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Synthesis and Characterization of Silver Nanoparticle Zingiber Officinale Extract and their Antibacterial Activity

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Abstract: *A commercial accessible noble metal such as Silver exhibits essentially distinct chemical, physical and Biological properties. Today Nano size material have more because of more fascination increase its small size particle dimension, high surface area and quantum dot effect so it give it give wide scope of utilization in drug, catalytical Industry. In past decay, focus on their catalytic, optical and electromagnetic and magnetic application of silver Nano size material. We are utilized green route to synthesis silver Nano size material of Zingiber Officinale extract by using sohelate extraction methods and collected sample using vacuum rotavapour method and characterization for their application observe in different distinct field.*

Keywords: Nano materials, Nano particle, Silver, Zingiber Officinale, Green method

I. INTRODUCTION

In Nano science the synthesis and creation of nanostructure is criticaltask to developed nanomaterial in range between 1-100 nm ranges for various sort of use. The different methods are utilized to combination, synthesis and characterization of nano-material is including in nanotechnology.

In last some decay biosynthesis of nanomaterial particle is seriously intriguing consideration since green way and ecofriendly to blend of nanoparticle. In Biosynthesis technique utilized the plants extract to alternative to high temperature thermal and hazardous chemical synthesis route technique. In food Industry and medications conveyance for human wellbeing the biosynthesis Nano- procedure is promising and applications in the areas supplement and through bioactive nano-epitome, to identify and measure microbes, just as clever assets for the assessment and improvement of newer, safer and effective drug formulations(1).

A silver nanoparticle (AgNPs) is very significance because of simple, easy preparation process and unique optical, electrical, and thermal properties which improveselectrical conductivity, near infrared absorption. Silvernano particles (AgNP) may utilized as impetuses in frightfully specific coatings for retention of sun oriented energy as optical sensorsin fabric tailoring as well as in electronics device and in various therapeutic activity of bactericidal agent(2) Among metal NPs, silver NPs is gaining tremendous interest in the research community of their wide extent of use in microbial science, chemistry, food innovation, cell science, pharmacology and parasitology(3). The morphology of the silver NPs is the main consideration their physical and synthetic properties. Essentially, a few strategies such as sol–gel method, hydrothermal method, chemical vapour deposition, thermal decomposition, microwave-assisted combustion method etc., have been utilized for the synthesis of silver NPs. Recently, bio-genic synthesis of silver NPs (AgNPs) using biomaterials such as plant extract and microbes as reducing agent and their antimicrobial activity is widely investigated(4-5). AgNPs are produced by oxidation of Ag+ to Ag0 by different biomolecules such as flavonoids ketones, aldehydes, tannins, carboxylic acids, phenolic and the protein of the plant extracts(6).In this study, AgNPs synthesized using synergistic aqueous extracts of the rhizome of Z. officinale and were used for analyzing in vitro antibacterial activity.

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II. Materials and Methods

2.1. Collection of Plant and Preparation of Extracts

The rhizome of Z. officinale was gathered from the localeof Akola District, Maharashtra, and India. Soil and other surface foreign substances present on fresh rhizome were removed utilizing regular tap water followed by distilled water. Further, the rhizome was air dried and makes a fine powder. The 10 g of mixed rhizome powder of the Z. officinale was added into 250 mL of distilled water and boiled for 30 min. After cooling to room temperature, the extract was centrifuged at 5000 rpm, and filtered using Whatman number-1 filter paper. Filtered extract was separate was additionally utilized for green synthesis of AgNPs by using sohelate extraction and vacuum rotavapour technique.

2.2. Green Synthesis of AgNPs using Rhizome Extracts

The prepared extract was utilized for the synthesis of AgNPs. 50 mL of 1 M AgNO3 solution was added into 80 mL of rhizome extract. Then extract along with optimized AgNPs was incubated until the colorless solution turns into brownish color, which reveals the reduction of Ag+ into Ag0 nanoparticle.

