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ECO-FRIENDLY SYNTHESIS OF SILVER NANOPARTICLES USING AZADIRACHTA INDICA (NEEM) LEAF EXTRACT AND EVALUATION OF THEIR ANTIMICROBIAL ACTIVITY

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ABSTRACT

Background: *More people want to learn about green synthesis methods and desire green nanomaterials. This is due of their connection. People know that silver nanoparticles, or AgNPs, destroy bacteria, but their current production uses environmentally harmful chemicals. This is true even though AgNPs are renowned for these properties. Azadirachta indica (Neem) is a safe, cost-effective, and ecologically friendly plant-mediated synthesis. This is because the plant possesses many phytochemicals.*

Methods: *The reducing and stabilising agent watery Neem leaf extract produced silver nanoparticles. This was done using chemicals. A colour shift was employed to visually identify nanoparticles, and UV–Visible spectroscopy confirmed their identification. Both approaches verified identification accuracy. Raman spectroscopy, dielectric analysis, XRD and EDS were utilised for additional characterisation. The agar well diffusion technique was utilised to test the synthesised AgNPs' antibacterial efficacy against several bacterial strains.*

Results: *A surface plasmon resonance peak in the UV–visible range proved nanoparticle production. Nanoparticle production enabled this discovery. Despite the EDS test showing a high silver content, the XRD study showed a crystalline structure. The investigation on antibacterial drugs found that Neem-mediated AgNPs inhibited microorganisms. This shows the nanoparticles' powerful antimicrobial effect.*

Conclusion: *According to the results of the study, the leaf extract of Azadirachta indica is an effective bio-resource that has the potential to be used for the synthesis of silver nanoparticles in a manner that is favourable to the environment. It has been shown that nanoparticles that have been synthesised possess strong antibacterial characteristics. As a result, these nanoparticles are attractive candidates for usage in the fields of medicine and pharmaceuticals.*

KEYWORDS: *Silver nanoparticles, Neem, Green synthesis, UV spectroscopy, XRD*, *Eco-friendly synthesis*

INTRODUCTION

Nanotechnology has transformed several sectors, creating new prospects. This area includes medicine, agriculture, environmental research, and materials engineering. Materials engineering is another example. Silver nanoparticles (AgNPs) are a popular nanomaterial. This is partly due to their exceptional physicochemical properties. Some of its features include its large surface area, unique optical behaviour, and high antibacterial activity. AgNPs, silver nanoparticles, are versatile and may be employed in many processes and applications. They're useful in various scenarios. This substance may be used to administer drugs, heal wounds, purify water, and apply antimicrobial coatings. Indeed, the production of silver nanoparticles often involves the use of hazardous chemicals, a lot of energy, and environmentally harmful byproducts. These nanoparticles are less sustainable and harder to use on a big scale due to their limitations (Singh et al.,2026).

Recent years have seen green synthesis technologies become a viable nanoparticle manufacturing technology. These alternatives may replace established methods. These techniques benefit the economy and environment and emphasise their environmental safety. The employment of environmental biomolecules as reducing and stabilising agents makes plant-mediated synthesis favourable. This is one of its benefits. its approach is useful because of its property. This category includes biomolecules including flavonoids, alkaloids, terpenoids, and phenolic chemicals. Here are a few examples. These phytochemicals also reduce silver ions to nanoparticles. These phytochemicals have additional benefits as well. Plant-based synthesis reduces the need for dangerous chemicals and difficult techniques (Nasir et al.,2026).

BACKGROUND

New options for the synthesis and use of nanomaterials that possess superior functional qualities have emerged as a result of the fast growth of nanotechnology, which has provided these chances. The creation of new opportunities has been brought about as a consequence of these nanomaterials. Silver nanoparticles, which are frequently referred to as AgNPs, have acquired significant prominence among these nanoparticles as a consequence of the amazing antibacterial, catalytic, and optical characteristics that they offer for themselves. Green synthesis techniques have been the subject of substantial investigation as potential alternatives that are less detrimental to the environment (Saravanan et al.,2025).

