PROJECT REPORT

On

GREEN SYNTHESIS OF MAGNESIUM OXIDE NANOPARTICLES USING *Moringa oleifera* LEAF EXTRACT

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In partial fulfillment for the award of the

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<u>B.Sc. CHEMISTRY PROJECT REPORT</u>

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This is to certify that the project "**GREEN SYNTHESIS OF MAGNESIUM OXIDE NANOPARTICLES USING *Moringa oleifera* LEAF EXTRACT**" is the work done by **ANUPAMA B., MARY ALFIYA ANTONY , SANAM A.A.,SANIYA T.S.**

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CERTIFICATE

This is to certify that the project work entitled "**GREEN SYNTHESIS OF MAGNESIUM OXIDE NANOPARTICLES USING *Moringa oleifera* LEAF EXTRACT**" is the work done by **ANUPAMA B., MARY ALFIYA ANTONY , SANAM A.A., SANIYA T.S.** under my guidance in the partial fulfilment of the award of the Degree of Bachelor of Science in Chemistry at St. Teresa's College (Autonomous), Ernakulam affiliated to Mahatma Gandhi University, Kottayam.

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<u>DECLARATION</u>

I hereby declare that the project work entitled "**GREEN SYNTHESIS OF MAGNESIUM OXIDE USING *Moringa oleifera* LEAF EXTRACT**" submitted to Department of Chemistry and Centre for Research, St. Teresa's College (Autonomous) affiliated to Mahatma Gandhi University, Kottayam, is a record of an original work done by me under the guidance of **Mr. LIYO VINCENT K, Mrs. DEVI KRISHNA K, ASSISTANT PROFESSOR,** Department of Chemistry and Centre for Research, St. Teresa's College (Autonomous), Ernakulam and this project work is submitted in the partial fulfilment of the requirements for the award of the Degree of Bachelor of Science in Chemistry.

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Chapter 1

Introduction

ABSTRACT

The preparation of nanoparticles from plant extracts constitutes an important alternative method because it is non-toxic, biocompatible, and environmentally friendly. In this study, green synthesis of MgO nanoparticles was carried out using aqueous extracts of *Moringa oleifera* leaves by mixing the extract and magnesium sulphate solution. The product was characterized using various techniques, including UV-visible (UV-Vis) spectroscopy, X-ray diffraction (XRD), and infrared spectroscopy. The UV-Vis spectrum of the MgO nanoparticles shows an absorption at 290 nm. MgO nanoparticles were successfully prepared using aqueous extract of *Moringa oleifera* leaves, providing an alternative method for the synthesis of MgO nanoparticles. [1]

1.1 NANOCHEMISTRY

Nanochemistry is a sub-field of nanoscience that deals with chemicals. Nanochemistry is a relatively new branch of chemistry that focuses on the study and development of methods to produce useful materials with nanometer dimensions (1-100 nm). Nanochemistry is a branch of solid state chemistry that focuses on the synthesis of building blocks based on the size, surface area, shape, and properties of defects, rather than the creation of materials. Atoms can be physically and chemically processed for training nanoscale molecules and assembly. Nanochemistry is a research of synthesis and characteristics of nanoscale materials.

Nanochemistry is the science of tools, techniques, and methodologies such as: new chemical synthesis, e.g. using synthetic chemistry to create desired (specified) shapes, sizes, surface compositions and structures, and controlled electric potentials. These building blocks actually self-assemble into various desired sizes. Nanoparticles have "unusual" structures and architectures due to their small size. Optical properties that can be used for catalysis, electro-optical devices, etc.

Nano materials have intermediate structural characteristics. A very important relationship between the surface and the volume of a small dimensions leads to a more dependent surface characteristics. Because the surface characteristics of nanoparticles are the most important. [2]

1.1.1 NANOPARTICLES

Nanoparticles have attracted increasing attention in a variety of application fields, including materials science, energy science, medicine, and biotechnology.

Nanoparticles are effective in biological and medical applications such as sensors, medical and optical devices, drug delivery, bacteriostasis, dye degradation, and DNA labeling.

These applications are due to their large surface area to volume ratio and small size. The synthesis of nanostructured materials can be carried out by physical, chemical, and biological methods. Various methods used in chemical synthesis like precipitation, pyrolysis, micellar, hydrothermal, sol-gel process, etc make chemical synthesis toxic and environmentally hazardous. To minimize this adverse impact on the environment, green synthesis comes as a savior. Biological feed stocks for green synthesis include microorganisms, algae and plants.