2.3. Characterization of AgNPs

UV spectrum analysis was assessed utilizing UV-1800 spectrophotometer (Shimadzu, Japan) with the wavelength range from 200 to 800 nm. AgNPs were additionally described utilizing FTIR to identify the functional groups, dynamic light scattering (DLS) particle size analyzer, XRD for elemental composition, and SEM for distinguishing proof of morphology and size of biosynthesized AgNPs

2.4 Antibacterial Activities

The antibacterial action of AgNPs was played out the impact of Ag NPs on the growth of S. aureus, B. subtilis, E. coli, was determined. The antibacterial activity was determined through measurement of bacterial growth at different time points against different concentrations of compounds. The growth of bacteria was determined through measurement of optical density at 600 nm using a microplate reader (BioTek, Winooski, VT, USA). The overnight bacterial culture was diluted 3–10 times; 5 µL of this bacterial suspension was added to media containing different concentrations like 0.05, 0.1, 0.2, 0.4, 0.8., and 1M of AgNPs were added and incubated for 24 h and followed for 48 and 72 h m of Ag NPs and After that, freshly prepared MTT [5 mg/mL of phosphate buffer solution] was added and incubated at 37 C for 4–6 h incubated at 37 ◦C. The OD600 (optical density) was recorded at different time points ranging from 0–8 h. The graph of OD600 vs. time was plotted to evaluate the effects of Ag NPs on the growth of microorganisms

III. Results and Discussion

3.1. Visual analysis of AgNPs

It was seen that NPssynthesis was initiated once the synergistic aqueous extracts of Z. officinale added in the 1 mM AgNO3 solution. The color of AgNPs and Z. officinale aqueous solutions was dynamically modified from yellow to brownish color which reveals the AgNPs formation. The color transformation during thesynthesis of AgNPs is related to the excitation effect of surface plasmon resonance (5). Thecurrent study examination that AgNPs were synthesizedusing rhizome extracts and the phytocompounds in the extractsofZ. officinale have potential for acting as a reducingagent.

3.2. UV–Visible Spectroscopy Analysis

UV–visible spectroscopy was utilizedto observe the AgNPs formation by the reduction of Ag ions through the exposure of plant extracts .UV–Visible spectroscopy indicated the surface plasmon resonance (SPR) sharp peak at 350–430 nmwavelength, which corresponds to the AgNPs production. AgNPs were absorbed radiation at 400 nm wavelength due to the transition of electrons. Colloidal AgNPs exhibit absorption wavelength at 390–420 nm (3). In our study, the spectrum analysis peak data [Figs. 1] showing that the silver synthesized product is only AgNPs. The,

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AgNPs were effectively synthesized, the Z. Officinale even at higher concentrations, and NPs are steadyUV–Vis absorption spectra of green synthesized AgNPs.

