© 2017 IJSRST | Volume 3 | Issue 9 | Print ISSN: 2395-6011 | Online ISSN: 2395-602X
National Conference on Green Approach towards Environment and Chemical Science

Bio-derived Synthesis of Silver Nanoparticles using aqueous Honey and Turmeric Solution (HTS) and their Antimicrobial Activity

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ABSTRACT

Nowadays, Nanotechnologyis playing an important role as a multidisciplinary research concept to primary scientific field. It involves the synthesis of nano-material using different ways and having huge applications.Recently, the use of bio-derived products for the synthesis of nano sized material of interest is in vogue leading to modern nanobiotechnology. In present investigation, we have developed rapid and eco-friendly method for green synthesis of Silver nanoparticles using aqueous solution of honey and turmeric (HTS-AgNPs).The synthesized Silver nanoparticles were characterized by UV-Visible Spectroscopy, FTIR Spectroscopy, Zeta potential, Polydispersity Index and their antimicrobial activity.The present study suggests that the bio-derivedSilver nanoparticles are having particle size 2.4 nm and show moderate antimicrobial activity.
Keywords: HTS-AgNPs, Zeta potential, Polydispersity index.

I. INTRODUCTION

Metallic nanomaterials have gained tremendous interest over past few decades. Amongst these, Silver nano structures have attracted much attention especially due to its antimicrobial application[1]. The synthesis of Silver nanoparticles has been reported using various method including physical and chemical methods, electrochemical and photochemical reduction[2]. The main disadvantage of these synthetic methods is that they involve hectic procedure, use of hazardous chemicals and their yield is relatively very low. Therefore, there is a growing need to develop ecofriendly nanoparticles.

The powerful antioxidant action of honey has been attributed to its high content of phenolic compounds[3]. Honey has been used in the field of nanotechnology to develop cost-effective and environmentally benign synthesis of nanoparticles[4,5]. Honey is a sweet viscous fluid produced from bees and is mainly composed of carbohydrates, enzymes, vitamins, minerals and antioxidants[6]. The use of honey in the synthesis of Silver nanoparticles has been reported recently[5,7-9].Nguyen Thi Ngoan[10]synthesizedSilver nanoparticle-Curcumin conjugates for wound dressing.

In this paper, we have exploited the mixture of honey and turmeric powder (HTS) with sunlight irradiation for fast synthesis of Silver nanoparticles. The honey serves as both reducing and capping agent. Hence no other stabilizing agent was added.

II. MATERIALS AND MEHODS

2.1 Chemicals and Materials

A.R.grade Silver nitrate was used. Natural honey sample and turmeric were obtained from local area of Sangamner (district Ahmednagar, Maharashtra) and used in this study.

2.2 Synthesis of Silver Nanoparticles

For the reduction of Silver ions, 5mL of honey and 2 g of turmeric powder were boiled with 50mL distilled water. The resultant solution was filtered and saved for further analysis. 1mM $AgNO_3$ were mixed with HTS in 1:9.This reaction mixture was stirred and exposed to sunlight for 2 hrs for accelerative bio reduction of $AgNO_3$. The brownish colorindicated that the formation Silver nanoparticles.

2.3 Purification of Silver Nanoparticles.
The reduced Silver nanoparticles solution was centrifuged at 10000 rpm for 5 minutes. The residue was purified with distilled water.

III. Characterization of Silver Nanoparticles

3.1 UV-Visible Spectral Analysis
The reduction of Silver ions was monitored by visual inspection of the solution. The colorof the reaction mixture changes to dark brown color showing the formation of Silver nanoparticles (Figure 1). UV-Visible analysis was done by using Chemito Spectrophotometer UV-2100 in the wavelength range 400-800 nm.

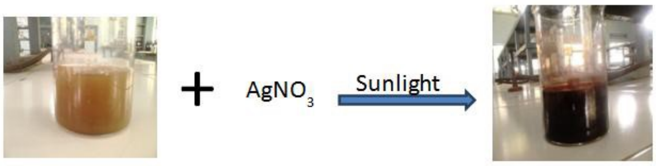

Figure 1. Synthesis of HTS-AgNPs

3.2 FT-IR Analysis
The characterization of functional groups on the surface of AgNPs was made by FT-IR(Bruker Alpha T) model and the spectra were scanned in the 4000cm^{-1}to 400 cm^{-1}range.

