the present study, agrees with the findings of Ghosh *et al*. (2014), Peter e*t al*. (2012), Philip, (2010) and Govindaraju *et al*. (2010) in a related experiments. However, the plant has also been reported to contain active coagulant which aid in the purification of water. For example, the oilseed residue left after the extraction of oil from *Moringa oleifera* seed can be use as a source of natural coagulants in water treatment (Anwar and Rashid, 2007; Anwar *et al.,* 2007; Kalogo *et al.,* 2000).

CONCLUSION

This study is designed at purifying water using AgNPs extracted from different parts of *M. oleifera* plant. Although determining the molecular activity behind the cleansing action of these particles is absent due to some challenges, this study reveals that biosynthesized Silver nanoparticles from various parts (root, stem bark, leaf and seed) of *M. oleifera* can effectively be used in water purification as a replacement to expensive and toxic chemicals..

ACKNOWLEDGMENT

The researchers are deeply grateful to Mr. Salisu and Miss Omo of Sheda Science and Technology Complex (SHETSCO) for their contribution to the success and completion of this work.

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