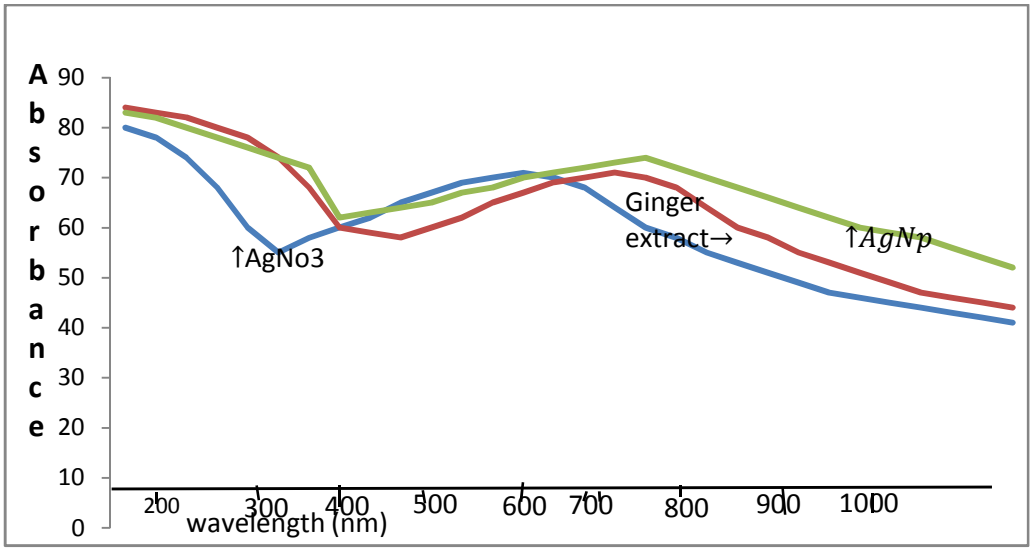

Figure 1: UV–Vis absorption spectra of green synthesized AgNPs

3.3. FTIR Analysis

FTIR analyzed data of AgNPs Z. officinale, rhi-zome extracts are shown in [Figs. 2]. FTIR characterization was used to examine the possible functional molecules, FTIR spectrum of theZ. officinalerhizome extracts showed a major absorption peak at 1387 cm-^{1}in the synthesis of AgNPs(9). A report revealed that the presence of absorption peak at 1055 cm^{-1}, which may have been attributed to vibration and amine (NAH) groups (8). The absorption peak appeared at 1459 cm-^{1}was specific for the vibration of proteins being a stabilizing agent through free amine groups or cysteine groups(10). In another study, FTIR spectra results identified the presence of amide groups in the fruit shell extract and they were found to be involved in the reduction of silver ions to AgNPs.

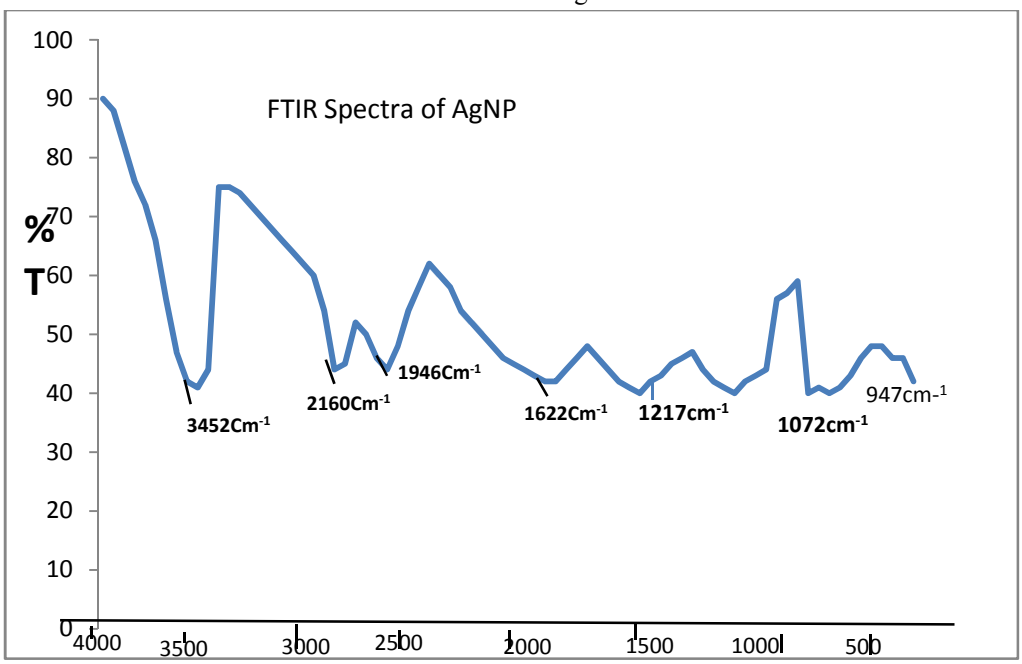

Fig -2. FTIR analyzed data of AgNPs Z. officinale, rhi-zome

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3.4. SEM analysis

SEM image provides morphological characteristics and size measurement of synthesized AgNPs (Figs. 3,).The SEM size was examined the range of 41.91to 60.91 nm(6). A study reported that AgNPs synthesized using Z. officinale extracts were in spherical shape and size of 30–50 nm(7). These size variations might be the presence of biomolecules from the rhizome extracts, which were the caping surface of AgNPs. It was observed that AgNPs have a uniform crystalline structure and relatively spherical. Accumulation of NPs was induced by solvent evaporation during the sample production. In a study, SEM analysis of NPs synthesized using possess that the synthesized nanoparticle metals are spheri- shape of the AgNPs is spherical, with ranged from 20 to 51 nm.

