A COMPARATIVE STUDY ON ANTIBACTERIAL ACTIVITY OF SILVER-COATED COBALT FERRITE, NANOCOBALT FERRITE, SILVER FERRITE NANOCOMPOSITE AND NANOSILVER PARTICLES

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ABSTRACT

A new silver coated cobalt ferrite nanocomposite, Ag@$CoFe_2O_4$, was prepared by a two-step procedure. In the first step, cobalt ferrite nanoparticles were synthesized by a combustion method using glucose as a fuel. This ferrite was then coated with nanosilver via chemical reduction of Ag+ solution. nanosilver ferrite is synthesised through co precipitation method, nanosilver is synthesized by chemical reduction of Ag+ solution. The synthesized nano Ag@$CoFe_2O_4$,nano $AgFeO_2$compostes were characterized by X-ray diffraction, transmission electron microscopy, and vibrating sample magnetometer.The antibacterial activity of these nanocomposites were investigated against some Gram-positive and Gram-negative bacteria and compared with those of silver nanoparticle.It was observed that nano silver Ferrite composite is better anti microbial than other studied nanoferrites, that means, in addition to its super paramagnetic and biocompatiblity it is better antimicroial ability. so it can be used as best magnetic target carrying agent.

Keywords: Antimicrobial activity , Nanosilver ferrite, nanosilver, Silver coated Nanocobalt ferrite, Target drug delivery

I. INTRODUCTION

Silver nanoparticles (AgNPs) have been used as antimicrobial agent for a long time because of their stability and broad spectrum antibacterial activity and microorganisms[1]. Ag nanoparticles are clusters of silver atoms (Ag) that range in diameter from 1to100nm. At the present time, silver nanoparticles are emerging as a new generation of antibacterial agent [2]; which have been used in, medical applications [3-4], Recent studies have revealed that silver nanoparticles have superior antibacterial activity compared to that of other silver compounds as well as bulk silver. The uses of silver nanoparticles are potential to treat the water which frequently infected with antibiotic resistant bacteria [5]. Treatment of water by chlorine may cause a high risk of human cancer due to the formation of halomethanes [6]. Unique interactions with bacteria and virus have been demonstrated of AgNPs of certain size ranges and shapes. Usually, smaller Ag nanoparticles are used due to the higher bactericidal ability than larger ones [3,7]. It has been reported that the mode of antibacterial action of silver ions

ISBN: 978-81-932074-1-3

is probably similar to that of silver nanoparticles[8]. Some reports proposed that AgNPs form depositions on the microbial cell wall and exert toxic effect by inactivating their essential enzymes by forming complexes [9]. In addition to their direct bactericidal activity, AgNPs are also known to disrupt the bio film formation [10]. Another problem encountering the application of argentiferous based antibacterial materials is the recovery of the disinfectants. Therefore, it is necessary to separate the Ag based disinfectants from water solution after treatment. It would be desirable to support the Ag nanoparticles on a specific matrix, with their positions controlled using methods such as an external magnetic field. Magnetic nanoparticles can be manipulated by an external magnetic field, and therefore magnetic nanoparticles coated with AgNPs could be readily separated from the bulk solution. The separation of magnetic composite by a magnetic field is more effective than filtration or centrifugation[11]. Among the materials available to create magnetic nanosphere, Fe_3O_4 is widely used because it is non-toxic and easily prepared [12]. Ag/Fe_3O_4 magnetic composites have been successfully synthesized by many groups and the antibacterial performance is also investigated [13-14]. Generally, two-step reactions are designed for the synthesis of Ag/Fe_3O_4 composite, namely nanostructured Fe_3O_4 is synthesized first, and then Ag particles reduced by suitable agents grow on the Fe_3O_4 sample [15].

An impressive range of extremely novel and ingenious methods for nanosilver synthesis have been reported in the literature Chemical reduction is the most frequently applied method for the preparation of silver nanoparticles Commonly used reductants are borohydride, citrate, ascorbate, and elemental hydrogen [16-19]. nanosilver ferrite nanocomposite, $AgFeO_2$ [20].nanocobalt ferrire and silver coated cobalt ferrite were synthesized[21] these are used for antimicrobial activity on various gram negative and gram positive bacteria[22-24].

II.EXPERIMENTAL

1. Materials and methods

All the chemicals used in this study are of analytical reagent grade. Silver nitrate, ferric nitrate, and sodium hydroxide procured from M/s. Merck and BDH [Analar] have been used as received. X-ray diffraction pattern of the composite was recorded using a Philips 1011 X-ray diffractometer (operating with 40 KV and 45 mA) with Cu Ka (1.5406 A˚) radiation. A Philips field effect (model XL 30) scanning electron microscope (SEM) with energy dispersive spectrometer (EDS) working at 30 kV was used to examine the surface morphology and elemental composition of the powders. The magnetization measurements of the samples were carried out at room temperature using a Lakeshore7400 vibrating sample magnetometer (VSM) with the applied magnetic field in the range of -15 to 15 kG.