The aim of this research was to find a way around these limitations so that they might be efficiently avoided. It has just come to light that using plants to make nanoparticles is one of the most promising technologies ever identified. People have just recently learned about this knowledge. A large part of this might be because it is easy to use, cheap, and good for the environment. Plant extracts might help make a wide variety of different types of bioactive chemicals. These compounds may be found in many different things and mixtures, and they can take on many different shapes. These compounds may take on a lot of different shapes. There are many different kinds of things that may be found here, such as flavonoids, phenolics, terpenoids, and proteins. Terpenoids are another kind of component that may be discovered here. Flavonoids are one of the parts that make up this category. These chemicals have been acting as natural agents that decrease and stabilise the particles from the very beginning of the process of making nanoparticles for use in the process. They have been doing this job from the very start of the procedure. They achieve this by acting as natural agents. This not only lessens the need for chemicals that might be harmful to people's health, but it also gives a useful way to make nanoparticles that are stable (Aljazzar et al.,2026).

LITERATURE REVIEW

Environmentally friendly silver nanoparticles (AgNPs) creation via plant extracts is a priority due to the limitations of standard chemical and physical synthesis methods. This is because environmental concerns are growing. Traditional methods often emit harmful byproducts, use too much energy, and use poisonous reducing agents. All of this reduces their biomedical value. In contrast, plant-mediated synthesis is simple, inexpensive, and environmentally friendly. Natural phytochemicals reduce and stabilise. Flavonoids, terpenoids, phenolics, and proteins help convert silver ions into stable nanoparticles. These biomolecules may alter nanoparticle size and form after production (Alqahtani et al.,2022).

Azadirachta indica, or Neem, has been extensively studied for green silver nanoparticle production. The plant possesses several phytochemicals and is recognised for its health advantages. Neem leaves include flavonoids and terpenoids. Many studies have shown that neem-facilitated synthesis is fast, cheap, and can be done in natural surroundings without specialised equipment or harsh chemicals. Numerous studies have shown that neem extract can synthesise and characterise silver nanoparticles. These scientists employed electron microscopy, XRD, and UV-visible spectroscopy to validate nanoparticle formation. Surface plasmon resonance (SPR) peaks at 420–450 nanometres indicate nanoscale silver particle formation. Nanoscale silver particles are crystalline according to XRD patterns. SPR peaks indicate nanoscale silver particle production. Research has also shown that nanoparticle size, shape, and stability may be affected by extract concentration, solution pH, temperature, and reaction time. This focuses improving nanoparticle formation conditions (El Amrani et al.,2025).

Silver nanoparticles assisted by plants have been extensively studied for their antimicrobial capabilities. This paper adds to nanoparticle manufacturing studies. Neem-derived silver nanoparticles suppress Gram-positive and Gram-negative bacteria like *Escherichia coli, Staphylococcus aureus*, and other microorganisms that harm humans. This study found that these nanoparticles usually operate better against Gram-negative bacteria. The structural modifications in Gram-negative bacteria's cell walls may explain this efficacy. AgNPs may damage microbial cell membranes, create reactive oxygen species, and disrupt metabolism and DNA replication. This relates to their antibacterial properties (Zainurin et al.,2022).

SILVER NANOPARTICLES

Azadirachta indica (Neem) leaf extract was utilised to manufacture silver nanoparticles in a way that is favourable for the environment. After gathering fresh Neem leaves and thoroughly cleaning them to get rid of any dirt, the leaves were allowed to dry on their own. Basically, heated the dried leaves in distilled water to get an aqueous extract, then filtered to get rid of any solid bits. This plant extract was both a reducing agent and a stabilising agent throughout the synthesis process. It was full of bioactive chemicals such phenolics, terpenoids, and flavonoids. While being stirred constantly at room temperature, the neem leaf extract was slowly combined with a solution of silver nitrate (AgNO3) in water. It may be inferred that silver nanoparticles were produced due to the change in colour, as the fluid transitioned from a bright yellow to a dark brown colour. The fact that this was the case was a clear sign that something had changed in the response. The colour of the solution changed. The shift in hue is most likely caused by the activation of surface plasmon vibrations in the nanoparticles. This is the reason behind this, as this is simply one of the possibilities that are available. Ultraviolet-visible spectroscopy helped us gain evidence that silver nanoparticles were formed. To reach this aim, the plan was to find a peak in Surface Plasmon Resonance (SPR). The researchers used X-ray diffraction (XRD) to find out that the nanoparticles were made up of crystals and had a face-centered cubic structure. The researchers found this out. An energy dispersive x-ray spectroscopy (EDS) study found that silver was the most common of these metals. This was different from the other trace elements that were found. Because of this, it may be assumed that the plant extract has a wide range of trace elements. The findings of this assessment make it clear that the steps used to grow and keep the materials stable worked. Using Raman spectroscopy and studying the dielectric properties of the nanoparticles, Researcher were able to learn more about their electrical properties. The Raman spectroscopy technique effectively achieved this purpose. Raman spectroscopy showed that particular plant biomolecules need to be involved in the reduction and capping processes for them to work effectively (Saravanan et al.,2025).