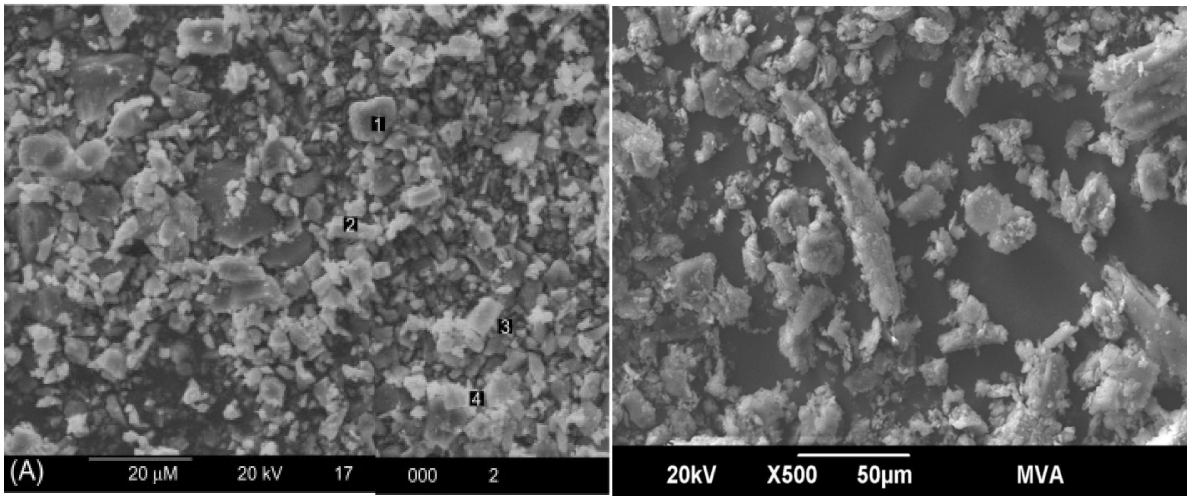

Figure 3:. SEM image provides morphological characteristics AgNPs

3.5 XRD Analysis

Synthesized crystalline AgNPs throughgreen synthesis using of AgNPs Z. officinale, rhi-zomeand observed XRD diffraction peaks at the 111, 200, 220, and 311 planes, which correspond to the AgNPs. Synthesized AgNPs were also confirmed for their antibacterial activity. In this study, the X-ray diffraction (XRD) patterns of the dried synergistic powder sample of green synthesized AgNPs had shown distinct four diffraction peaks at 2h angles of 38, 44, 64and 77, which can be endorsed to the reflections from lattice planes indexed to the (111), (200), (220), and (311) planes, reflected the crystal structures of AgNPs.

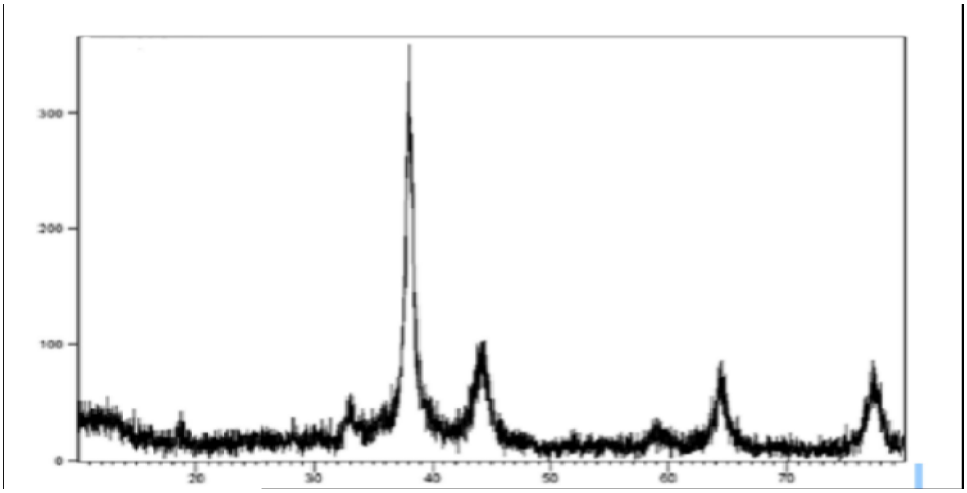

Figure 3.5: The X-ray diffraction (XRD) patterns ofAgNPs Z. officinale, rhi-zome

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IV. The Antibacterial Activity

The synthesized AgNPs using different conditions was assessed through the disc diffusion method against Gram-positive S. aureus and Gram-negative E. coli. The antibacterial activity was clearly observed in the AgNO3 solution (a positive control) and AgNP samples. Conversely, the sterile DI water, which was used as a negative control, showed no antibacterial activity as shown by no inhibition zone .As presented in Figures, the inhibition zones of the synthesized AgNPs. These results clearly indicated that the synthesized AgNPs using RB extract exhibited more effective antibacterial activity against Grampositive bacteria than against Gram-negative bacteria,

