PROJECT REPORT

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DECLARATION

This is to certify that this dissertation entitled "Green synthesis and characterisation of ocimum Tenuiflorum Functionalized Silver nanoparticles" towards partial fulfilment of requirements for the award of Bachelor of Degree of Science in Physics is an authentic record of work carried out by Miss Fidha Fathima K H , Siya Tomy , Henin Mary Eldo, Mr. Jagan Antony puthussery .Reg. No: 210021034408 , 210021034413 , 210021034410 , 210021036654 under my supervision and guidance. Submitted for the practical exam held on .... At Bharata Mata College.

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ABSTRACT

Ocimum tenuiflorum is widely distributed medical herb expressed wide range of anti bacterial and microbial activities. Green synthesis of nanoparticles is an important method due to its non toxic effects to the normal human cells. The present study aims the preparation of Ocimum Tenuiflorum functionalized silver nanoparticles. The synthesised silver nanoparticles were characterisation by TEM (transmission electron microscopy) , XRD , FTIR ,DLS and UV Visible absorption spectroscopy. The crystallographic structure was confirmed using XRD and the size and shape of nanoparticle was confirmed using TEM .The hydrodynamic diameter of nanoparticle confirmed using DLS and encapsulation of Ocimum Tenuiflorum on AgNPs was confirmed using FTIR.The localised surface plasmon resonance of silver nanoparticle was measured using UV spectroscopy.

CONTENTS

CHAPTER - 1

NANOPARTICLES

1.1 Introduction

Particles with an interfacial layer around them and sizes between 1 and 100 nm are referred to as nanoparticles. All of its qualities are essentially impacted by this interfacial layer. The interfacial layer is generally composed of ions, organic, and inorganic molecules. Generally speaking, inorganic materials are referred to as nanoparticles. Although we think of nanoparticles as being a part of current science, they have a very extensive history dating back to the fourth century in Rome, when artists began using them in their creations.

Due to their ability to serve as a link between atomic and bulk materials, nanoparticles are of considerable scientific interest. In contrast to bulk materials, which have constant physical properties regardless of size, qualities that depend on size can be observed at nanoscales. As a result, a material's properties vary as it gets smaller from macro to nanoscale. Their material properties and practical applications in several domains such as industrial, medical, engineering remediation, and engineering level make them unique. In general, nanoparticles can be categorised as carbon-based, inorganic, or organic. Both biodegradable and non-toxic are organic nanoparticles. Among them are liposomes, dendrimers , and micelles, among others. Non-carbon-based inorganic nanoparticles consist of metal and metal oxide-based nanoparticles. All that makes up carbon nanoparticles is carbon. These comprise carbon nanotubes, graphene, fullerene, and so on.

There are several uses for nanoparticles in contemporary science and technology. The diagnosis of cancer or other complex disorders is a major one of them. Due to their great mobility and increased specific surface area, quantum effects nanoparticles are highly effective and require no replacements. Nanotechnology is used by the sunscreen and cosmetics sectors to create extremely stable products. High brightness and clarity huge display monitors were replaced by nanoparticles. Nanoparticles are employed because of their large surface area to facilitate effective catalytic activity.

The application of nanoparticles in medicine has significantly improved drug delivery. The introduction of nanotechnology has also made the building process quicker, more effective, and less expensive. Because nanotechnology is efficient and environmentally benign, it will play a major role in our daily lives and has already improved our quality of life by improving the functionality and performance of commonplace objects.

Silver nanoparticles, which have garnered significant interest in recent years owing to their appealing electrical and chemical characteristics and their potential utility in the advancement of novel technologies, are the subject of our discussion here.

1.2 Methods of synthesis

1.2.1 Gas condensation

Metals and alloys with nanocrystalline structures can be created using this method. This method uses thermal evaporation to evaporate a metallic or inorganic material in an environment with a pressure between 1 and 50 m bar. These techniques use plasma techniques and sputtering electron beam heating as their energy sources.

1.2.2 Vacuum deposition and vaporization

Vacuum is used to evaporate and deposit alloys or chemicals in the vacuum deposition process. The thermal process of vaporisation is used, and it operates in a vacuum of 10 to 0.1 Mpa and at pressures less than 0.1 Pa.

1.2.3 Chemical vaporisation and chemical vapour condensation

A well-known technique causes a solid to be deposited on top of a heated surface through a chemical interaction with the vapour. Activation energy is needed for this process to continue. There are several ways to provide this energy. Thermal CVD requires a temperature more than 900 degrees Celsius to initiate the process.

1.2.4 Mechanical Attrition

Coarser grained materials structurally break down to become the nanostructures produced by mechanical attrition. The procedure can be carried out in low energy tumble mills, centrifugal type mills, vibratory type mills, and high energy mills. Attrition Ball Mill is one type of high energy mill. planetary ball mill Ball Mill with Vibrating Technology Tumbling Mill with Low Energy Consumption High-Powered Ball Mill.

1.2.5 Chemical Precipitation

This technique uses the halted precipitation method to control the size. The fundamental strategy in this method is to synthesise and examine the nanomaterial in the same liquid medium to prevent any physical alterations or small crystallite aggregation.

1.2.6 Electrodeposition

Nanoparticles can also be created using electrodeposition. The films made with this technique are consistent and powerful. It is evident that significant advancements in nanostructured coatings using DVD and CVD have been made.

1.2.7 Sol Gel

Another extensively used technique is the Sol Gel Technique. As colloidal particles are much larger than normal molecules or nanoparticles, upon mixing with a liquid colloidal particles appear bulky. But nanoparticles when mixed with a liquid look clear. Their will be formation of colloidal suspension (sol) and gelatin to form a network in continuous liquid phase (gel). Tetramethoxysilane (TMOS), is one of the most widely used precursor for synthesizing these colloids. Sol-gel formation occurs in four stages. They are Hydrolysis, Condensation, Growth of particles, Agglomeration of particles.

The Sol Gel Method is another widely utilised approach. Colloidal particles seem bulky when mixed with a liquid because they are larger than regular molecules or nanoparticles. However, nanoparticles appear clear when combined with a liquid. In order to create a network in a continuous liquid phase, gelatin and colloidal suspension (sol) will form (gel). One of the most often used precursors for creating these colloids is tetramethoxysilane (TMOS). There are four steps in the production of sol-gel. They are Particle Agglomeration, Particle Growth, Condensation, and Hydrolysis.