CHARACTERISATION TECHNIQUES THE SYNTHESIZED NANOPARTICLES WERE CHARACTERIZED USING THE FOLLOWING TECHNIQUES

Several different kinds of analyses were conducted on the silver nanoparticles synthesized to prove the stability, shape, size, configuration, and structure of nanoparticles. One of the main methods for tracking down the conversion of silver ions into silver nanoparticles is ultraviolet-visible spectroscopy. In this case, a unique surface plasmon resonance (SPR) band appears within the wavelength range of 400 to 450 nm. For the identification of functional groups responsible for the reduction and stabilization (capping) of nanoparticles, a method of Fourier transform infrared spectroscopy (FTIR) was employed by researcher. In addition, X-ray diffraction analysis was performed to identify the phase of crystalline nanoparticles formed. (Rana et al.,2024).

The SEM and TEM methods were utilised to measure the size, morphology, and surface morphology of the nanoparticles. The data obtained helped us understand the dispersion, uniformity, and morphology of the nanoparticles, which were uniformly distributed and spherical in nature. This helped us know the level of uniformity of the nanoparticles. The Energy Dispersive X-Ray Analysis technique was done simultaneously with the SEM technique to ensure the purity and elemental composition of the silver nanoparticles. Using the surface charge and stability of the particles, the behavior of the nanoparticles in the medium can be predicted by the zeta potential value. (Kumari et al.,2025).

SEM ANAYSIS

A scanning electron microscopy (SEM) research investigated the surface morphology, shape, and dimensions of silver nanoparticles synthesised from *Azadirachta indica* (Neem) leaf extract. The SEM pictures mostly revealed nanoparticles that were round and the same size. But strong surface energy made some particles stick together. The environmentally friendly process generated silver nanoparticles with diameters in the nanometre range, which proved that they could be made. The photos showed a flat surface, which made it seem like the neem extract had bioactive molecules that could wrap around it and keep it stable. The SEM study demonstrated the biosynthesis, shape, and spread of silver nanoparticles as a whole (John et al.,2026).

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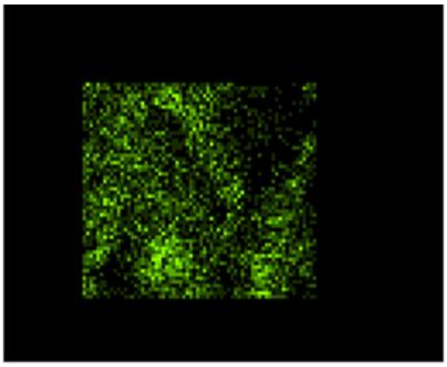


Figure 1: SEM images of silver nanoparticles using *Azadirachta indica* Extracts

TEM ANALYSIS

To gain detailed knowledge about the size, shape, and internal structures of the silver nanoparticles prepared using *Azadirachta indica* (Neem) leaf extract, Transmission Electron Microscopy TEM analysis was conducted. TEM images displayed the nanoparticles to be spherical in shape and well-distributed but with some aggregation. Size of the nanoparticles varied from 10 nm to 50 nm in diameter, thus showing successful nanofabrication. The well-defined borders of the particles indicated efficient stabilization due to the presence of the phytochemicals in the neem leaf extract. Also, high-resolution TEM images confirmed the nanoparticles' crystallinity, thus proving the development of silver nanoparticles using a sustainable green synthesis process (John et al.,2026).