Green synthesis is one of the widely used, cost-effective, non-toxic and safe methods to produce simple metal oxides. The nanoparticles produced by green synthesis have various applications such as anti-inflammatory and antimicrobial activity, efficient drug delivery, bioactivity, tumor targeting, anticancer drugs and bio-absorption. Besides biological applications, they are also used in transistors, magnetic devices, photo-catalysts, micro electronic devices, anti-corrosion coatings, electro-catalysts and powder metallurgy.

In green synthesis technology, different parts of plant extracts (roots, stems, leaves, roots, seeds) are used for material preparation. The plant extract reacts with metal salts, resulting in the formation of nanoparticles of different sizes, shapes and surfaces. [1]

1.1.2 USES OF NANOPARTICLES

- Nanoparticles are now used in scratch-resistant eyeglasses, crack-resistant paints, anti-graffiti coatings for walls, transparent sunscreens, stain-resistant fabrics, self-cleaning windows, and ceramic coatings for solar panel.
- Nanoparticles can help create stronger, lighter, cleaner, and smarter surfaces and systems.
- Nanomaterials are also used in a variety of ways in biology and medicine, including the direct application of products to patients. Examples include products for drug delivery and gene therapy, separation and purification of biomolecules and cells, fluorescent

biological tags, imaging agents, tissue engineering, DNA probes and nanoscale biochips, microsurgical techniques, etc. [4]

- Catalysis is using more and more nanoparticles to enhance chemical responses. As a result, less catalytic material is required to generate the intended outcomes while lowering pollution and saving *money. [4]*

1.2 *Moringa oleifera*

Moringa leaves are used to synthesize magnesium oxide (MgO) because the plant contains phytochemicals that act as stabilizing and capping agents. Moringa leaves contain many phytochemicals, including phenols, amino acids, proteins, vitamins, and antioxidant compounds. Using plant extracts to synthesize nanoparticles is a green, eco-friendly, and cost-effective method. Moringa leaves promote the formation of nanoparticles and increase the success rate of synthesis. MgO nanoparticles synthesized using Moringa leaves have significant antioxidant activity. MgO nanoparticles synthesized using Moringa leaves do not cause significant hemolysis on human red blood cells. MgO nanoparticles synthesized using Moringa leaves do not cause cytotoxicity on human ovarian cancer cells. MgO nanoparticles synthesized using Moringa leaves have no significant effect on seed germination.

1.3 MAGNESIUM OXIDE NANOPARTICLES

Magnesium oxide (MgO) is an environmentally friendly, economically viable, and industrially important nanomaterial due to its unique physicochemical properties. Excellent corrosion resistance, high heat conduction, low electricity conduction, physical strength, stability, flame resistance, dielectric resistance, mechanical strength, excellent optical transparency. For the above characteristics, magnesium oxide used as a semiconductor material, organic conversion catalyst, organic and inorganic pollutant adsorption of organic and inorganic pollutants, electrochemical biosensors, photo catalysts and intractable materials. It also has excellent antibacterial, anticancer and antioxidant properties. [5]

They have excellent properties and are useful in sensors, catalysts and biomedical applications. Among all metal oxide nanoparticles, magnesium oxide (MgO) nanoparticles have excellent activity to be used as antibacterial agents. Several researchers have synthesized MgO nanoparticles using several methods, including sol-gel, sonochemical, co-precipitation, and chemical reduction. [6]

The metal oxide MgO is of particular interest because it is not only stable under harsh process conditions but is also generally considered to be a safe material for humans and animals. Magnesium oxide is an interesting basic oxide that has many applications in catalysis, adsorption and the synthesis of refractory ceramics. It is a unique solid with high ionic character, simple stoichiometry and crystal structure, and can also be produced in a wide range of particle sizes and shapes. [7]

Metal oxides like CuO, MgO, ZnO, and NiO are commonly used in production of nanomaterials since these are stable at heavy conditions and also considered to be safe. Nano Magnesium Oxide has different thermal, optical, mechanical, electronic, chemical and magnetic properties because of its unique structure nano MgO has been used in microelectronics, diagnostics and bio molecular detection. [8]

