Biosynthesis of Bimetallic Silver-Iron Bimetallic Nanoparticles by using S.officinalis for Antimicrobial Applications

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Abstract: The facile, seedless, one-pot green synthesis of Ag-Fe bimetallic nanoparticles via reduction process using phytochemicals present in the Salvia officinalis aqueous extract. During the Phyto-assisted nanofabrication of Ag-Fe nanoparticles, the reduction of Ag+ and Fe3+ metal ions to Ag-Fe NPs takes place according to their reduction potential. The UV-visible spectroscopic technique was initially used for the Ag-Fe nanoparticle formation in which the absorption band at 450 nm, 350 nm, and 352 nm were observed for Ag NPs, Fe NPs, and Ag-Fe nanoparticles, respectively. Bioactive compounds obtained from plants efficiently involved in the reduction, capping as well as stabilization of Ag-Fe NPs. Therefore, without using any chemical and toxic agents present study concluded a simpler method to synthesise Ag-Fe bimetallic NPs using leaf extract of S. officinalis and it's antimicrobial applications towards different bacterial strains comprising E. coli., S. aureus, S. putrefaciens.

I. INTRODUCTION

Nanomaterials can potential resolve many environmental as well as bio medicated challenges in the field of medicine, waste water treatment, solar energy conversion etc. Biosynthesis of nanoparticles using plants being used in many methods of synthesis including physical and chemical methods. Metal nanoparticles have been used in various fields including electronics, medicine, etc [1]. The toxic chemicals (such as solvent, reducing agent, capping agent) which may not be harmful for the synthesis of nanoparticles in industrial purposes but it is always expected to synthesize the nanoparticles in biological approach in the application of environmental and biological issues. So, there is growing need to develop eco-friendly processes to avoid the use of toxic and hazardous chemicals in the earth synthesis [2]. S. officinalis Linn. Is a valuable medicinal plant which belongs to the family oleaceae. The plant generally grows in tropical and subtropical region. S. officinalis commonly known as night jasmine, Haarsinghar & Parijat [3]. Silver, copper and Silver-Copper based nanoparticles have been synthesised from several plant extracts such as Magnolia kobu, Terminalia arjuna, Aloe vera, Bifurcaria bifurcate, Tabernaemontana [4], In the current study, we synthesized an aqueous extract of S. officinalis prepare silver, iron, and silver-iron bimetallic nanoparticles, the prepared nanoparticles were used in the antimicrobial studies.

II. ANTIBACTERIAL STUDIES

The microorganisms used for antimicrobial evaluation were S. aureus, E. coli and S. petrification. Zone of inhibition was determined by using well diffusion method. 100 ml inoculum of 24 hr. old cultures of each bacterium was taken and spread on nutrient agar plates with the help of sterile spreader. Subsequently, wells of 10 mm diameter were pierced into the medium and filled with the different concentration of Ag-Fe NPs synthesized by using

S. officinalis and endorsed to diffuse at room temperature for 1 hr. further, these plates were kept undisturbed into incubator at 370c for 24 hr. After incubation period zone of inhibition were measured into mm. Data was expressed as mean standard deviation.

III. PLANT EXTRACT PREPARATION:

The freshly dried leaves of S. officinalis were washed thoroughly multiple times with double-distilled water to remove all the dust particles and other impurities from the leaves' surface. These washed S. officinalis leaves were shade dried at room temperature until all the water on the surface removes. The stems of the S. officinalis plant were removed, and only leaves of the plant were used for further experiments. The dried leaves were crushed

into powder, and 5 g of the leaf powder was soaked in 250 ml hot water and continuously heated at 50 C for 30 min with constant stirring. The extract was kept overnight to get the better extract, followed by filtration with Whatman No. 1 filter paper. The extract was kept in the dark under low temperature (4 C) in a refrigerator and was used for the synthesis of Ag-Fe bimetallic nanoparticles.

Fig 1. S. officinalis plant

IV. SYNTHESIS OF AG-FE BIMETALLIC NANOPARTICLES

The one-pot green synthesis of Ag-Fe bimetallic nanoparticles was carried out by applying a seedless synthesis approach at room temperature. The precursor solutions of AgNO3 (20 ml, 0.01 M) and Fe (NO3)3 (20 ml, 0.01 M) were mixed in a single-neck flask with top opening closed with glass stopper under continuous stirring on a magnetic stirrer for about 20 min. A 20 ml of freshly prepared aqueous S. officinalis leaf extract was added to the Ag-Fe solution with constant stirring. The reaction progress was monitored by observing the color change from light brown to dark brown, indicating the Ag-Fe nanoparticles' formation. The dark brown reaction mixture was centrifuged at 12,000 rmp for 20 min to acquire precipitated Ag-Fe. This brown colure precipitate was washed three times with ultrapure deionized water and was dried in the furnace at 80 C for 2 h, and finally, a fine brown powder of Ag-Fe nanoparticles was collected.

