

# Anti Microbial Activity of Nanosilverferrite Composite

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**ABSTRACT:** A new silver ferrite nanocomposite, AgFeO<sub>2</sub>, was prepared by co-precipitation procedure. The synthesized AgFeO<sub>2</sub> was characterized by X-ray diffraction, Scanning electron microscopy, and vibrating Sample magnetometer. It is paramagnetic. The antibacterial activity of this composite was investigated against some Gram-positive and Gram-negative bacteria and compared with those of silver nanoparticles and some standard antibacterial drugs. The AgFeO<sub>2</sub> nanocomposite shows higher antibacterial activity than those of Ag nano particles and some standard antibacterial drugs.

**KEYWORDS:** Nano Silver ferrite composite, Antibacterial activity.Target Drug delivery

## I. INTRODUCTION

Silver nanoparticles (AgNPs) have attracted considerable attention and have been used as antimicrobial agent for a long time because of their stability, and broad spectrum antibacterial activity and microorganisms, which develop resistance to Antibiotics [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 [3-5], and antibacterial water filter [6]. Among metallic nanomaterials like copper, zinc, titanium and gold, silver nanoparticles have higher antibacterial effect [2]. 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 [7]. Treatment of this water usually requires using high concentrated chlorine compounds which may cause a high risk of human cancer due to the formation of halomethanes [8].

The principle characteristic of AgNPs is their ultra small size which leads to high surface area per mass as is the case with all nanomaterials. 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 [3,9]. To prevent the aggregation of silvernanoparticles a wide range of materials such as TiO<sub>2</sub> [10], SiO<sub>2</sub> [11], zeolites [12], and activated carbon fibers [13] have been employed to support AgNPs.

It has been reported that the mode of antibacterial action of silver ions is probably similar to that of silver nanoparticles [14]. Some reports proposed that AgNPs form depositions on the microbial cell wall and exert toxic effect by inactivating their essential enzymes by forming complexes with the catalytic sulphur of thiol groups in cysteine residues and through the production of reactive oxygen species such as superoxide anions, hydrogen peroxide, and hydroxyl radicals [15]. In addition to their direct bactericidal activity, AgNPs are also known to disrupt the biofilm formation [16].

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Another problem encountering the application of argentiferous based antibacterial materials is the recovery of the disinfectants. The argyria and clinical toxicity of AgNPs to mammiferous cells and other aquatic organism has been confirmed by many researchers [17]. 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 [18].

Among the materials available to create magnetic nanosphere,  $\text{Fe}_3\text{O}_4$  is widely used because it is non-toxic and easily prepared [19]. Ag/ $\text{Fe}_3\text{O}_4$  magnetic composites have been successfully synthesized by many groups and the antibacterial performance is also investigated [20–26]. Generally, two-step reactions are designed for the synthesis of Ag/ $\text{Fe}_3\text{O}_4$  composite, namely nanostructured  $\text{Fe}_3\text{O}_4$  is synthesized first, and then Ag particles reduced by suitable agents grow on the  $\text{Fe}_3\text{O}_4$  sample [27–32].

Generally, metal nanoparticles can be prepared and stabilized by physical and chemical methods; the chemical approach, such as chemical reduction, electrochemical techniques, and photo-chemical reduction is most widely used [33]. Studies have shown that the size, morphology, stability and properties (chemical and physical) of the metal nanoparticles are strongly influenced by the experimental conditions, the kinetics of interaction of metal ions with reducing agents, and adsorption processes of stabilizing agent with metal nanoparticles. Hence, the design of a synthesis method in which the size, morphology, stability and properties are controlled has become a major field of interest [33].

An impressive range of extremely novel and ingenious methods for nanosilver synthesis have been reported in the literature, although only a few have been adopted in main stream production. Chemical reduction is the most frequently applied method for the preparation of silver nanoparticles as stable, colloidal dispersions in water or organic solvents [34,35]. Commonly used reductants are borohydride, citrate, ascorbate, and elemental hydrogen [36-43]. The reduction of silver ions ( $\text{Ag}^+$ ) in aqueous solution generally yields colloidal silver with particle diameters of several nanometers. Initially, the reduction of various complexes having  $\text{Ag}^+$  ions leads to the formation of silver atoms ( $\text{Ag}^0$ ), which is followed by agglomeration into oligomeric clusters [44,45,46]. and nanosilver ferrite nanocomposite,  $\text{AgFeO}_2$  [47]. and it is used for antimicrobial activity on various gram negative and gram positive bacteria.