1.3.1 USES OF MAGNESIUM OXIDE NANOPARTICLES

Magnesium oxide nanoparticles have excellent properties, but their large crystal size and small surface area limit their practical use. The special microstructural properties of MgO, such as high porosity, a large specific surface area and the presence of so-called acid-base sites, make its surface suitable for a variety of applications. There are several reports on the application of MgO in photo-catalysis as an antibacterial agent in energy cells and sensors. Emerging applications of magnesium oxide (MgO) nanoparticles in biomedical engineering are also an emerging area of research. MgO is used for tissue regeneration, implant coating, bio imaging, wound healing, and the development of cancer treatments. [9]

1.3.2 ADVANTAGES OF MAGNESIUM OXIDE NANOPARTICLES

Magnesium oxide nanoparticles are odorless, non-toxic, and feature high hardness, high purity and high melting point. Magnesium oxide nanoparticles appear as a white powder.

These nanoparticles have beneficial physicochemical properties such as excellent corrosion resistance, high thermal conductivity, remarkable refractive index, good physical strength, low electrical conductivity, excellent optical transparency, and dielectric resistance. MgO-NPs possess the ability to combat both bacteria and fungi, effectively inhibiting their growth. MgO-NPs have demonstrated effectiveness against various types of cancer cells. MgO-NPs can scavenge oxygen radicals, aiding in the protection of a plant’s internal enzyme system. MgO-NPs are non-toxic and odorless. Elevated melting point: MgO-NPs feature a high melting point. MgO-NPs exhibit significant hardness. MgO-NPs are characterized by their high purity. MgO-NPs can be produced at a low cost. Compatibility with biological systems: MgONPs are compatible with biological organisms. Enhanced thermal stability: MgO-NPs possess high stability at elevated temperatures. [10]

1.4 SYNTHESIS OF MAGNESIUM OXIDE NANOPARTICLES

Various approaches to synthesize MgO NPs have been reported. Physical, chemical and biological methods are generally used to synthesize MgO nanoparticles. Various synthetic methods of MgO NPs such as water heat, spray, microwave oven, sound chemical frost, joint posture, and thermal dissolution of salt have been developed. These normal preparation methods include the necessity of toxic chemicals, large amounts of external heat, biologically, and silly products that may become environmental. Therefore, it is always necessary to develop environmentally friendly, economical, energy-efficient biochemical procedures in order to evade the toxicity of chemicals in the manufacture of NP. To avoid these complications, natural organisms (plants, bacteria, seaweed and sponges) provide alternative resources for biosynthesis of metal and metal up NP. These plants contain various biomolecules, that is, flavonoids, alkaloids, terpenoids and carbon acids, which can serve as a chelating and recovery agent, as well as stabilize the formation of NP metals oxide. NP MgO biosynthesis with plant extract is also a simple security process, less toxicity and environmentally friendly nature. Generally, the nanoparticle synthesis can be divided into two methods, “top-down” and “bottom-up.” The first starts from the miniaturization of bigger particles to produce nanostructures and the second starts from atoms or molecules to build-up blocks of nanostructures. In both categories, the methods can be physical or chemical. In the “top-down” methods, MgO can be synthesized by laser ablation and mechanical ball milling.

Here we use magnesium sulphate as the metal precursor and Moringa oleifera leaf extract as the reducing agent. In this work, we present a green method for the synthesis of magnesium oxide nanoparticles using plant extract of *Moringa oleifera.*

1.5 CHARACTERIZATION OF MAGNESIUM OXIDE NANOPARTICLES

X-RAY DIFFRACTION

X -ray conversion (XRD) is a young analysis method used for research. Crystal structure of material. Used in various science Industrial site that determines the position of atoms in the crystal Providing valuable information about substances and materials. Crystal science, crystal size, direction, and phase assembly. X-rays are generated using an X-ray tube and directed towards the sample, which is in crystalline form. When X-rays strike a sample, they interact with the crystal lattice, causing constructive interference and scattering in different directions. The result is a diffraction pattern that is recorded detector. The resulting diffraction pattern contains information about the distance between the crystal planes of the sample, which is converted into a diffraction profile called an X-ray diffraction pattern or X-ray diffraction spectrum. Scientists can analyze the X-ray diffraction pattern to determine the crystal structure of the material, including lattice parameters, unit cell dimensions, and atomic arrangement. X-ray diffraction is used in a variety of applications, including materials characterization, pharmaceuticals, geology, chemistry, materials science, and quality control. It is a non-destructive technique that provides detailed information on the internal structure of materials and is a fundamental tool in various fields. [2]