1.3. Silver Nanoparticles – Properties and Applications

1.3.1 Silver nanoparticles and need for its synthesis

Silver nanoparticles are diminutive particles of silver ranging in size from 1 to 100 nm. Despite the frequent designation as "silver," some predominantly consist of silver oxide due to their elevated surface-to-bulk silver atom ratio. Various methods can be employed to fabricate nanoparticles contingent upon their intended application. Although spherical silver nanoparticles are commonly utilized, thin sheets, diamond, and octagonal forms are also prevalent. Ionization ensues upon interaction with a reducing substance, transitioning metallic silver ions into their active state, whereas previously they remained inert. Ionic silver represents an active form of silver, inducing substantial structural modifications in bacterial morphology by adhering to their cell walls.

Silver nanoparticles (AgNPs) induce denaturation of DNA and RNA, thereby accelerating cell death. Due to its bactericidal properties at low concentrations, silver is also referred to as oligodynamic, and consequently, it has primarily been utilized in medical products.

The anticipated rise in demand for silver is foreseen due to its emerging utilization across various industries, encompassing textiles, plastics, and medicine. It is increasingly employed in surgical and dental instruments, as well as in coated water filters, sanitizers, and detergents. Silver, as an elemental substance, possesses inherent non-toxic characteristics, particularly in terms of its thermal and electrical conductivity. Additionally, its application extends to soap and bandages. As these innovations proliferate within the global marketplace, the emission pattern of silver undergoes transformation, notably influenced by its integration into healthcare practices for addressing conditions such as mental illness, convulsions, drug addiction, and sexually transmitted diseases like gonorrhoea and syphilis. Various methodologies, including electrochemical synthesis, reduction, irradiation, and chryochemical synthesis, are available for the production of nanosilver. Nanosilver exhibits distinctive properties compared to conventional metals, such as permeability to changes in pH and dissolved ions, and can be tailored into desired configurations. Silver nanoparticles (AgNPs) prolong the contact time of nanosilver due to their ability to generate a greater surface area per unit mass.

Along with healthcare, food packaging, textiles, cosmetics, and other industries, consumer demand has sharply increased.

Silver nanoparticles are used in a wide range of scientific disciplines. Among them are fields like electronics, medical research, and the chemical industry.

Applications:

- In electronics, adding silver nanoparticles to a circuit's connecting area can improve its electrical conductivity.
- To improve conductivity, silver nanoparticles are added to the inks used to print circuit boards. In circuitry, they are also employed to connect electronic parts.

- To create colorimetric sensors, AgNPs are utilised. Silver nanoparticles are also utilised as a substrate in Raman spectroscopy in order to quantify the energy of chemical bonds.
- Silver nanoparticles are employed in the medical field to eradicate tumour cells. Tumour cells can be killed with silver nanoparticles by heating them up with a light source.
- Additionally, cardiac illness diagnosis involves the utilisation of AgNPs.
- The transporters in blood are silver nanoparticles. Its greater surface area than any other nanoparticle is a result of its nanosized . Drugs and genes can therefore be transported through the body by it.
- In many experimental devices, silver nano particles have important role. In Transition Electron Microscopy, it is used as probes.
- The immunosilver staining process makes use of high density electrons.
- In chemistry, titanium dioxide and silver nanoparticles are utilised as a photocatalyst.
- An oscillating light field that approaches a nanoparticle interacts with free electrons to cause an oscillation in electron charge that is in resonance with the visible light frequency. Plasmons are a type of quantized oscillation that is recognised. These resonance characteristics of In some circumstances, selective oxidation or reduction is accomplished using silver nanoparticles.

1.4. Green Synthesis

Combining advances in biology and nanoscience opens up a wide range of molecular and cellular research applications. A variety of techniques, such as mechanical, physical, chemical, and Ecological methods. Every conventional method—apart from the biological method—will yield nanoparticles, but they will be extremely expensive to produce and hazardous to the environment. In an effort to overcome these drawbacks of chemical and physical synthesis, biological approaches of nanoparticle creation have been investigated in recent years.

Biological synthesis, sometimes referred to as "green synthesis," creates nanoparticles using plant extracts as a substrate.

This alternate, effective, and affordable technique is becoming more and more popular in the field of the process of nanosynthesis. This method produces faster and more stable nanoparticles at a faster rate of synthesis. The following illustrates a basic instance of green synthesis.

Figure 1: Silver nanoparticle production from plant extracts

It is possible to create nanoparticles with a variety of shapes that, depending on their forms, have various properties. Green synthesis is the ideal method for producing nanoparticles on a big scale.

1.6. Silver Nanoparticles from plant extract

The most intriguing topic for researchers is the synthesis of nanoparticles, particularly silver nanoparticles. In this article, various natural methods for producing silver nanoparticles are covered. Techniques that combine chemistry and physical science, such as chemical reduction from more costly and environmentally dangerous include the hydrothermal method, silver gel, etc. However, it is more efficient and effective to think about natural methods for making silver nanoparticles. It uses less money and doesn't damage the environment. A variety of fungi, bacteria, and plant extracts are among the biological processes used to produce silver nanoparticles. Silver nanoparticles may be produced in vast quantities in a short amount of time thanks to green synthesis. Verdant the stages involved in synthesis are as follows.

Plant extract → metal solution from reduction or stabilization → Metal nanosolution → Separation of nanoparticles

This is accomplished by using a variety of plants. Below is a list of some plant extracts:

- Acalypha Indica (Indian Acalypha) leaf extract is used to quickly synthesise AgNPs. Cancer therapy makes use of these nanoparticles
- Lemongrass extract can be used to create triangle-shaped nanoparticles by the reduction technique.
- AgNP synthesis also makes use of Cymbopogon Citratus (Oil Grads) leaf extract.
- Zingiber officinale (ginger) extract can yield particles as small as 10 nm.

- Syzygium cumini (Java plum) fruit extract is utilised in the production of AuNP.
- Abelmoschus esculentus (okra) seed extract is frequently employed as an anti-fungal agent and for the synthesis of AuNP.
- Very stable AgNPs are synthesised using Pelargonium graveolens, often known as Sweet Scent Geranium. Moreover, it can generate nanoparticles of different sizes.

Plant extracts listed below can be used to create AgNPs with certain shapes.

- Spherical nanoparticles are made from extract from mango seeds.
- Gymnocladus can be utilised to make nanoparticles with hexagonal, pentagonal, or triangular shapes.
- It is possible to create cubic-shaped nanoparticles with Pogostemon benghalensis, also known as Bengal pogostemon.
- It is possible to generate spherical nanoparticles with a size range of 6.75nm to 57.97nm using coriander extract. Hibiscus cannabinus (kenaf), Eucommia ulmoides, Solanum nigrum (black nightshade), Sesbania

grandiflora (vegetable hummingbird), and other extracts can also form spherical-shaped nanoparticles.