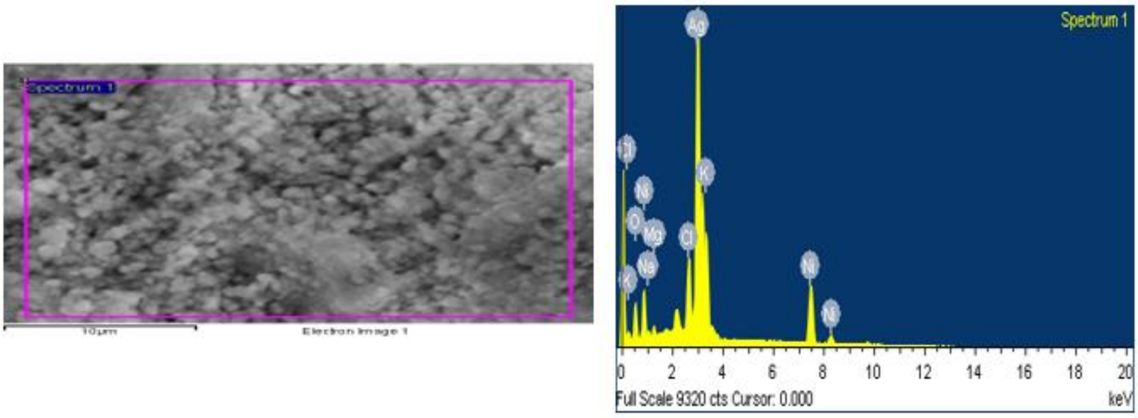


Figure 2: TEM images of silver nanoparticles using *Azadirachta indica* Extracts

STRUCTURE ANALYSIS USING XRD

Purity and crystalline structure of silver nanoparticles synthesised using Neem leaf extract were determined using XRD analysis. Distinct diffraction peaks corresponding to the planes (111), (200), (220), and (311) of fcc crystalline structure for silver metal appeared on the XRD spectra at the angles 38°, 44°, 64°, and 77°, respectively. The observation of specific peaks gave more assurance that the particles had been successfully synthesised with crystalline structure. It can be observed from the XRD spectra that there were no additional peaks, hence indicating that the particles were highly pure and exhibited good crystallinity. Furthermore, the use of Debye-Scherrer equation to determine crystallite size of nanoparticles proved that the particles were in nanometre dimensions. Therefore, it can be concluded that the XRD findings indicated that the synthesied silver nanoparticles had good crystalline structures (Singh et al.,2026).

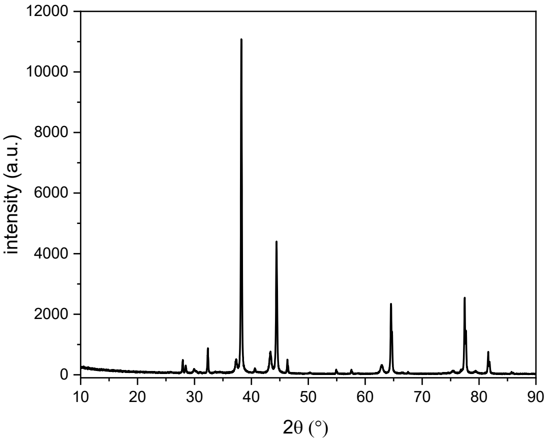


Figure 3: XRD analysis of silver nanoparticles using Azadirachta indica Extracts

UV–VISIBLE SPECTRAL ANALYSIS

The application of the leaf extract of *Azadirachta indica* (Neem) is one of the topics that underwent investigation aimed at identifying the formation of silver nanoparticles. The experiment was conducted using the technique known as ultraviolet-visible spectroscopy. The detection of the Surface Plasmon Resonance (SPR) peak in the 400 to 450 nanometre region confirmed that silver nanoparticles were made from silver ions. It was able to learn more about the nanoparticles' size and shape by looking at the peak heights and wavelengths (Nasir et al.,2026).

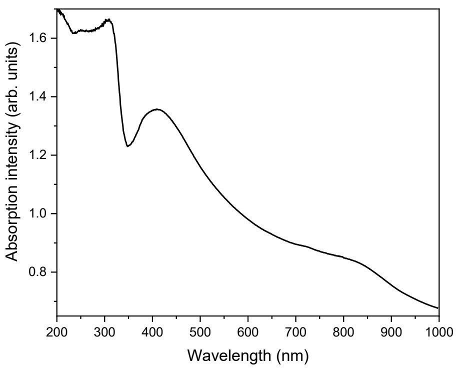


Figure 4: UV–visible spectral analysis of silver nanoparticles using *Azadirachta indica* Extracts

DIELECTRIC ANALYSIS

The researcher used dielectric analysis to investigate the electrical characteristics and polarisation behaviour of silver nanoparticles synthesised from *Azadirachta indica* (Neem) leaf extract. This investigation was successfully conducted by dielectric analysis. Also, the results showed that the dielectric constant went down as the frequency went up. The finding happened because the space charge polarisation is lower at higher frequencies. Based on this, one may think that the normal dielectric dispersion happens. This behaviour not only showed that nanoparticles might be employed in electrical and sensing devices, but it also showed that the form of the nanoparticles and how their charges were spread out affected how they acted (Ezeh et al.,2024).