FOURIER TRANSFORM INFRARED SPECTROSCOPY

Fourier Transform Infrared Spectroscopy (FTIR) is an analytical technique widely used in chemistry and materials science to identify and characterize the chemical composition of substances. It measures the interaction of materials with infrared radiation, which lies just beyond the visible light range of the electromagnetic spectrum. FTIR principle. The spectroscopic method is to vibrate with a characteristic frequency of molecules. When infrared passing through the sample, some of them are absorbed. Sample, as a result, the sample absorption schedule is scheduled as a function of infrared light frequency. This absorption is related to molecules. We can provide information about vibration and functional groups and chemical bonds in samples. Samples can be gas, liquid, or solid. With the conventional FTIR the optical light and the detector measures the interference model of the result. A computer then performs a Fourier transformation on the interferogram to obtain the infrared spectrum, which shows peaks at specific wavelengths associated with the sample's chemical constituents.

FTIR spectroscopy is used in a wide range of applications, including the identification of unknown substances, quality control in manufacturing, environmental analysis, forensic science, pharmaceuticals, and monitoring chemical reactions. Provides qualitative and quantitative information about sample chemical composition. The infrared area of the electromagnetic spectrum is divided into three main domain : semi -infrastructure (NIR), infrared medium (MIR), and polarization. FT-IR spectroscopy works mainly in the mid-infrared region. This is usually between 4000 and 400 cm^-1 (wavenumbers). In conclusion, FT-IR spectroscopy is a versatile and powerful analytical tool. It is used in various scientific and industrial fields to characterize materials. For quality control and research purposes. It provides valuable information about composition of chemical structure and a wide range of substances, making it a valuable tool in various fields. [2]

UV VISIBLE ABSORPTION SPECTROPHOTOMETER

UV-VIS absorption spectroscopy is a widely used analytical technique that studies the absorption of ultraviolet and visible light by molecules and atoms in a sample. It provides valuable information about the electronic structure, concentration and chemical composition of materials. The principle of UV-Vis spectroscopy is that molecules or atoms can absorb light of a particular wavelength if the energy of the incident photon matches the energy difference between the ground and excited states. The key instrument used in this technique is the UV-VIS spectrophotometer, which consists of a light source, a monochromator, a sample holder or cuvette, a detector, and a computer for data analysis. The sample is typically dissolved in a suitable solvent, and its absorbance is measured in a cuvette. The spectrophotometer measures the intensity of the incident and transmitted light, and the difference in intensity is used to calculate the absorbance (A) of the sample. Absorption data are used to construct an absorption spectrum, which is a plot of the absorption (A) as a function of the wavelength (or frequency) of the incident light. UV-visible spectroscopy is used for qualitative and quantitative analysis, to determine the concentration of a particular substance in a sample. Applications of UV-Vis spectroscopy include quantitative analysis, qualitative analysis, chemical kinetics, biology and biochemistry, environmental analysis, and pharmaceuticals. [2]

1.6 APPLICATION OF MAGNESIUM OXIDE NANOPARTICLES

Magnesium oxide nanoparticles have potential application in various fields, including electronics, catalysis, ceramics and petrochemistry.

When combined with natural materials such as wood chips and shavings, they can be used to produce lightweight, thermally and acoustically insulating materials, fireproof fiberboards, and metal ceramics. Potential applications of magnesium nanoparticles include:

1. Electrical insulation materials such as crucibles, melting furnaces, insulating pipes, and electrode rods and sheets. Used in radio industry as high frequency magnetic bar antenna, magnetic equipment filler, insulator filler, various supports.
2. Electrical insulation materials such as crucibles, melting furnaces, insulating pipes, and electrode rods and sheets. Used in radio industry as high frequency magnetic bar antenna, magnetic equipment filler, insulator filler, various supports.
3. Fuel additives, cleaning agents, anti -anticolor, corrosion inhibitors.
4. It can protect substance from environmental damage by neutralizing free radicals.
5. Used to produce lightweight, heat insulating, and sound-proofing materials. [7]

1.7 OBJECTIVES

- To synthesis MgO NP’s using *Moringa oleifera* leaf extract and magnesium sulphate as a precursor.
- Characterization of synthesized nanoparticles using spectroscopic methods.
- Studying dye adsorption using synthesized nanoparticles.

Chapter 2

Materials and Methods

This chapter gives a brief description of the materials and experimental procedures adopted for the present investigation.

2.1 MATERIALS

2.1.1 Magnesium sulphate

Magnesium sulphate manufactured by Merck Specialities Private LTD. Mumbai.

