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Green Synthesis, Characterization of Manganese Oxide Nanoparticles using Ziziphus Abyssinia Plant Extract and their Antimicrobial Efficacy

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Abstract

Development of green technology is generating interest of researchers towards eco-friendly and low-cost methods for biosynthesis of nanoparticles (NPs). In this study, manganese oxide (MnO) NPs were synthesized using a manganese acetate precursor and Ziziphus Abyssinia leaves extract. The biosynthesized MnO NPs were characterized using an X-ray diffractometer (XRD), scanning electron microscopy (SEM), Ultraviolet visible spectroscopy (UV-Vis), and Fourier transform infrared (FTIR) spectroscopy. XRD characterization confirmed that the biosynthesized MnO NPs possessed a good crystalline nature which perfectly matched can be assigned to tetragonal structure. FTIR spectra of MnO NPs revealed the presence of O-Mn-O stretch vibration at around 913.80 and 796 cm-1. Furthermore, the results obtained from SEM showed that the biosynthesized MnO NPs were spherical in shape which is also in agreement with that reported by Jayandran et al. (2015). Moreover, the antimicrobial activities of different concentrations of MnO NPs synthesized using Ziziphus Abyssinia extract were also tested. From the inhibition zone results, synthesized MnO NPs were showed better inhibition activity than the Ziziphus Abyssinia leaf extract against Escherichia coli, Staphylococcus aureus Salmonella Typhi, Shigella bacteria and also exhibited similar inhibition activity to standard drug against Candida albicans, Candida Tropicalis, Aspergillus Niger and Aspergillus flavus. Thus, our findings report Mn nanoparticles synthesized from the above proposed green method are show promise results in the view of pharmaceutical and therapeutic applications.

Keywords: ***Fungal strain, green chemistry, bacteria, Biosynthesis, Nanotechnology, Ziziphus Abyssinia.***

Introduction

In the last ten years, scientists from all around the world have become increasingly interested in using nanomaterials to regulate microbial proliferation. Increased health issues are a result of microbes becoming more resistant to antimicrobial drugs, including antibiotics. Numerous studies have shown that novel uses for metal nanoparticles can be found by fusing the three forces of material science, nanotechnology, and the built-in antibacterial properties of some metals. Numerous studies have documented the toxicity of metal and metal oxide nanoparticles toward a variety of bacteria. It is possible to effectively use these nanoparticles to halt the growth of different bacterial species [1].Numerous studies have been carried out in an effort to improve the current antimicrobial therapies as a result of the spike in the creation of multi-drug resistant microorganisms, which is presenting a serious challenge for public health. It has been determined that one or more of the first- and second-line medications that have historically been used to treat the infection have developed resistance in about 70% of bacterial infections. The creation of innovative

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antimicrobial drugs that are also effective must be developed and synthesized faster than ever before. Nanoparticles as antibacterial agents have shown to be an innovative solution to this problem since they have the capacity to create a strong nanostructure that can be used to deliver the antibacterial agents, effectively and locally targeting bacterial growth . Additionally, nanoparticles have shown to be so powerful that viruses have little opportunity to develop a resistance to them. At the doses that have been used to kill bacterial cells, the majority of the metal oxide nanoparticles s that are now available are not harmful to mammalian cells, which makes employing them on a wider scale advantageous. It has been established that metal nanoparticles with antibacterial activity include Gold (Au), Silver (Ag), Silicon (Si), Silver Oxide (Ag_2O), Titanium Dioxide (TiO_2), Zinc Oxide (ZnO), Copper Oxide (CuO), Calcium Oxide (CaO), And Magnesium Oxide (MgO).

The majority of current methods for creating metal nanoparticles often rely on physical or chemical principles. However, neither preparation technique is eco-friendly. The integration of nanotechnology with green chemistry will be popular in the coming decades. Nanotechnology is a ground breaking science that is still in its early stages. Green synthesis has emerged as an alternative to the limitations of traditional technologies . Green synthesis focuses primarily on the disposal of hazardous wastes, the use of environmentally friendly chemicals, solvents, and renewable resources, as well as sustainable procedures [2]. The manufacture of various metal nanoparticles utilizing green nanotechnology has been reported to use yeast, fungi, bacteria, algae, plant extract, etc.

Because using plants to synthesize nanoparticles is proving to be more advantageous than using microbes due to the presence of a wide variety of bio-molecules in plants that can act as capping and reducing agents, plant extracts used in reduction methods can be considered to be more effective green approaches for synthesizing metal nanoparticles [3,4]. Thus, under benign experimental conditions, such as relatively low reaction temperature and ambient pressure, improves the rate of reduction and stability of nanoparticles and synthesis can be carried out .Due to their superior physicochemical qualities, manganese oxides can be used in a variety of applications, including batteries, magnetic materials, water treatment, and imaging contrast agents. One of the most significant materials is MnO_2, and many researchers are interested in how adding MnO_2 affects the electromagnetic properties of ferrite materials. MnO_2 created at the nanoscale has been prepared using a variety of techniques. Although there are numerous reports of environmentally friendly manganese nanoparticle production, the simplest, most affordable, and environment-friendly technique is to reduce and stabilize Mn metal into nanoparticles using plant extracts, as was stated above. The well-known medicinal ingredient from the *Ziziphus Abyssinia* plant has been found to offer a variety of therapeutic effects. Additionally, it has been claimed that the fruits of this plant contain antifungal, antibacterial, antiulcer, and anti-inflammatory properties [5-6].

Most of the reports are focusing on the characterization and application of the formed manganese nanoparticles in catalytic activity, electronic properties, but the antimicrobial effects of manganese nanoparticles are investigated rarely. Based on the foregoing discussions, this inquiry is concerned with the environmentally friendly synthesis of Mn nanoparticles utilizing *Ziziphus Abyssinia* leaf extract. The biological applications of Mn nanoparticles, such as antibacterial and antifungal properties against some bacterial and fungal strains, are the main emphasis of this work

Materials and Methods

Sample Preparation

Ziziphus Abyssinia leaves were collected from Yola South of Adamawa State. The sample was washed thoroughly with distilled water to remove dust allowed to dry at room temperature on a clean polythene plastic bag for at least two weeks. The dried leaves were grounded mechanically using sterile pestle and mortar. The sample was sieved, parked in polyethylene bags labelled and

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CONCLUSION

Ziziphus Abyssinia leaf extract was employed in this experiment to make MnO nanoparticles. This strategy is effective, rapid, and affordable. We deduced from the XRD that the produced manganese oxide nanoparticles had a tetragonal structure and were extremely crystalline in nature. The SEM examination revealed the morphology of synthesized MnO nanoparticles to be spherical in shape. FTIR spectra show the effect of plant extracts on the extraction of NPs. The antibacterial and antifungal properties of MnO nanoparticles were better than that of leaf extract of *Ziziphus Abyssinia*.

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