2. Synthesis

Silver nanoparticles were prepared according to the procedure reported by Lu and Chou [19]. Silver Ferrite nanoparticles were prepared according to the procedure reported by Murthy et al [20]. A new silver coated cobalt ferrite nanocomposite [Ag@$CoFe_2O_4$], was prepared by a two-step procedure. In the first step, cobalt ferrite nanoparticles were synthesized by a co precipitation method followed by combustion method using glucose as fuel . This nano cobalt ferrite was then coated with nanosilver via chemical reduction of Ag+ solution using glucose as reducing agent [21-22].

3. Antimicrobial disc method

100 micro liters of 10^{-3} dilute soil sample in nutrient agar media (3grames/100ml) is taken and Antimicrobial disc method is used.The microorganisms used in this work include *Bacillus subtilis* and *Staphylococcus aureus* (as Gram positive bacteria)and *Escherichia coli* and *Pseudomonas aeruginosa* (as Gram negative bacteria).

III.RESULTS AND DISCUSSION

The synthesized nano CoFe2O4, nano Ag@$CoFe_2O_4$],nanoAg and nano $AgFeO_2$compostes were characterized by X-ray diffraction, Scanning electron microscopy/transmission electron microscopy, and vibrating sample magnetometer[19-22].their sizes and magnetic natures are as in the table.1.

Nano particles	Size (nm)	Magnetic nature
Nano silver	22nm	para magnetic
Nano cobalt ferrite	26nm	Ferromagnetic
silver@cobalt ferrite	28.37 nm	Ferro magnetic
Silver ferrite	4.5nm	Super paramagnetic

Table.1 .sizes and magnetic natures of the tested nano particles

The microorganisms used in this work include Escherichia coli and Pseudomonas aeruginosa (as Gram negative bacteria). Bacillus subtilis and Staphylococcus aureus (as Gram positive bacteria).In this, bactericidal activities of AgNPs, nanocobalt ferrite,nanoAg@Fe_2O_4 and nano$AgFeO_2$ composites against the above mentioned bacteria were evaluated by determining the presence of inhibition zones. The results of this study are presented in Table 2.

Compound	Conc. mg/lit	Inhibiting zone(mm)			
		E.Coli	P.aureginosa	S.aureus	B.subtilis
CoFe2O4	40	5	5	na	6
Ag Nps	40	12	12	15	18
Ag@CoFe2O4	40	14	12	17	21
Ag Feo2	40	16	13	18	23

Table 2: Effect ferrites on Bacteria

As the inhibition zone diameter over 7mm, indicates that the tested compounds are active against the bacteria under investigation. The antibacterial activity of $AgFeO_2$ composite against almost all tested bacteria is slightly higher than that of other nano particles used in testing in table 3.

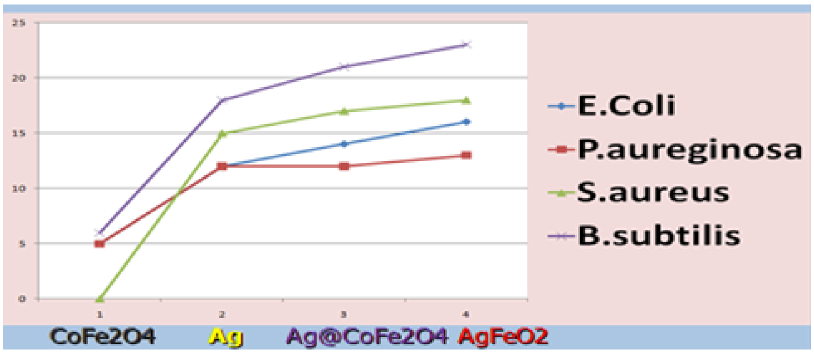

Table 3: Antimicrobial nature of Nano ferrites

It is known that AgNPs exert toxicity to bacteria and other organisms for more than a decade, the very recent study by Alvarez etal.demonstrated that the antimicrobial activity of AgNPs is solely due to Ag^+ release Therefore, the observation of higher antibacterial activity of the novel $AgFeO_2$ composite compared to AgNPs and other tested nanoferrites in our study can be attributed to the faster Ag^+ release rate from $AgFeO_2$ composite.

IV.CONCLUSION

The antibacterial activity nanocobalt ferrite, silver coated nano cobalt ferrte and nano silver ferrite were investigated against some Gram-positive and Gram-negative bacteria and compared with those of silver nanoparticles. it was observed that nano silver ferrite has more antimicrobial action than all these nano particles. As the nano silver ferrite has small particle. size (4.5nm), good antimicrobial nature, super paramagnetic and biocompatibility, it is concluded that nano silver ferrite is better tool for target drug delivery than other tested ferrites.

V.ACKNOWLEDGEMENTS

Authors are grateful to The Management and principal, Sri Sivani College of Engineering, Srikakulam for providing the facilities. We are thankful to Mr. Ch. Sudhakar and Smt. Indira Priyadarshini, Faculty of microbiology, Govt. Degree & PG College, Srikakulam for their help in Antimicrobial studies. I am grateful to Department of Chemistry, AndhraUniversity for support and knowledge sharing.

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