2.1.2 Sodium hydroxide pellets

Sodium hydroxide pellets manufactured by Nice Chemicals Private LTD. Edappally, Kochi were used for the study.

2.2 EXPERIMENTAL METHODS

The collected fresh *Moringa oleifera* leaves were washed using tap water, and then they were allowed to air-dry for a few weeks, and finally ground into powder and stored at room temperature. A dried powdered sample of *Moringa oleifera* leaves 5g was weighed and mixed with 100 mL of distilled water. The mixture was then heated to 60°C for 30 min with stirring until all the samples were evenly mixed. After heating, the solution was allowed to cool and filtered and the filtrate was collected. The resulting filtrate was used for the synthesis of magnesium oxide nanoparticles.

2.2.1 Synthesis of Magnesium oxide nanoparticles

During the synthesis, 200 mL of 0.2 M $MgSO_4.7H_2O$ solution was mixed with the filtrate obtained from the M. oleifera leaf extract solution. The mixture was then heated to 100 °C for 30 min. The two solutions were combined uniformly,10 mL of 2M NaOH was added dropwise to the mixture to attain a pH of roughly 10, and the resulting mixture was then kept for one hours at 90 °C to make the precipitation of magnesium hydroxide. Centrifugation at 1000 rpm for 45 min at room temperature was used to separate the precipitate from the mixture. The precipitate was then washed four times with distilled water and filtered. To remove any residual water, the precipitate was dried in an oven. The precipitate was dried, grounded into a powder using a mortar and pestle, and then calcined at 600°C for 5 hours.

2.2.2 CHARACTERIZATION

2.2.2.1 UV Spectroscopy

The UV-visible spectrum of magnesium oxide has a broad absorption peak at 290 nm.

2.2.2.2 Infra-red spectroscopy (IR)

The IR spectrum of synthesized nanoparticles was recorded using Fourier Transform Infra-Red spectrometer, Thermo Nicolet iS50 3300 cm^{-1} to 3600 cm^{-1} with resolution 0.2 cm^{-1}.

2.2.2.3 X-ray diffraction

The X-ray pattern was recorded using Bruker D8 Advance 16 **.**

2.2.3 APPLICATION

2.2.3.1 Dye adsorption of Methylene blue

About 0.1g methylene blue was taken and made up to 100ml using distilled water.10 ml of this solution was pipetted out into a beaker. The pipetted solution was made up to 100ml using distilled water to make 10ppm Methylene Blue solution. To 10ml of the above solution, 0.01g of MgO was added. The solution was kept under the sunlight for two hours . The supernatant solution obtained was clear . The solution obtained after adding magnesium oxide nanoparticles as well as the colored solution of Methylene blue was given for UV-vis spectroscopy.

2.2.3.2 Purification of water

Magnesium oxide nanoparticles are used to purify water by removing pollutants like arsenic, heavy metals, and phosphates. Magnesium oxide is a cost effective and efficient adsorbent used in waste water treatment to filter out suspended solids and precipitate heavy metals. It's favourable electrostatic attraction and small ionic radius make it suitable for adsorption of arsenic, phosphorus and fluoride**.**

Chapter 3

Results and discussion

3.1 UV-VIS SPECTROSCOPY

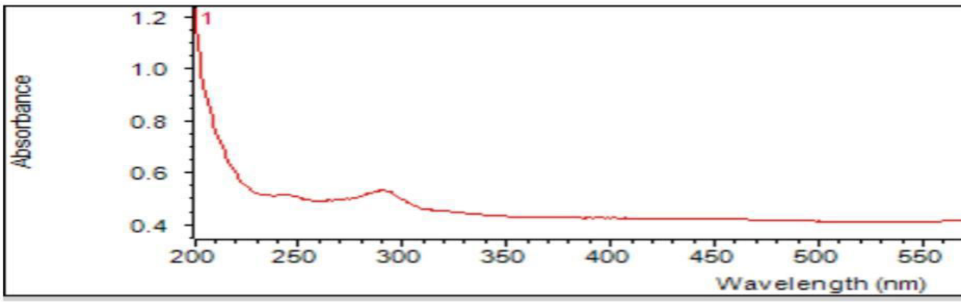

Fig 3.1 UV-vis spectrum of MgO nanoparticles

The UV-vis spectrum of Magnesium oxide has a broad adsorption peak at 290 nm

3.2 INFRA-RED SPECTROSCOPY

The characteristic peaks between 400 and 900 cm $^{-1}$
in the FTIR spectra (fig 3.2) confirms the formation of Magnesium Oxide nanoparticles.