In addition, it could be noted that the smaller size of AgNPs provided the larger inhibition zone as obviously shown in Figure Because AgNPs would attach to the bacterial cell membrane and release silver ions to penetrate and interact with biomolecule and DNA, the smaller size of NPs, the higher surface area to volume ratio of NPs could lead to more attachment and stronger binding to the cell membrane, resulting in the higher efficacy.This phenomenon may be caused by the different membrane structure of the microorganism. Due to the thick layer of peptidoglycan in Gram-positive bacteria, it makes them more rigid and makes them less permeable for the silver ions to get inside the cells (5-7). However, the opposed antibacterial susceptibility of AgNPs on Gram-negative and Gram-positive bacteria could be affected by the different physicochemical properties of AgNPs, which played a critical effect on their antibacterial potential including shape, size, surface charge, and concentrations. In addition, AgNPs in the spherical shape were effective against both Grampositive and Gram-negative bacterial than the rod shape as shown by the lower minimum inhibitory concentrations. Because AgNPs in the spherical shape has larger effective specific contact area as compared to the rod shape, they could achieve closer contact with bacterial cell and causes more damages So, the antibacterial efficacy of light assisted AgNPs using RB extracts was based on the bacteria strain and the size of AgNPs. Apart from effective inhibition of susceptible bacteria, AgNPs could inhibit the formation of bacterial biofilm, which is one of the virulence factors of resistant bacteria.Therefore, their antibacterial activity of AgNPs on multidrug resistant bacteria in both standard and clinical isolates, and antibiofilm formation are deserved for further investigation

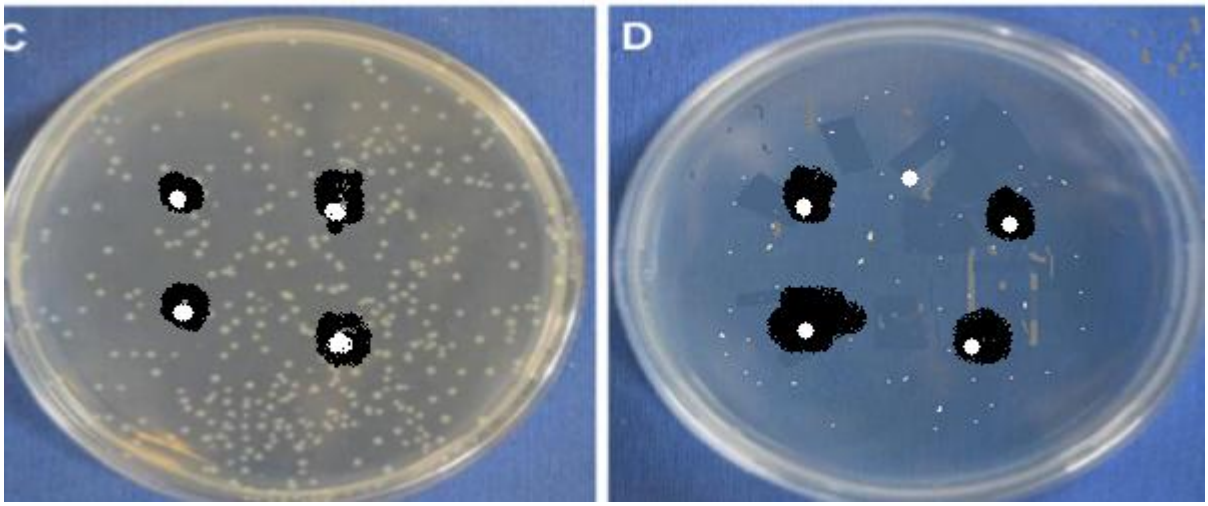

Figure 4: Antibacterial activity against Grampositive bacteria and against Gram-negative bacteria, E. coli.