- Olive extract can create nanoparticles with a hexagonal, spherical, or triangular form.

CHAPTER – 2

Experimental Techniques And Characterization Tools

2.1 Ocimum tenuiflorum

Figure 2 : Ocimum tenuflorum

Ocimum tenuiflorum, often known as holy basil or tulisi, is a perennial plant that is native to the Indian subcontinent and is widely grown as a crop across the tropical regions of Southeast Asia. It is a member of the Lamiaceae family. An antioxidant called tulasi aids in delaying the ageing process. Basil, also known as tulasi, lowers free radicals, balances antioxidant enzymes, and protects against oxidative damage. Phenolic acids, alkaloids, flavonoids, polyphenols, Terpenoids and sugars are some of the ingredients of Tulasi leaf extract. When basil is applied, the skin becomes smoother, less scaly and rough, wrinkles are avoided, and the moisture content of the skin is maintained. Ocimum tenuiflorum is a key ingredient in Siddha and Ayurvedic medicine traditions because of its purported ability to heal inflammatory illnesses.

2.1.1 Chemical composition

The plant Ocimum tenuiflorum has a variety of chemical compounds in distinct structural regions. Several primary chemical compounds have been identified and investigated, including:

Phenolic acid: One of the main factors causing plants to develop resistance is phenolic chemicals. Phenolic chemicals that are generally generated from seeds, roots, or residue decomposition have the ability to combat soil-borne diseases and insects that feed on roots.

Alkaloids: These substances help plants defend themselves from diseases and predators. By producing toxicity or a disagreeable taste, they can discourage herbivores. A important medical resource, some alkaloids also have pharmacological effects on people and animals. They may be analgesic, antibacterial, or psychotropic, for instance.

Flavonoids : These are secondary metabolites that have a variety of functions in plants. They frequently serve as antioxidants, assisting plants in fending off oxidative stress brought on by contaminants, UV rays, and infections. Moreover, flavonoids draw pollinators and aid in controlling the growth and development of plants. Furthermore, flavonoids can hinder microbiological growth and discourage feeding insects, which strengthens a plant's defence against infections and herbivores.

Polyphenol:The natural non-nutrient products of plants, sometimes referred to as plant secondary metabolites, are called polyphenols and are present in everyday foods such fruits, vegetables, and seeds. Widespread in the kingdom of plants, polyphenols are a vast family of chemicals generated by secondary metabolism. The majority of them are produced by the phenylpropanoid pathway from l-phenylalanine.

Terpenoids : They have biological and pharmacological qualities that are advantageous to humans in addition to being essential for plant survival. Plants have two distinct routes by which they can synthesis dimethylallyl diphosphate (DMAPP) and isopentenyl diphosphate (IPP).

Ocimum tenuiflorum, has small, rounded, black seeds. Usually, when the blooms have flowered and dried, they are plucked off the shrub. These seeds hold cultural and therapeutic significance in Hindu traditions, in addition to their potential for plant propagation. In addition to being widely utilised in herbal medicine, holy basil seeds are also widely used by gardeners to grow this highly esteemed plant.

Figure 3: Ocimum tenuflorum seeds

2.1.2 Health advantages

Ocimum tenuiflorum seeds, also provide a number of health advantages;

Antioxidants: Antioxidants included in holy basil seeds help shield cells from harm brought on by free radicals, lowering the risk of chronic illnesses and improving general health.

Digestive Health: Eating holy basil seeds can help ease bloating, lessen pain in the digestive tract, and improve digestion. They aid in the gastrointestinal tract's gastric emptying thanks to their carminative qualities.

Stress Relief: Holy basil seeds are regarded as adaptogens, which means they can support mental acuity and relaxation while assisting the body in adjusting to stress. Including them in your diet could help you feel less stressed and more in general.

Immune Support: The seeds' vital nutrients and chemicals boost the immune system, making it easier for the body to fend against diseases and infections.

Blood Sugar Regulation: Based on certain research, holy basil seeds may be able to assist control blood sugar levels, which could be advantageous for those who already have diabetes or are at risk of getting it.

Cardiovascular Health: By lowering inflammation and fostering good circulation, holy basil seeds may help lower cholesterol and enhance heart health

Skin and Hair Care: Packed with vitamins and minerals, the seeds nourish skin and hair, encouraging good skin tone and hair development.These health advantages and improved overall wellness can be obtained by using holy basil seeds in your diet, for example, by blending them into salads, smoothies, or desserts. Nonetheless, for best effects, they must be taken in moderation and as a component of a balanced diet.

2.2. Characterization Techniques

2.2.1 *X-ray Diffraction (XRD) Technique*

In order to learn more about the structure of crystalline materials, X-ray diffraction (XRD) uses the dual wave/particle duality of X-rays. The technique is mostly used for characterising and identifying substances according to their diffraction pattern.

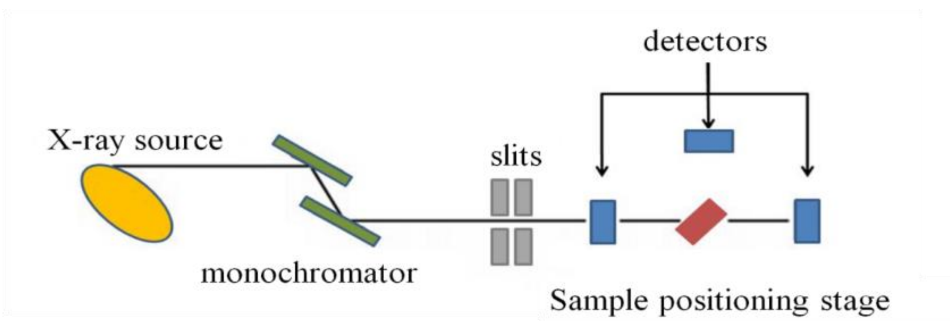


Figure 4: X- ray diffraction

A crystalline sample and constructive interference from monochromatic X-rays provide the basis for X-ray diffraction. A cathode ray tube produces these X-rays, which are then focused, collimated, and directed towards the sample after being filtered to produce monochromatic radiation. When Bragg's Law ($n\lambda=2d \sin \theta$) is met, the incident rays' interaction with the sample results in constructive interference and a diffracted beam. This rule connects the diffraction angle and lattice spacing in a crystalline sample to the electromagnetic radiation's wavelength . After that, these diffracted X-rays are found, handled, and tallied. The random orientation of the material should allow for the attainment of all conceivable diffraction directions of the lattice by scanning the sample across a range of 2θ angles.