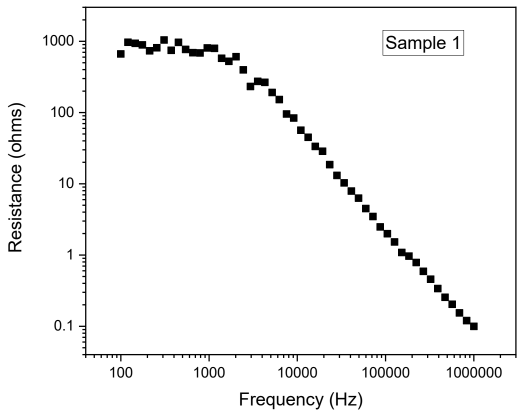


Figure 5: Dielectric analysis of silver nanoparticles using *Azadirachta indica* Extracts

RAMAN SPECTROSCOPY

Raman spectroscopy was utilised to look at the molecular interactions and vibrational properties of the silver nanoparticles that were made with the help of *Azadirachta indica* (Neem) leaf extract. This was done to meet the goal of the study. There were clear peaks in the Raman spectra that matched the functional groups of the biomolecules in the neem extract. The Raman spectra showed these peaks. These peaks showed what these biomolecules did to help the nanoparticles become smaller and stay stable. The study also concluded that silver nanoparticles and phytochemicals interact, hence facilitating the effective synthesis of ecologically favourable molecules (Mani et al.,2025).

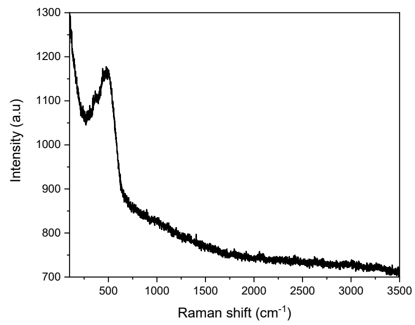


Figure 6: Raman spectroscopy of silver nanoparticles using *Azadirachta indica* Extracts

RESEARCH OBJECTIVES

- To synthesise silver nanoparticles using *Azadirachta indica* (Neem) leaf extract through an eco-friendly green synthesis method.
- To characterise the synthesised silver nanoparticles to confirm their formation, size, shape, and structural properties.
- To investigate the role of neem leaf extract phytochemicals in the reduction and stabilisation of silver nanoparticles.
- To evaluate the effect of the synthesised silver nanoparticles on antimicrobial activity against selected microorganisms.

SIGNIFICANCE OF THE STUDY

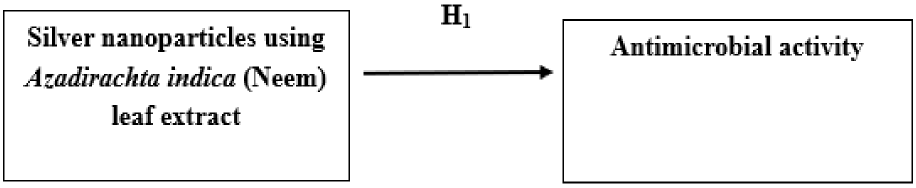
The main reason this discovery is important is because it adds to the quickly growing area of environmentally friendly nanotechnology. It gives a method for making silver nanoparticles that is good for the environment and can be used again. This method uses the leaf extract of *Azadirachta indica*, which is also called Neem. This method, unlike the usual chemical and physical methods, helps to reduce the environmental problems that are already there. It achieves this by getting rid of harmful compounds and using less energy. Based on this, the study's results support the ideas of green chemistry and call for safer ways to make nanoparticles. Both of these ideas are becoming increasingly important when it comes to protecting the environment and promoting sustainable development. This research is very important since it shows how to utilise neem, a therapeutic plant that is easy to get, in a way that works. Neem has a lot of bioactive chemicals that might work as natural agents to reduce and stabilise things.