GRAM-NEGATIVE bacteria normally found in the gastrointestinal tract that can be responsible for disease in man (sepsis). Bacteria are considered gram-negative because of their characteristic staining properties under the microscope, where they either do not stain Crystal violet or are decolorized by alcohol during Gram's method of staining. This is a primary characteristic of bacteria that have a cell wall composed of a thin layer of peptidoglycan covered by an outer membrane of lipoprotein and lipopolysaccharide containing endotoxin. *E.coli* cause severe stomach cramps, diarrhoea (often bloody), and vomiting and perhaps slight fever. They produce a toxin that can attack the body in several areas: the gut (causing bloody diarrhoea), the kidneys (causing kidney failure), and sometimes the nervous system. *Pseudomonas aeruginosa* may cause infections in the body including premature and newly-born babies. These infections commonly involve the pulmonary tract, urinary tract infections, burns, wounds, and other blood infections[48].

GRAM-POSITIVE bacteria are those which retain the crystal violet stain or that are resistant to decolorization by alcohol during Gram's method of staining. This is a primary characteristic of bacteria whose cell wall is composed of a thick layer of peptidoglycan containing teichoic and lipoteichoic acid complexed to the peptidoglycan. If *staphylococcus aureus* enters the blood it can cause a number of problems in the body: bacteremia and sepsis, toxic shock syndrome (TSS), pneumonia meningitis osteomyelitis, endocarditis. *Bacillus*

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*subtilis* bacteria can contaminate food, however, they seldom result in food poisoning. Some *Bacillus* organisms can cause more severe illnesses. *Bacillus anthracis*, for example, causes Anthrax[48].

## II. EXPERIMENTAL

### 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 K $\alpha$  (1.5406 Å) 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 Lakeshore-7400 vibrating sample magnetometer (VSM) with the applied magnetic field in the range of -15 to 15 kG.

### Synthesis of silver and AgFeO<sub>2</sub> nanoparticles

Silver nanoparticles were prepared according to the procedure reported by Lu and Chou [46]. Silver Ferrite nanoparticles were prepared according to the procedure reported by Murthy et al [47].

### Antimicrobial disc method

100 micro liters of 10<sup>-3</sup> dilute soil sample in nutrient agar media (3grams/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 sizes of the nano silver and nanosilver ferrite particles annealed at 400°C calculated using the Scherer formula as 30nm, 4.5 nm [46],[47] respectively. The bactericidal activities of AgNPs and AgFeO<sub>2</sub> nanocomposite against the above mentioned bacteria were evaluated by determining the presence of inhibition zones(photo.1).

It is generally accepted that an inhibition zone diameter over 7 mm indicates that the tested compounds are active against the bacteria under investigation. It is observed that The antibacterial activity of AgFeO<sub>2</sub> composite against almost all tested bacteria is slightly higher than that of AgNPs (Table 2). Moreover, on comparing the biological activity of the AgFeO<sub>2</sub> nanocomposite with the standard drugs, the following results are obtained (Table 2& Fig.6).

**Table 2. Antimicrobial activity of silver nanoparticles and nano silver ferrite particles**

Compound	Concentration (mg/mL)	Inhibition Zone (mm)			
		<i>E. Coli</i>	<i>P. aeruginosa</i>	<i>S.aureus</i>	<i>B.subtilis</i>
AgNPs	10	10	9	12	14
	20	11	11	14	16
	40	12	12	15	18
Nano AgFeO <sub>2</sub>	10	12	10	15	18
	20	14	11	17	20
	40	16	13	18	23
Pencillin	10	12	NA	26	13
Streptomycin	10	16	NA	12	22
Cefixime	5	18	NA	NA	9
Amoxicillin	25	9	NA	28	23
Erythromycin	15	NA	NA	25	27

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Note: Pencilline(10mg/disc), Streptomycin(10mg/disc), Cefixime(5mg/disc), Amoxicillin (25mg/disc), Erythromycin(10mg/disc), NA means no activity.