Transforming the each mineral has a distinct set of d-spacings, which makes it possible to identify the mineral using diffraction peaks to d-spacings. Usually, d-spacings are compared to common reference patterns in order to do this every diffraction technique is predicated on the production of X-rays within an X-ray tube. The diffracted beams from these X-rays are collected after they are directed towards the sample. The angle between the incident and diffracted rays is a crucial factor in all cases of diffraction.

2.2.2 UV-Visible Spectroscopy

Ultraviolet-visible spectroscopy, sometimes known as UV–Vis or UV/Vis, is the study of absorption or reflectance spectroscopy in portions of the ultraviolet and the entire, neighbouring visible spectrum ranges. molecules that have bonding and in order to drive non-bonding electrons (n-electrons) to higher anti-bonding molecular orbitals, these electrons can absorb energy in the form of UV or visible light. Longer wavelengths of light can be absorbed by an absorber the more easily excited the electrons are (smaller energy gap between HOMO and LUMO). In essence, spectroscopy studies how light and matter interact. The outcome of matter absorbing light is a rise in the energy content of the atoms or molecules.

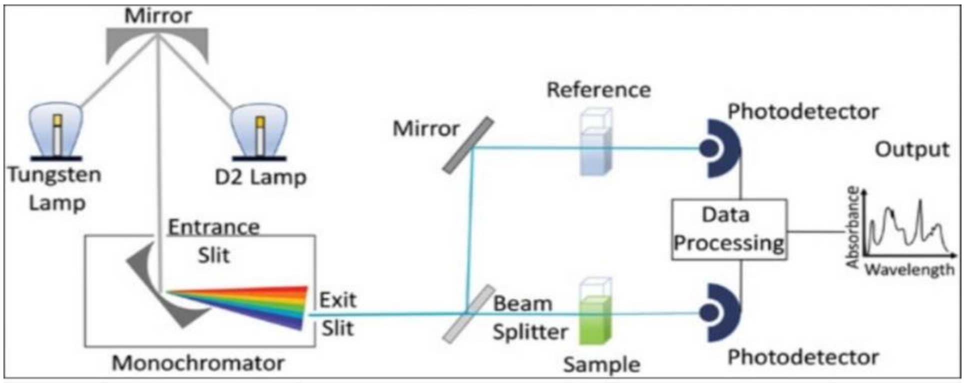


Figure 5 : U V visible spectroscopy

Distinct spectrum is produced when a chemical substance absorbs either visible or ultraviolet light. This UV spectrophotometer operates on the basis of Beer-Lambert Law. According to this law, the concentration of the solution and the incident radiation are actually proportional to the decreasing rate of radiation intensity and the thickness of the absorbing solution that occurs everytime a monochromatic light beam passes through it.

This equation can be used to express this law:

$A = \log (I0/I) = ECl$

A denotes absorbance, I0 denotes light intensity entering a sample cell, l denotes light intensity leaving the sample cell, C denotes solute concentration, L denotes sample cell length, and E denotes molar absorptivity.Based on the Beer-Lambert law, it has been determined that the amount of light absorbed increases with the number of molecules that can absorb light at a given wavelength

2.2.3 *Transmission Electron Microscopy (TEM)*

The shorter de Broglie wavelength of electrons allows transmission electron microscopes to image at a far higher resolution than light microscopes. This allows the device to record minute details, even those as little as a single a column of atoms that is hundreds of times smaller than an item that can be resolved with a light microscope. A very thin sample is exposed to a high intensity electron beam. By observing the interactions between the electrons and atoms, details like the crystal structure and structural elements like dislocations and grain boundaries can be seen. By using the condenser lens, the electron beam from the electron cannon is concentrated into a tiny, thin, coherent beam.

High angle electrons are prevented from entering this beam by the condenser aperture. Following the specimen's impact by the beam, portions of it are transmitted based on the thickness and electron transparency of the example. The objective lens focuses this transmitted part into an image on.

Phosphor screen or charge coupled device (CCD) imaging system. By excluding high-angle diffracted electrons, optional objective apertures can be used to improve contrast. After passing through the projector and intermediate lenses and down the column, the picture is fully enlarged the method.

When an image hits the phosphor screen, light is produced, enabling the viewer to view the image. Whereas the lighter portions of the image show sections of the sample that have more electron transmission through them, the darker portions of the image show areas of the sample that have less electron transmission. A transmission electron microscope (TEM) (JEOL JEM 2100 with LaB6 filament) was used to examine the material's size and shape.

2.2.4 Fourier-transform infrared spectroscopy

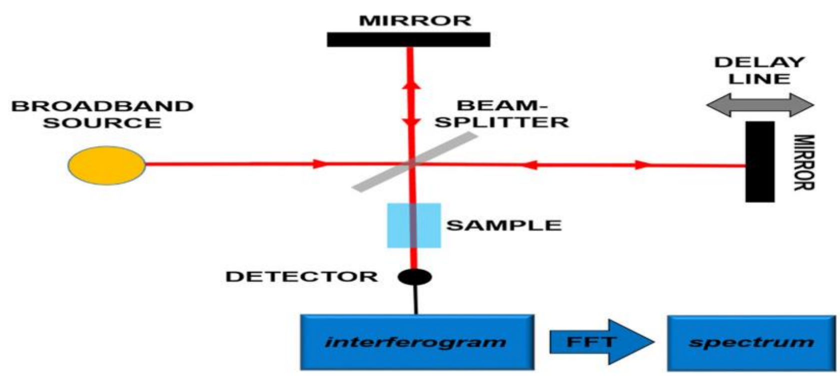


Figure 6: Fourier transform spectroscopy

A method for obtaining an infrared spectrum of a solid, liquid, or gas's absorption or emission is called Fourier-transform infrared spectroscopy, or FTIR. High-spectral-resolution data throughout a broad spectral range is concurrently collected by an FTIR spectrometer. Using this method, a beam of light with many frequencies is simultaneously shone, and the amount of the beam that is absorbed by the sample is measured. Subsequently, an alternative frequency combination is added to the beam, providing a second data point. This procedure is carried out repeatedly. A computer then uses all of this information to work backward and determine the absorption at each wavelength.