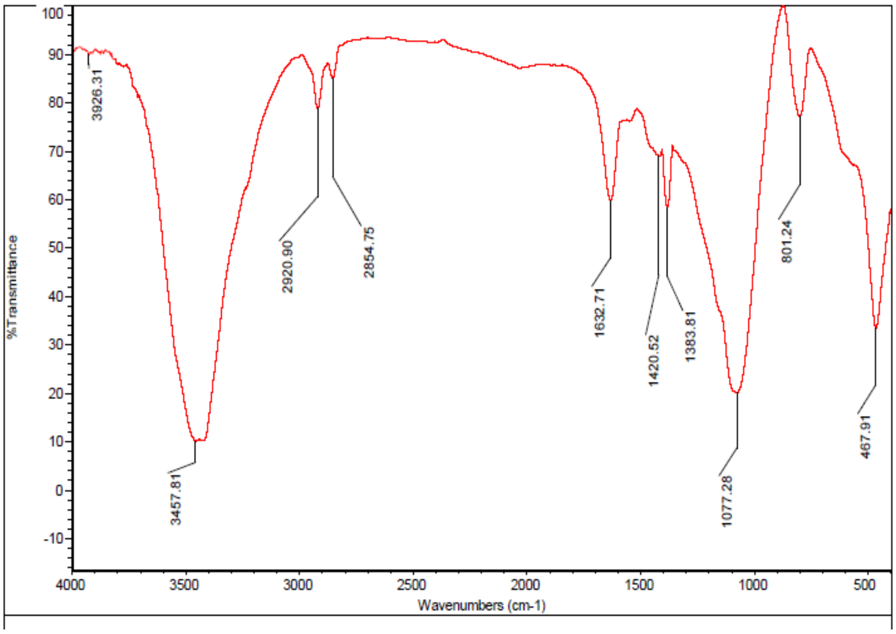

Fig 3.2 IR spectrum of MgO nanoparticles

3.3. XRD

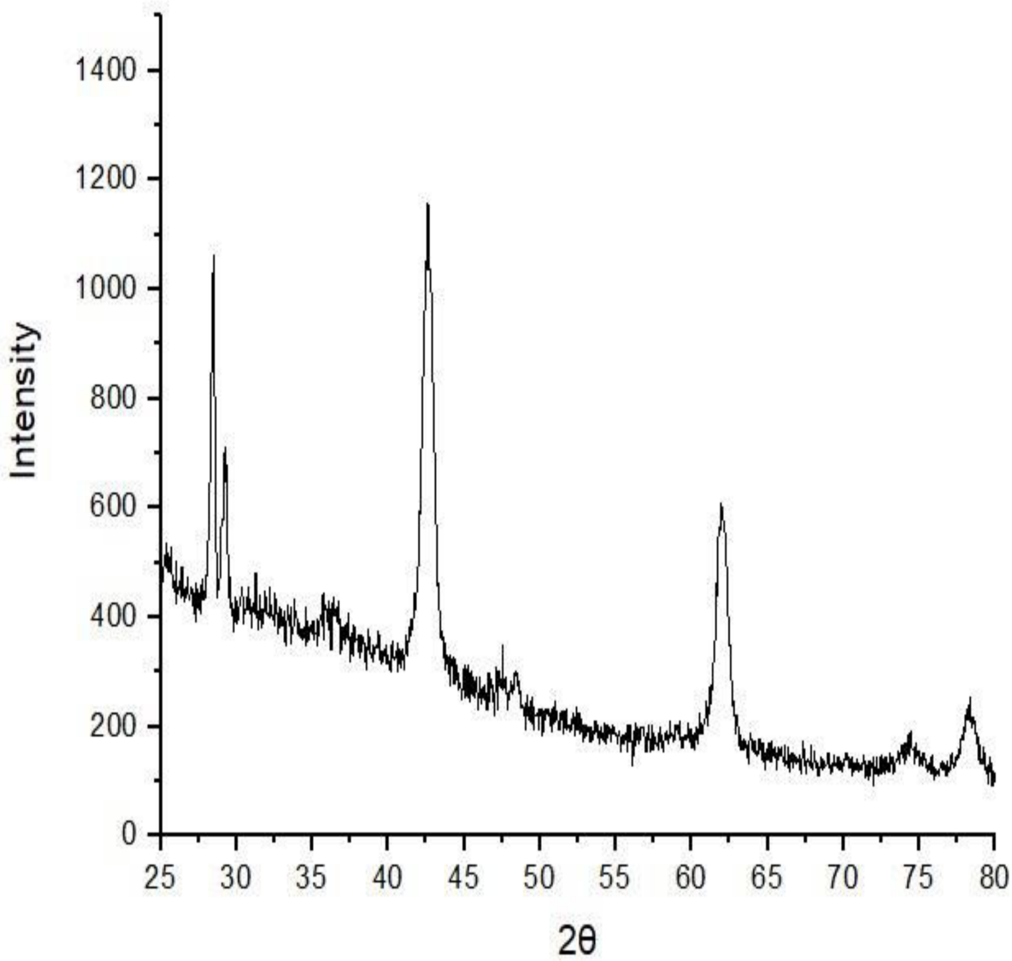

FIG 3.3 XRD pattern of MgO nanoparticles

XRD analysis is performed in the range of 20-80° (2θ) using Cuka radiation. XRD studies of the MgO nanoparticles is shown in Fig 3.3. It clearly exhibits the peaks at angles 18.57°,36.96° ,38.02°,42.98°, 62.36°, 74.71° and 78.66° corresponds to (111), (0 0 2), (2 0 2), (1 1 3), and

(2 2 2) planes (JCPDS No. 87-0653), which reveals the formation of polycrystalline cubic structure of MgO nanoparticles. No other impurity phase is found in the XRD pattern. XRD pattern shows high intense (002) orientation peak revealing the high crystallinity of the synthesized material. The mean crystallite size is calculated using (002) reflection and found to be 13.105 nm.