RESEARCH QUESTIONS

- How can *Azadirachta indica* (Neem) leaf extract be used for the eco-friendly synthesis of silver nanoparticles?
- What are the physicochemical characteristics (size, shape, and structure) of the synthesised silver nanoparticles?
- Which phytochemical components in the neem leaf extract are responsible for the reduction and stabilisation of silver nanoparticles?
- What is the effect of the synthesised silver nanoparticles on antimicrobial activity against selected microorganisms?

METHODOLOGY

CONCEPTUAL FRAMEWORK



HYPOTHESIS

There is a close connection between the nanoparticles generated from *Azadirachta indica* (Neem) leaf extract and their ability to kill germs. The green nanoparticles were better at killing germs because they contained both silver ions and bioactive phytochemicals from neem extract in them. This was done by combining the two types of compounds. The membranes of microbial cells become more porous when these nanoparticles engage with them. They also interfere with critical biological processes including DNA replication and enzyme activity, which inhibits bacteria from developing. Nanoparticles can get into and battle a lot of harmful infections that affect plants and animals since they are so small and have a lot of surface area. The nanoparticles' characteristics make this ability even greater. This indicates that neem-mediated silver nanoparticles possess a significantly enhanced potential for antibacterial activity in comparison to the plant extract alone. This reveals that these nanoparticles can kill germs naturally (Barik et al.,2024).

On basis of the above discussion the researcher formulated the following hypothesis which will investigate the relationship between silver nanoparticles using *Azadirachta indica* (Neem) leaf extract and antimicrobial activity.

H_0: There is no significant relationship between silver nanoparticles using *Azadirachta indica* (Neem) leaf extract and antimicrobial activity.

H_1: There is no significant relationship between silver nanoparticles using *Azadirachta indica* (Neem) leaf extract and antimicrobial activity.

RESEARCH DESIGN

COLLECTION

The fresh leaves of *Azadirachta indica* (Neem) were sourced from a local farm. It fell on the shoulders of the Department of Pharmacognosy and Natural Medicine at the University to verify the identity of the plant. Extracts obtained from the leaves of the *Azadirachta indica* plant served as the chemicals for the experiment.

Figure 7: Fresh Azadirachta indica (Neem) leaf plant

EXTRACT PREPARATION OF AZADIRACHTA INDICA

As soon as the fresh leaves of *Azadirachta indica* (Neem) were collected, they were cleaned with distilled water to get rid of any dust or other impurities that could have been there. After washing, the leaves were let to air-dry at room temperature to get rid of any moisture that may have been on the surface. After the leaves were dry, they were either broken into tiny bits or chopped into smaller pieces with care. To get the bioactive chemicals out of the plant material, it was necessary to boil a given amount of it in distilled water for a certain amount of time (usually between ten and twenty minutes). This was done to get the chemicals out. It was then filtered using Whatman filter paper once it had cooled down to achieve a clear leaf extract. This was done to get the effect that was wanted. Researcher collected the filtrate and kept it at four degrees Celsius so that it would be available to use later to make silver nanoparticles (Rana et al.,2023).

Figure 8: Extract Preparation of *Azadirachta indica*

PHYTOCHEMICAL ANALYSIS OF PLANT EXTRACT

As soon as the new leaves of *Azadirachta indica* (Neem) were picked, they were washed with distilled water to get rid of any dirt or other contaminants that could have been present. After washing, the leaves were let to dry in the open air at room temperature to get rid of any moisture that could have been on the surface. After the leaves had dried, they were either broken up into little pieces or carefully cut into smaller pieces. To obtain the bioactive compounds out of the plant material and boil a particular quantity of it in distilled water for a certain period of time, generally between ten and twenty minutes. This was done to remove the chemicals. After it had cooled down, it was filtered using Whatman filter paper to get a clear leaf extract. This was done to acquire the desired effect. Researcher gathered the filtrate and stored it at four degrees Celsius so that might utilise it later to manufacture silver nanoparticles (Aljazzar et al.,2026).

A Soxhlet device is used to continuously extract bioactive compounds from dried *Azadirachta indica* (Neem) leaves so that a phytochemical study may be done on the plant extract. This is done to achieve the goal of the research. This is done to make sure that everything runs as smoothly as possible. The extraction process is done using the right solvent, such ethanol or methanol, all the time. The plant matter is deposited in the Soxhlet chamber, and then the solvent goes through a number of cycles that involve heating, evaporating, and condensing. This process goes on until all of the plant stuff is gone. This is done to make sure that the extraction procedure is done in the best way possible given the situation. After that, the material that was obtained from the environment is tested for quality. This shows that it has phytochemicals such flavonoids, alkaloids, phenols, tannins, saponins, and terpenoids. Flavonoids are also in this group. Before any of these tests can be done, the extraction process must be done correctly. Phytochemicals are what make silver nanoparticles and keep them stable. They also help them become smaller (Gbadamosi et al.,2026).