While all the five screened drugs are not effective against *P. Aeruginosa*, but  $AgFeO_2$  found to be effective, (Fig.6). The antibacterial activity of  $AgFeO_2$  against *E. coli* is higher than Amoxicillin, Erythromycin and Penicillin but less than Erythromycin and Cefixime drugs. The inhibitory effect of  $AgFeO_2$  composite against *S. aureus*, is higher than Cefixime and Streptomycin but less than the other three examined drugs. The biological activity of this new synthesized nanocomposite against *B. subtilis* is also higher than Penicillin and Cefixime drugs. Apparently, the examined  $AgFeO_2$  nanocomposite seems to be more effective against Gram-negative (*E. coli* and *P. aeruginosa*) bacteria. Although researchers have debated the mechanisms by which AgNPs exert toxicity to bacteria and other organisms for more than a decade, the very recent study by Alvarez et al. 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 in our study can be attributed to the faster  $Ag^+$  release rate from this composite.

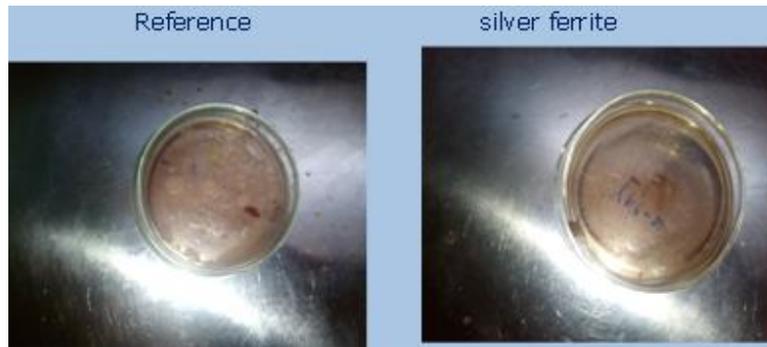


Photo 1. Photograph of the Reference and Silver ferrite during the experimental conditions

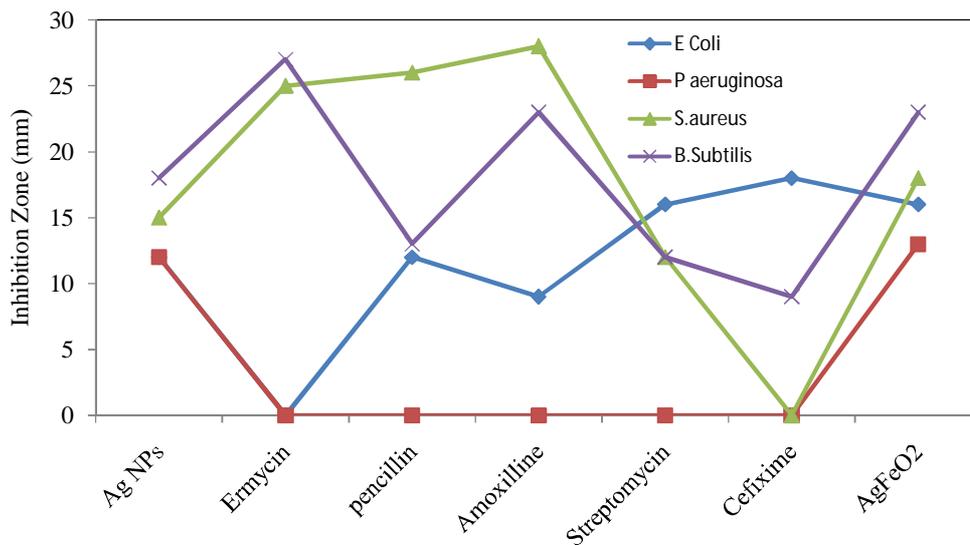


Fig.6. Effect of nanosilverferrite on E.Coli, P.aeruginosa B.Subtilis, S.aureus.

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## IV.CONCLUSION

Now, The antibacterial activity of nano silver and AgFeO<sub>2</sub> composite is studied and reported that the AgFeO<sub>2</sub> nanocomposite shows higher antibacterial activity not only than AgNPs but also than some standard antibacterial drugs. In addition to the higher inhibitory effects of nanosilver ferrite composite compared with AgNPs, The nanosilver ferrite possess magnetic nature. So it can be easily removed from water by using a magnetic field after its anti microbial action on water. Due to more Antibacterial,ferro/superparamagnetic and biocompatibility of nanosilverferrite. Its usage for Target drug delivery is also more commendable.

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