3.4 APPLICATION

3.4.1 ADSORPTION OF METHYLENE BLUE

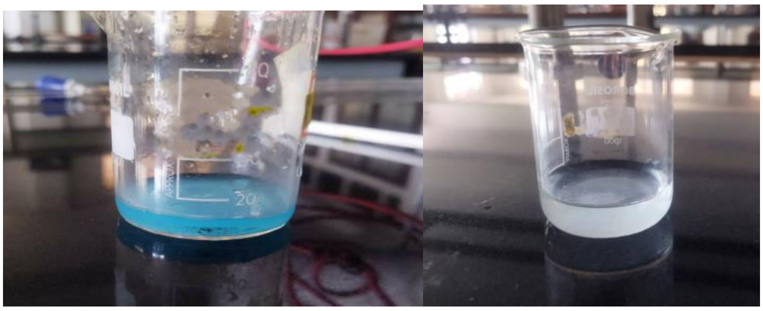

Fig 3.4 Methylene blue before and after adsorption

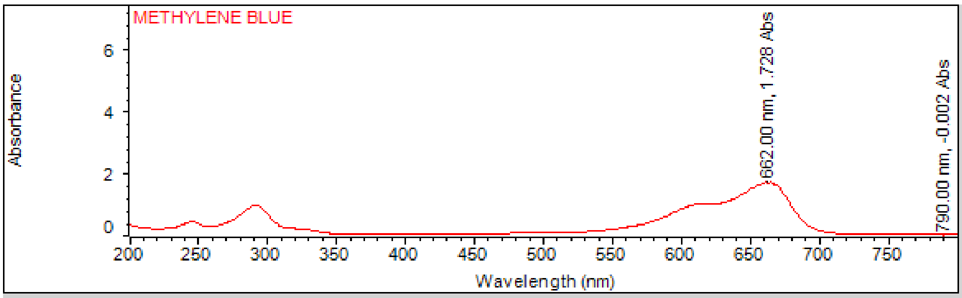

Fig 3.5 UV-vis spectrum of Methylene blue before adsorption

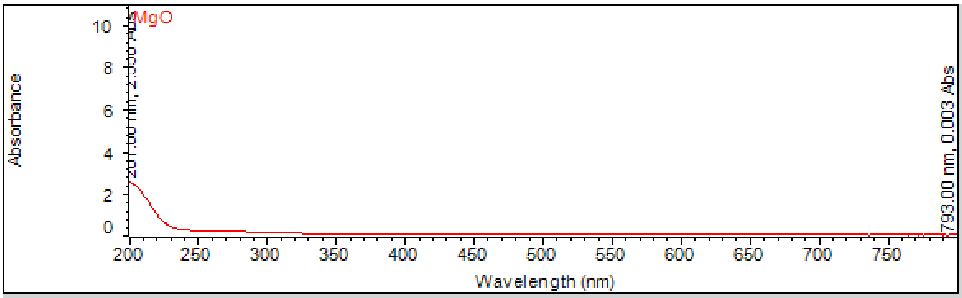

Fig 3.6 UV-vis spectrum of Methylene blue after adsorption

Fig 3.4 shows the photograph of the before and after adsorption of Methylene blue dye by MgO nanoparticles . Fig 3.5 (graph) and fig 3.6 (graph) shows the absorbance spectrum of Methylene blue solution before and after adsorption .The spectrum shows a decline in the absorbance value after adding MgONP's.The decline in the absorbance value of the dye shows the complete adsorption of the dye by MgO nanoparticles.

Chapter 4

Conclusions

This study provides a distinctive approach for the green synthesis of MgONP's by using leaf extract of *Moringa oleifera*. The Green synthesis method that takes advantage of using leaf extract from a medicinal plant is cost effective and eliminates the need for toxic chemical reducing agents. The prepared nanoparticles were characterized using, UV-vis Spectroscopy, Infrared Spectroscopy FTIR and XRD. FTIR and XRD results corroborates the formation of MgONP's. The results shows that the MgONP's synthesized from *Moringa oleifera* leaf extract has ability to adsorb non-biodegradable dyes such as Methylene blue. MgO nanoparticles are cost-effective and efficient adsorbents that purify water by removing arsenic, heavy metals, phosphates and fluoride through adsorption and precipitation.

1. Fatiqin, A., Amrulloh, H., & Simanjuntak, W. (2021b). Green synthesis of MgO nanoparticles using *Moringa oleifera* leaf aqueous extract for antibacterial activity. Bulletin of the Chemical Society of Ethiopia, 35(1), 161– 170.