2.2.5 Dynamic Light Scattering

The average particle size of silver nanoparticles was investigated using dynamic light scattering (DLS), a technique that combines several scattering techniques with the laser diffraction approach. It sheds light on how soft materials behave dynamically by measuring single scattering events, which denotes that the sample has only ever scattered each observed photon once. A sample is exposed to a monochromatic light source—typically a laser—through a polarizer. Following a second polarizer, the dispersed light is collected by a photomultiplier and projected onto a screen to create the final image. We call this pattern a speckle pattern. The light is striking every molecule in the solution, and every molecule diffracts the light in every direction. All of the molecules' diffracted light can interfere either constructively (in the bright regions) or destructively (in the dark regions). This process is repeated at brief intervals, and

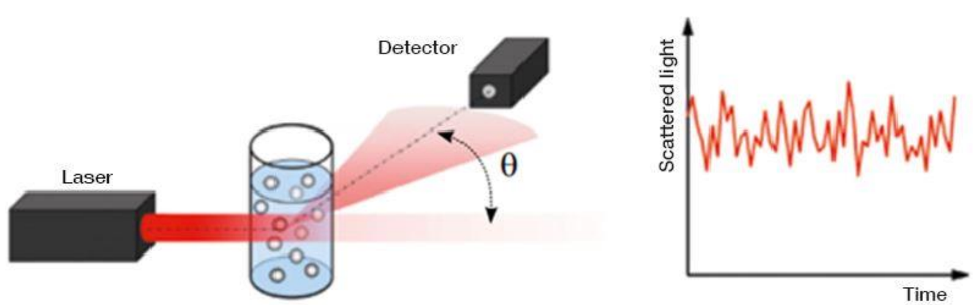


Figure 7: Dynamic Light Scattering

an autocorrelator that compares the light intensity at each point over time is used to analyse the resulting set of speckle patterns. The detector can theoretically be placed at any location to carry out the

DLS measurements perspective. The qualities of the sample determine the optimal angle to choose. In essence, DLS determines the particles' diffusion coefficient by measuring changes in the intensity of scattered light caused by diffusing particles. It is convenient to conduct stability investigations via means of DLS. A sample's periodic DLS measurements can reveal whether the particles aggregate over time by seeing if the particle's hydrodynamic radius grows. There will be a greater population of particles with a larger radius if the particles combine.

CHAPTER – 3

GREEN SYNTHESIS OF NANOPARTICLES

3.1 Instruments

Test tube , beaker, magnetic stirrer, Glass road , Hot plate heater, whatman filter paper , funnel ,petri dish, wash bottle, centrifuge tubes etc .

3.2 Chemical compounds

Silver nitrate (AgNO3) , Sodium hydroxide (NaOH), Ocimum tenuiflorum seed extract, Methanol (CH3OH), Distilled water etc .

3.3 Synthesis of nanoparticles

Ocimum tenuiflorum seeds are chosen for the synthesis of silver nanoparticles. These seeds were collected by handpicking, and the seeds were separated by sieving. Then 25g of the seed is soaked in 30 ml of methanol to prevent the growth of microorganisms and avoid contamination. Then refrigerated for two to three days. From this, 5 ml of extract is taken and made into 50 ml of solution by adding distilled water.

We have 169.87 g/mol of silver nitrate (AgNO3) in our possession. We calculated the volume of AgNO3 and distilled water using the molality calculator by taking the mass (0.24099 gm), molecular weight (169.87 g/mol), and concentration (100 millimolar). And we obtain the 50 millilitre volume.We also calculated the needed volume of AgNO3 in the stock solution using the molality calculator, with a 100 milli molar stock concentration, a 50 milli molar desired end volume, and a 1 millimolar goal concentration. We also obtain the necessary volume of 12.5 ml.

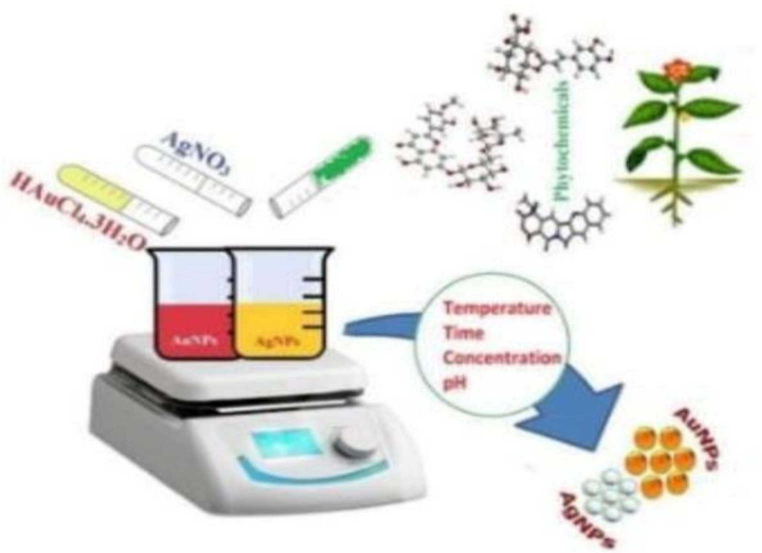


Figure 8: synthesis

12.5 ml of AgNO3 are taken in a beaker and diluted with 50 ml of distilled water using a pipette. A bead was put to the beaker and the beaker was placed in a digital spinot that was operating at 31 degrees Celsius and 500 rpm.We took two 0.3268g sodium hydroxide pills since we did not see any colour change with a mass of 0.3268 g, a molecular weight of 40 g/mol, and a concentration of 10 millimolar, we computed the volume using the mass and concentration calculator. The solution was then added to the beaker and heated to 70 degrees Celsius for 15 minutes in the spinot to cause capping. We detected the presence of silver nanoparticles in the plant extract by observing the necessary colour shift.