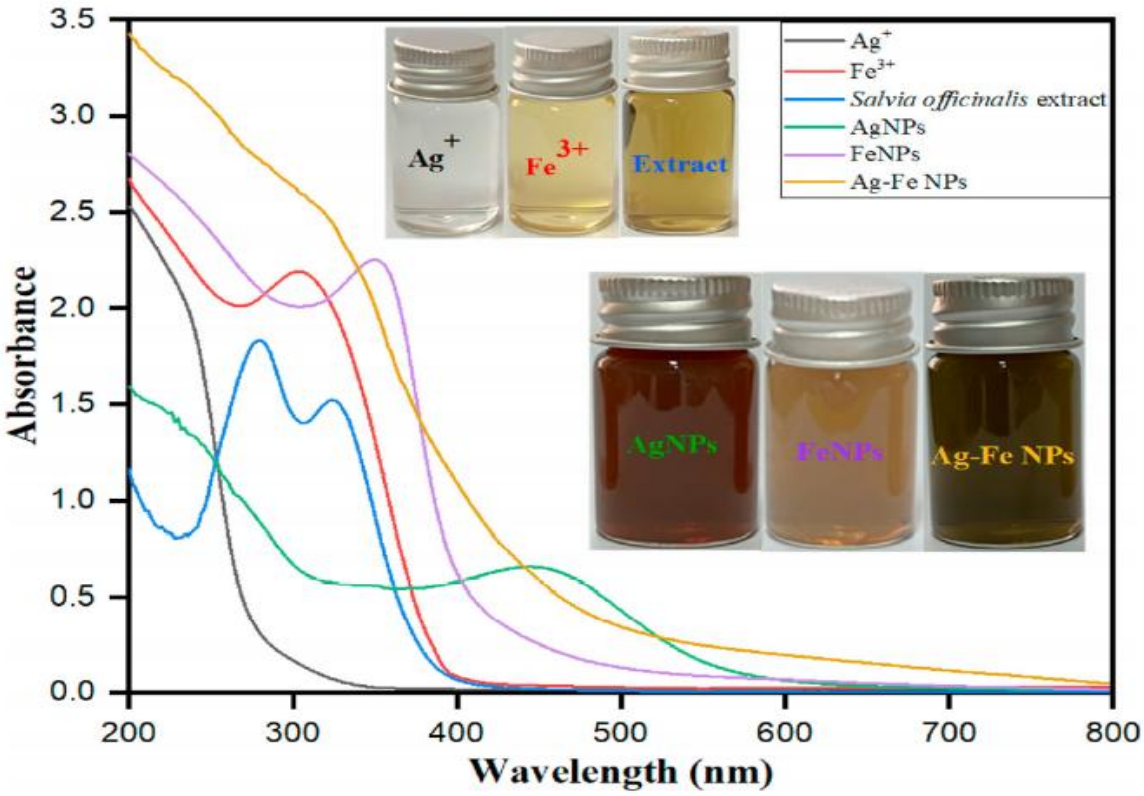

Fig. 2 –UV-visible absorption bands and optical images (insert) of pure Ag+ and Fe3+ metal ions, Salvia officinalis extract, AgNPs, FeNPs, and Ag-Fe bimetallic nanoparticles.

The UV-visible spectroscopic technique was initially used for the Ag-Fe nanoparticle formation in which the absorption band at 450 nm, 350 nm, and 352 nm were observed for AgNPs, FeNPs, and Ag-Fe bimetallic nanoparticles, respectively in fig.2