3.3Zeta Potential Study
The sample was dispersed in deionized water using ultrasonication.The solution was centrifuged for 15 min with 8000 rpm and the supernatant was collected. The supernatant was diluted for 4 to 5 times and then the particle distribution in light was studied in a computer controlled particle size analyzer. The zeta potential of dispersion is measured by applying an electric field across the dispersion. Particles within the dispersion with a zeta potential will migrate toward the electrode of opposite charge with a velocity proportional to the magnitude of the zeta potential. The particle size distribution is exhibited in terms of Span value which is obtained by using formula[11].

$$\text{Span value} = (D_{90} - D_{10}) / D_{50} \times 100$$

Where D_{90}, D_{50} and $D_{10}$are the calculated Mean Diameter at which 90,50 and 10% (cumulative %) of the nanoparticles are counted.

IV. ANTIMICROBIAL ACTIVITY

The bacterial strains used in this study were E.coli (ATCC 25922), Pseudomonas aeruginosa (ATCC 27853), Staphylococcus aureus (ATCC 25923) and Candida sp.

V. RESULT AND DISCUSSION

- **UV-Visible Spectroscopy**

Metallic nanoparticles display characteristic optical absorption spectra in the UV-Visible region called Surface Plasmon Resonance (SPR). Figure 2 shows UV-Visible spectra of synthesized Silver nanoparticles. Absorption spectra of Silver nanoparticles formed in the reaction mixture has a peak at 438 nm. The broadening of the peak at that wavelength is attributed to the formation of polydispersed Silver nanoparticles[12].

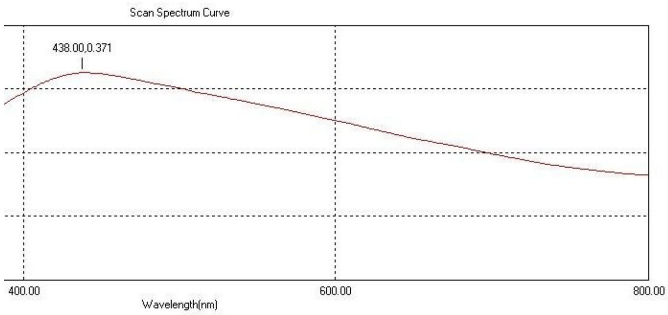

Figure 2. UV-Visible Spectra of synthesized HTS-AgNPs

- **FT-IR Spectroscopy**

FT-IR analysis has been employed to detect the biomolecules presented in HTS-AgNPs (Figure 3). The broad band appeared at 3225.76 cm^{-1}corresponds to the N-H stretching of 1^0, 2^0 amines and amides. The band appeared 1632.62 cm^{-1} belongs to –C=C- heterocyclic compounds e.g. alkaloid or flavones. Band at 2942.58 cm^{-1} appeared due to O-H stretching of carboxylic acids and bands at 1294.13 cm^{-1} and 1137.63 cm^{-1} belong to the
C-N stretching of aromatic and aliphatic amines respectively.

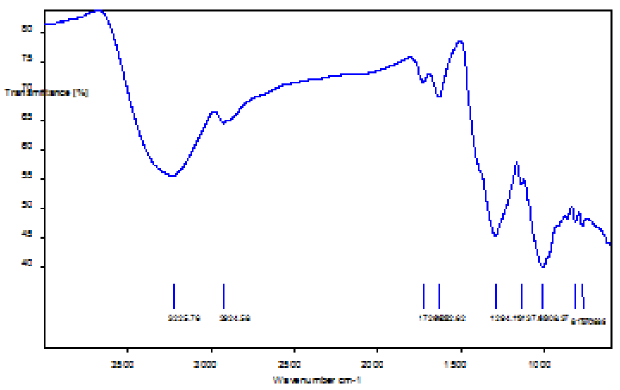

Figure 3. FT-IR of Synthesized Nanoparticles

- **Particle Size Distribution**

The average size and Polydispersity index of the synthesized Silver nanoparticles were determined by Horiba Particle Size Analyzer SZ-100 Ver-1.90 and the result was shown in Figure 4. The particle size of synthesized Silver nanoparticles was found to be 2.4 nm. It shows the average aggregate particle diameter 2097.7 nm and Polydispersity index 0.197.