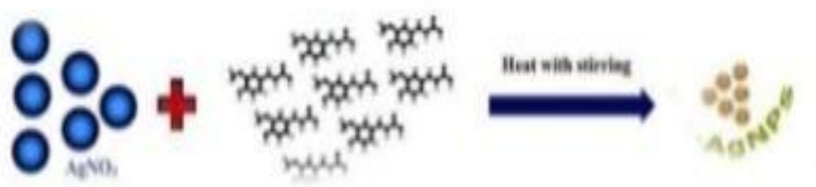


Figure 9: Ocimum tenuflorum seeds extract

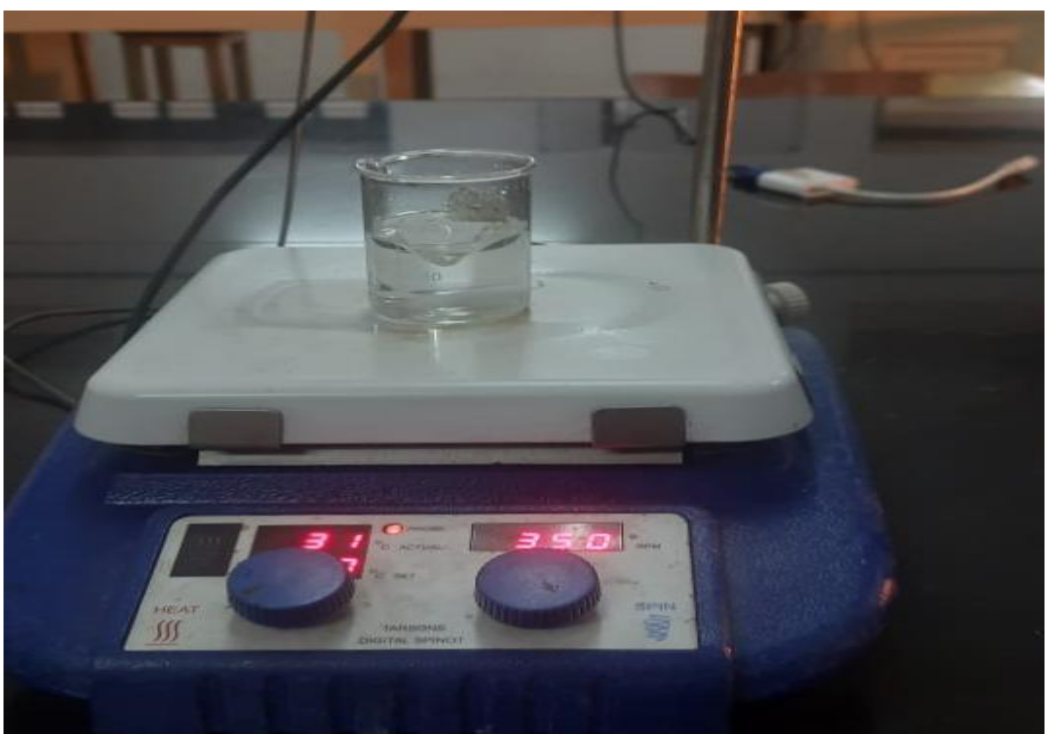


Figure 10: Heating with magnetic stirrer

Figure 11 : colour shift

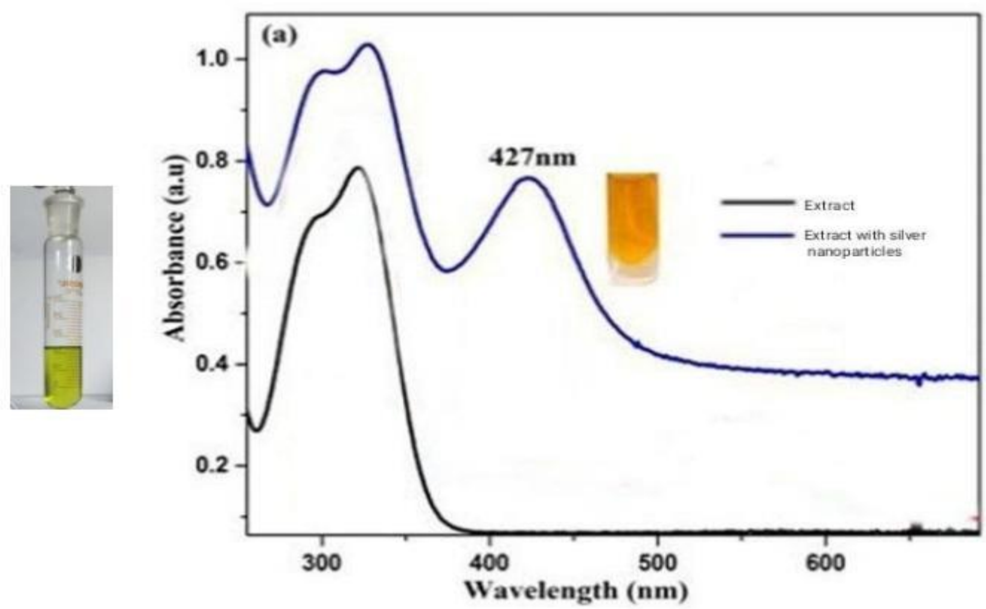
CHAPTER - 4

OBSERVATION AND RESULTS

4.1 Observation

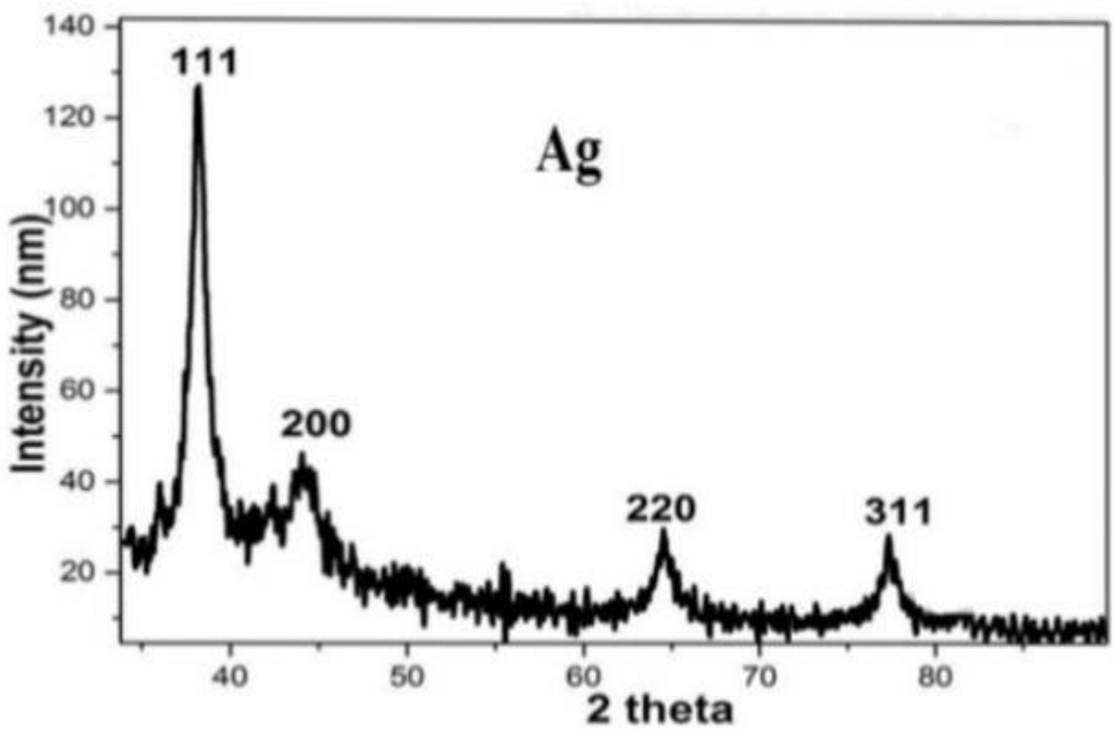
4.1.1 UV Visible spectroscopy

Localized surface plasmon resonance (LSPR)