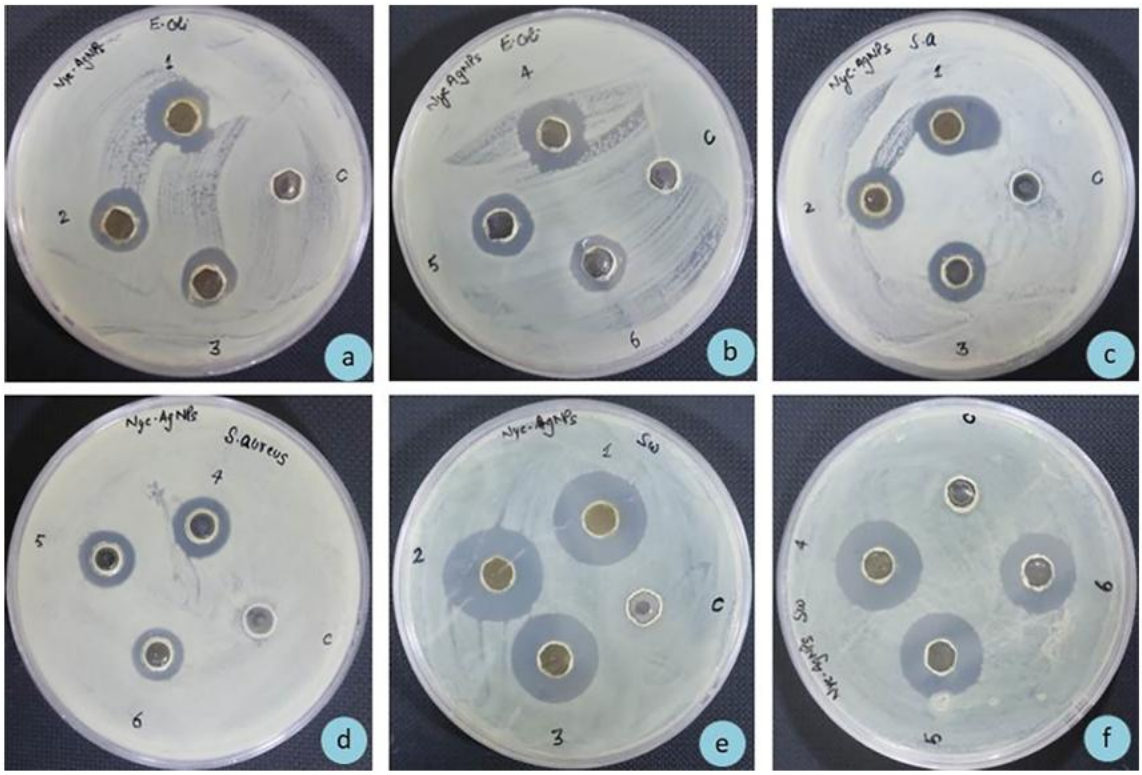

Fig. 3 Antibacterial efficiency of synthesised Ag-Fe bimetallic nanoparticles at different concentrations (1: 0.2%, 2: 0.1%, 3: 0.05%, 4: 0.025%, 5: 0.012%, 6: 0.006%) "a-f" a,b: zone of inhibition obtained against E.coli., c,d: S. aureus, e,f:S. putrefaciens.

V. ANTIMICROBIAL STUDIES

S. officinalis-based Ag-Fe bimetallic NPs efficiently showed antimi crobial potential against three different bacterial strains including E. coli., S. aureus, S. putrefaciens. Maximum antimicrobial efficiency was observed against S. putrefaciens i.e. 22.3 ± 0.2 at 0.2% concentration. Besides, it is also showed good antibacterial efficiency against E. coli. and S. aureus, zone of inhibition at different concentration was clearly described in and Fig 3. There are reports and studies concluded that plant-based NPs showed strong antibacterial activities against various bacterial strains.

VI. CONCLUSION

Green approach considered as efficient as well as innovative search for more eco-friendly ways in the production of nanomaterials. Plant based bimetallic Ag-Fe NPs has been resourcefully used in various field to resolve many difficulties associated with biomedical, textile, food, cosmetics, agroindustry etc. S. officinalis rich source of bioactive compounds including arbortristoside-A, arbortristoside-B, 6,7-di-O-benzonylnyctanthoside (I), astraglin, nicotiflorin, quercetin and many more; that specifies their prospec tive as therapeutic agent and also for foretelling and controlling the eminence of this plant. Bioactive compounds obtained from plants efficiently involved in the reduction, capping as well as stabiliza tion of Ag-Fe bimetallic NPs. Therefore, without using any chemical and toxic agents present study concluded a simpler method to synthesise Ag-Fe bimetallic NPs using leaf extract of S. officinalis and it's antimi crobial applications towards different bacterial strains comprising E. coli., S. aureus, S. putrefaciens.

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