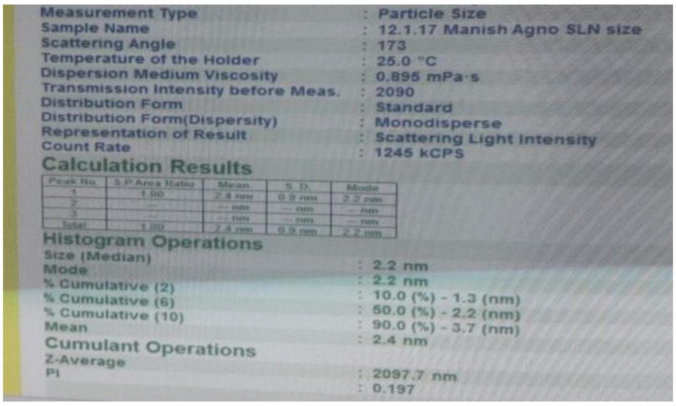

Figure 4. Polydispersity Index of HTS-AgNPs

- **Zeta Potential Analysis**

The stability of the Silver nanoparticles was determined using Zeta potential analysis (Table 1). The Zeta potential value was found to be -0.5 mV (Figure 5).

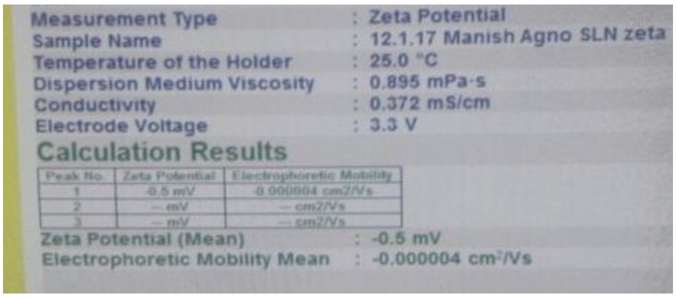

Figure 5. Zeta Potential of HTS-AgNPs

Table 1. Relationship between Zeta potential and the stability of the particles

Zeta potential(mV)	Stability behavior of the particles
From 0 to +-5	Rapid Coagulation or Flocculation
From 10 to +- 30	Incipient Instability
From 30 to +- 40	Moderate Stability
From 40 to +- 60	Good Stability
More than +- 61	Excellent Stability

- **Antimicrobial Activity**

The antimicrobial activity of synthesized Silver nanoparticles was carried out in the agar plate and the zone of inhibition bySilver nanoparticles and by Standard were compared. The zone of inhibition for different strains using saturated solution ofHTS-AgNPsin DMSO as compared with Gentamicin and Nystatin as Standards were summarized in Table 2.

Table 2 : Antimicrobial activity of synthesizedHTS-AgNPs

Bacteria / Compound	E.coli (ATCC 25922)	P.aeruginosa (ATCC 27853)	S.aureus (ATCC 25923)	Candida sp.
HTS-AgNPs	10 mm	17 mm	16 mm	-
Gentamicin	22 mm	27 mm	31 mm	-
Nystatin	-	-	-	22 mm

VI. CONCLUSION

The bio-directed synthesized Silver nanoparticles using the mixture of honey and turmeric powder provides ecofriendly, simple and cost effective method for synthesis of nanoparticles. The spectroscopic techniques like as UV-Visible spectroscopy and FT-IR. Polydispersity studies suggested that the HTS has played important role in the reduction of Silver to Silver nanoparticles and synthesized HTS-AgNPs has been show the rapid coagulation. The particles size of HTS-AgNPs from Zetapotential is about 2.4 nm. The moderatemicrobial activity against Pseudomonas aeruginosa, S.aureus and E.coli are shown by HTS-AgNPs.

VII. ACKNOWLEDGMENT

We are thankful to Principal Dr K.K.Deshmukh for providing the facilities and motivation.

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