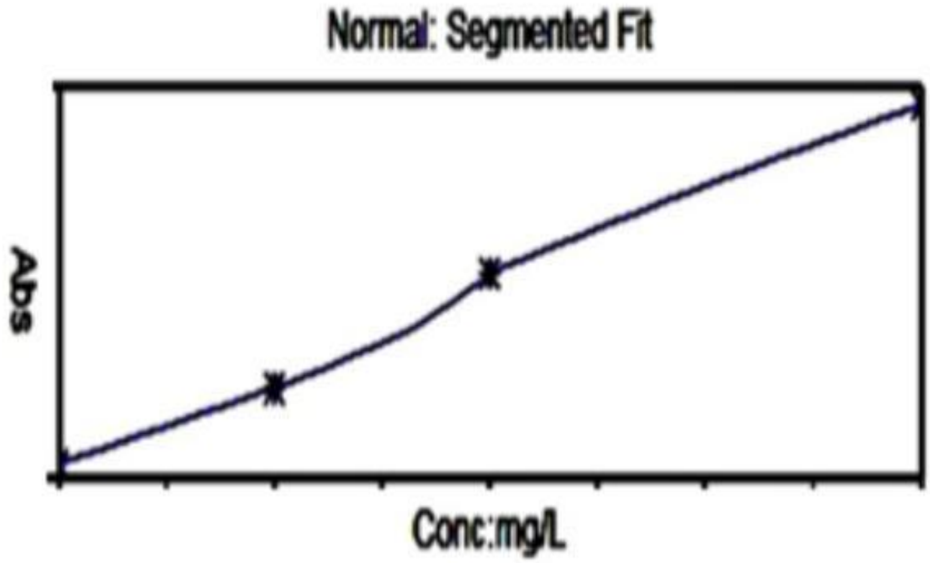
AgNPs' LSPR displays a prominent absorbance band in the 400–500 nm visible range. Silver nanoparticle production is shown by the AgNPs' expression of an LSPR at 427 nm.

4.1.2 X-ray Diffraction (XRD) Technique



AgNPs' crystalline character was investigated by XRD analysis, as seen in Fig. The face-centered cubic (fcc) structure of AgNPs, as indicated by the (111), (200), (220), and (311) planes, was indexed to the four main diffraction peaks (JCPDS No: 04- 0784).

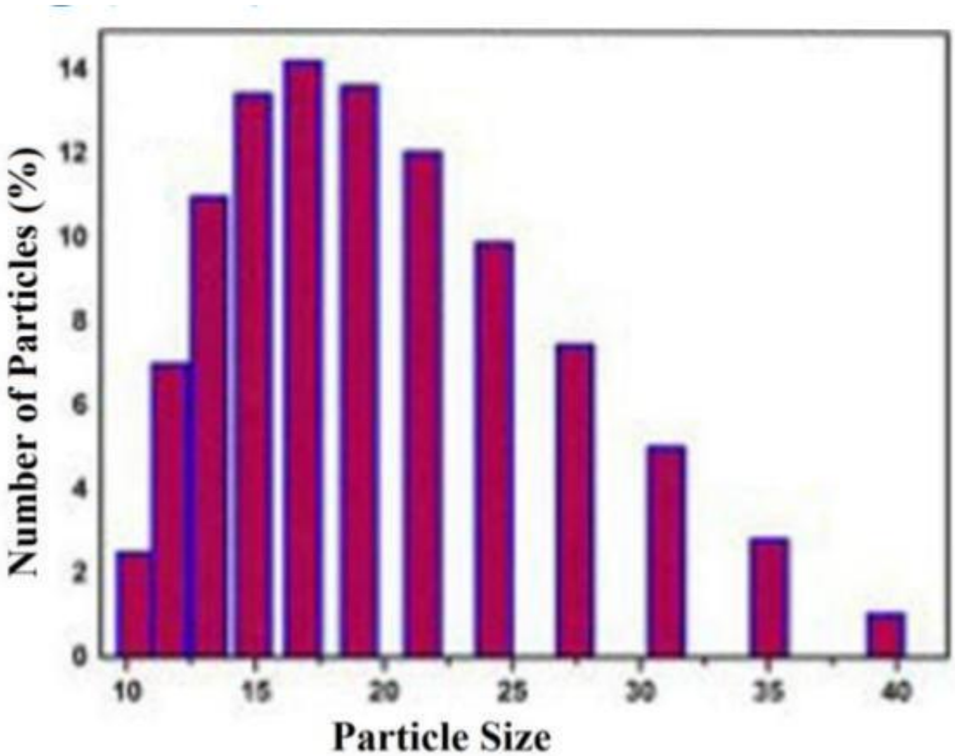
4.1.3 Atomic Absorption Spectroscopy



Molarity = mg/L / (molecular weight of solute) x 1,000.