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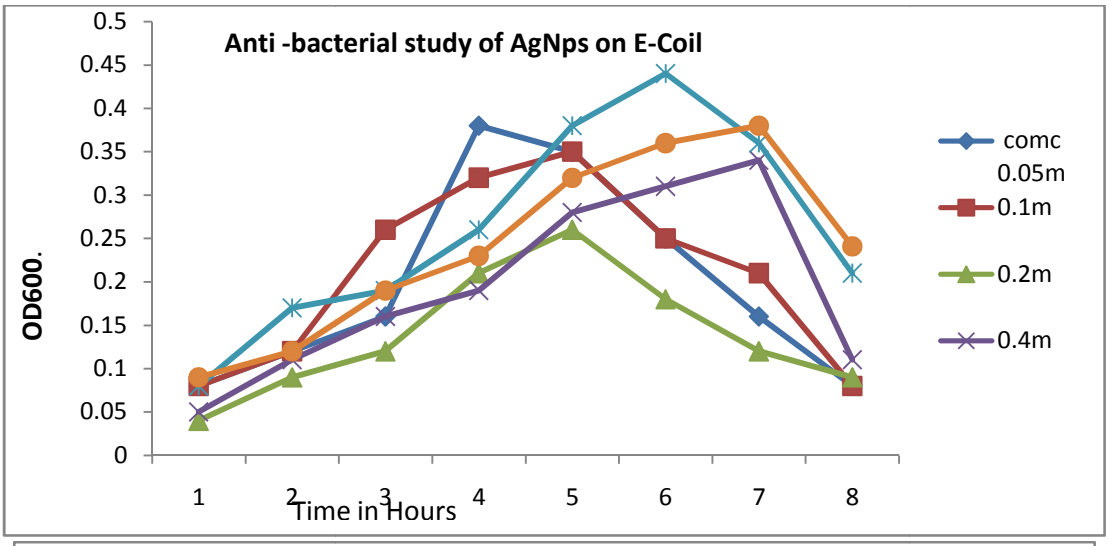

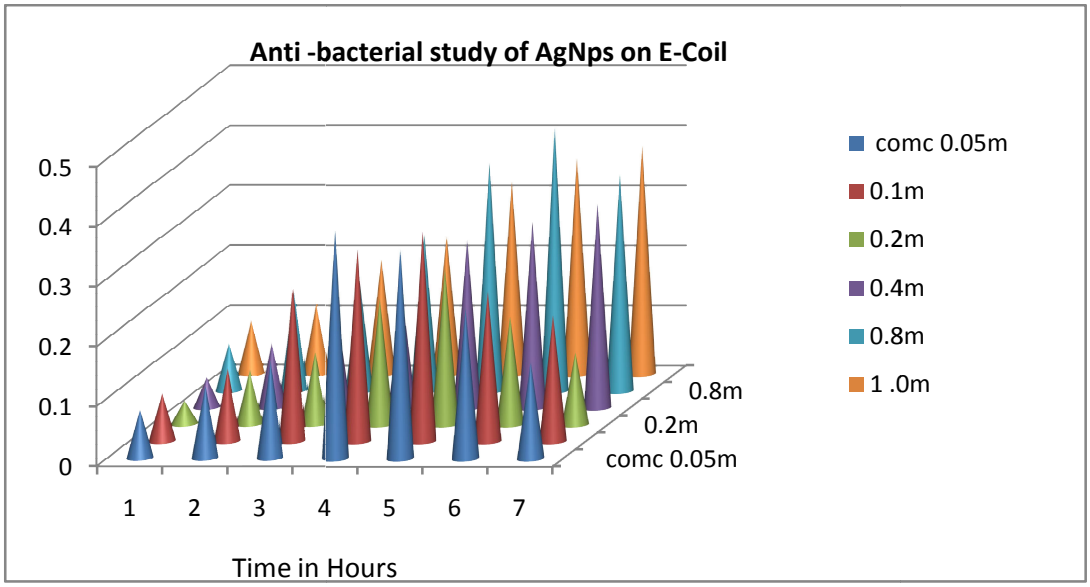

V. Conclusion

In this study, synergistic aqueous extracts of rhizome of Z. officinale have been used for the green synthesis of AgNPs. The spectral vibration of carboxyl and amine groups in the Z. officinale extracts might be involved in the synthesis of AgNPs. SEM results revealed that AgNPs are in a spherical or some crystalline shape with the size ranging from 42 to 61 nm,. The antibacterial study reveals that AgNPs had shown good antibacterial activity against Gram-positive S. aureus and Gram-negative E. coli. However, the toxicity/antibacterial activity of Ag NPs(from 0.05 to 1.0 ug/mlconc) increased with increasing concentrations of GE used in their preparation, which can be a result of the increased solubility of the resultant Ag NPs due to the better stabilization of NPs at higher concentrations of the extract but in this study 0..8 ug/ml conc gives better result solution for AgNps.

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