2. Mohamed, E. A. (2020). Green synthesis of copper & copper oxide nanoparticles using the extract of seedless dates. Heliyon, 6(1), e03123. https://doi.org/10.1016/J.HELIYON.2019.E03123
3. Rotti, R.B.Sunitha, D.V. Manjunath, R.,Roy,A.Mayegowda, S. B.Gnanaprakash,A.P.,Alghamdi,S., Almehmadi, M.Abdulaziz, O.Allahyani, M.Aljuaid, A.Alsaiari, A.A.Ashgar, S.S. Babalghith, A. O. Abd El-Lateef, A. E. & Khidir, E. B. (2023). Green synthesis of MgO nanoparticles and its antibacterial properties. Frontiers in Chemistry, 11(March),1–13. https://doi.org/10.3389/fchem.2023.1143614
4. SCENIHR, undefined. (2006). What are the uses of nanoparticles in consumer products https://www.mendeley.com/catalogue/a9e84319-c44e-3f678ac91bd157f688fe/?utm_source=desktop&utm_medium=1.19.5&utm_campaign=open_catalog&userDocumentId=%7Bd9f0c7d4-f879-350b-b7e9f029fc1f7fae%7D
5. Vergheese, M., Vishal, Sk., & Mary Vergheese, C. (2018). Green synthesis of magnesium oxide nanoparticles using Trigonella

foenum-graecum leaf extract and its antibacterial activity. ~ 1193 ~ Journal of Pharmacognosy and Phytochemistry, 7(3), 1193–1200.

6. Kumar, P. P., Bhatlu, M. L. D., Sukanya, K., Karthikeyan, S., & Jayan, N. (2021). Synthesis of magnesium oxide nanoparticle by eco friendly method (green synthesis) – A review. Materials Today: Proceedings, 37(Part 2), 3028–3030. https://doi.org/10.1016/J.MATPR.2020.08.726
7. Abinaya, S., Kavitha, H. P., Prakash, M., & Muthukrishnaraj,A. (2021b). Green synthesis of magnesium oxide nanoparticles and its applications: A review. In Sustainable Chemistry and Pharmacy (Vol. 19). Elsevier B.V. https://doi.org/10.1016/j.scp.2020.100368
8. Cai, L., Chen, J., Liu, Z., Wang, H., Yang, H., & Ding, W. (2018). Magnesium oxide nanoparticles: Effective agricultural antibacterial agent against Ralstonia solanacearum. Frontiers in Microbiology, 9(APR), 335574. https://doi.org/10.3389/FMICB.2018.00790/BIBTEX