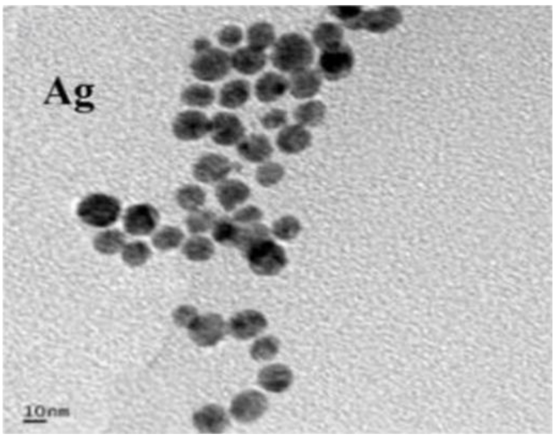
Molar concentration of OTM-AgNPs = ((19.19)/107.86)×1000 = 184.4μm

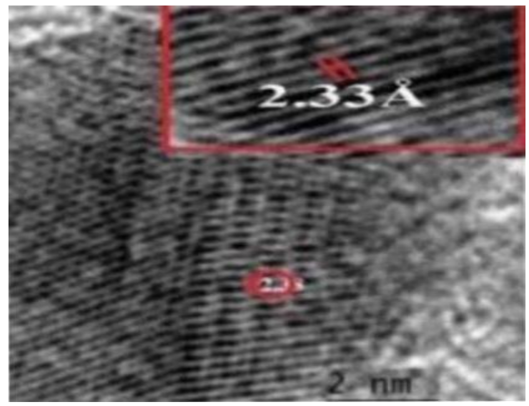
4.1.4 Dynamic Light Scattering (DLS)



The hydrodynamic diameter of the OTM-AgNPs in the solution were analysed using DLS as 20±2nm respectively. The hydrodynamic diameter measured parameters like the hydration layer of water moieties and molecular size of the particles including stabilizer.

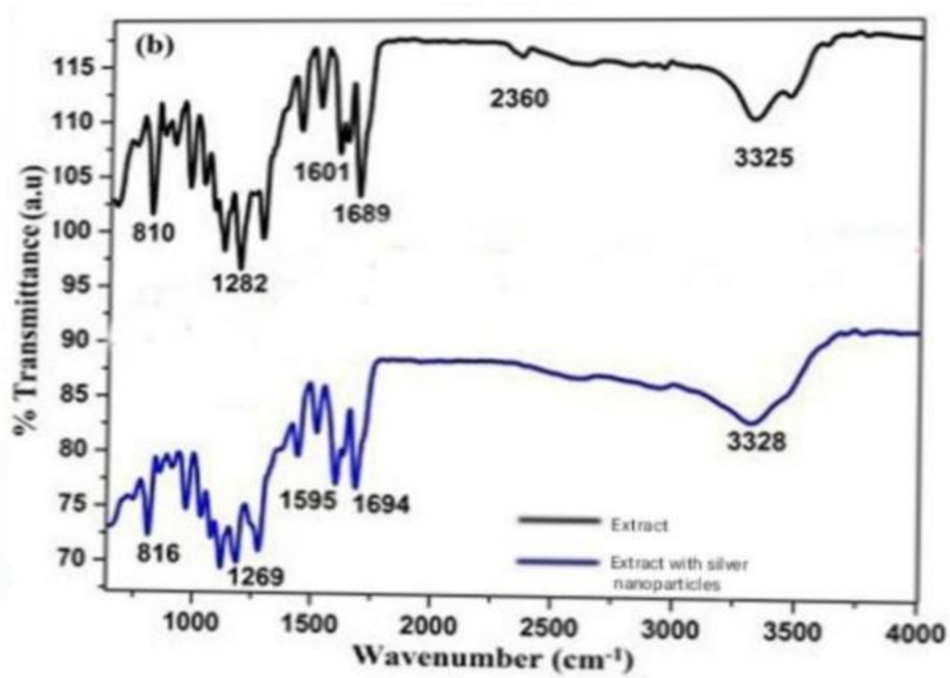
4.1.5 Transmission Electron Microscopy (TEM)





The TEM measurements revealed that OTM-AgNPs attained spherical morphology with an average particle size of 14±3nm. The bright circular rings observed in the SAED patterns of OTM-AgNPs corresponded to the (1 1 1), (2,0 0), (2 2 0) and (3 1 1)reflection planes.

4.1.6 Fourier-transform infrared spectroscopy (FTIR)



The FTIR spectra more precisely explain the capping mechanism of OTM during the formation of AgNPs. In the OTM spectrum, the peaks at 3325cm-1 and 1689cm-1 represented the characteristic -OH and C=O stretching vibrations. The bands at 1601cm-1,1282cm-1 and 810cm-1 were attributed to the in-ring C-C stretching vibrations of an aromatic ring, C-O stretching vibrations and C-H "oop" bending vibrations of OTM.

The FTIR of OTM-AgNPs expressed a characteristic shift and broadening of the peak from 3325cm-1 to 3328cm-1 corresponding to the –OH stretching vibrations. However, the shift from 1689cm-1 to 1694cm-1 analogous to the C=O band was attributed to the binding of Ag ions to the hydroxyl and carboxylate group of OTM.

4.2 Results

The synthesised silver nanoparticles were characterised by TEM (Transmission Electron Microscopy) ,XRD,FTIR,DLS and UV -Visible absorption spectroscopy .

CHAPTER - 5

CONCLUSION AND REFERENCE

5.1 Conclusion

The environmentally friendly production of silver nanoparticles from natural sources or safe chemicals is known as “green synthesis of silver nanoparticles.” This method offers various benefits over traditional synthesis techniques by reducing silver ions into nanoparticles using plant extracts, bacteria, or other biological entities.

The main advantage is sustainability. Green synthesis reduces the use of hazardous chemicals and energy-intensive procedures by utilising the stabilising and reducing capabilities of natural compounds, such as phytochemicals or biomolecules from microbes, hence mitigating its impact on the environment.

Green synthesis also enhances biocompatibility, which qualifies silver nanoparticles for a range of biomedical uses, including antibacterial agents, medication transport, and wound healing. The safety profile of the produced nanoparticles is improved and the danger of cytotoxicity is decreased by the use of natural chemicals.

Additionally, by choosing particular plant extracts or microbes, green synthesis enables the customisation of nanoparticle features, resulting in characteristics that are specifically fitted for intended applications. Because of their adaptability, silver nanoparticles can be investigated for a variety of possible applications in industries like environmental remediation, medicine, and catalysis.

In conclusion, the green synthesis of silver nanoparticles presents a biocompatible, adaptable, and sustainable method of producing nanomaterials, with possible uses in a range of fields and sectors. Additionally, we conclude in this study that , Capped silver nanoparticles successfully synthesized using simple one pot method. Characterization of synthesized Nanoparticles can measured through XRD, DLS,FTIR and LSPR . XRD unveiled the the crystalline nature of AgNPs and LSPR measurements confirmed the formation of silver nanoparticles. The FTIR spectra more precisely explain the capping mechanism of OTM during the formation of AgNPs. TEM and DLS unrevealed the spherical particle size and hydrodynamic diameter of the AgNPs.

5.2 Reference

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