Figure 9: Soxhlet Apparatus

TESTS FOR FLAVONOIDS

A methanolic extract was selected as the researchers believed that methanol would effectively extract a wide variety of phytochemicals like flavonoids, phenols, and alkaloids from *Azadirachta indica* leaves. Such compounds significantly participate in the synthesis and stabilisation of silver nanoparticles and contribute to their antimicrobial activities. Hence, methanol was chosen for extracting bioactive compounds. Through conventional qualitative techniques, flavonoids present in the leaf extract of *Azadirachta indica*, often referred to as Neem, were easily identified. By subjecting the extract to Shinoda's test through the addition of magnesium turnings and concentrated hydrochloric acid to it, the extract turned into a pink or scarlet colour. This observation indicated the presence of flavonoids within the extract, proving our hypothesis. For further identification of the bioactive compound, an alkaline reagent test was performed on the extract through the addition of sodium hydroxide solution. The colour of the extract turned brilliantly yellow. On the other hand, the dilution of acid resulted in colour loss of the extract (Barik et al.,2024).

Table 1: "Data showing the extractive value of whole plant of *Azadirachta indica*" Extract

Solvent	Weight of Plant Powder (g)	Weight of Extract Obtained (g)	Extractive Value (%)
Methanol	50 g	6.8 g	13.6%
Ethanol	50 g	5.2 g	10.4%
Aqueous (Water)	50 g	3.1 g	6.2%
Chloroform	50 g	1.4 g	2.8%

ANTIMICROBIAL ACTIVITY

Agar well diffusion method was one of the important methods for assessing whether or not the *Azadirachta indica* (Neem) leaf extract possesses the ability to eliminate different types of bacteria and fungi. The use of this method was important in evaluating the level at which the extract was able to inhibit the diseases. Since there were clear zones of inhibition surrounding the wells, it was evident that the extract possessed great inhibitory abilities. These zones were present throughout the entire course of the experiment. Some of the bioactive compounds possessing strong antibacterial abilities include flavonoids, terpenoids, and phenolics among others. It is probable that these distinct types of molecules are linked to this action. This might happen. The neem extract was shown to be effective against several pathogenic bacteria and had the potential to serve as a natural antibacterial agent (Gbadamosi et al.,2026).

The antibacterial properties of Muller Hilton Agar plates were tested using the Agar Well Diffusion Method. To get the Muller Hilton Agar plates ready, dissolve 6.46 grammes of MHA in 100 millilitres of distilled water in a conical flask set over a hot plate. The conical flask should be covered with aluminium foil and cotton-plugged before being subjected to an autoclave for fifteen minutes at 121 degrees Celsius. Autoclaved Petri dishes were used to transfer the medium once it had cooled to room temperature, which was between 30 and 40 degrees Celsius, in volumes of 20 millilitres each plate. At the end of the twenty-four-hour incubation period, the Petri plates were left at room temperature. As soon as the incubation was over, any infected plates were thrown out, and the rest were put in the fridge until they were needed again. The solution was prepared by dissolving 1.12 grammes of Nutrient Broth in 40 millilitres of distilled water in a conical flask by boiling it on a hot plate. After that, we autoclaved the 5 mL test tubes for 15 minutes at 121 °C after transferring the solution to them. The nutrient soup was sterilised and put in the fridge before further investigation. An inoculating loop from the initial culture plate was used to look at the bacteria *(Staphylococcus aureus, Escherichia coli, Salmonella typhi, and Klebsiella pneumonia*) in a sterile way. Then, the bacteria were moved to a test tube with 5 millilitres of Nutrient Broth. After looking at the microbes, this was done. The next step was to place the inoculums in an incubator at 37 degrees Celsius for one day. To find out whether plant extracts might kill bacteria, the Zones of Inhibition (ZOI) on petri plates were looked at and measured. Using this scale, it was possible to get an idea of the diameter of the inhibitory zone. Pharmacognosy and alternative medicine personnel were in charge of making sure that the microbiological testing were done appropriately.

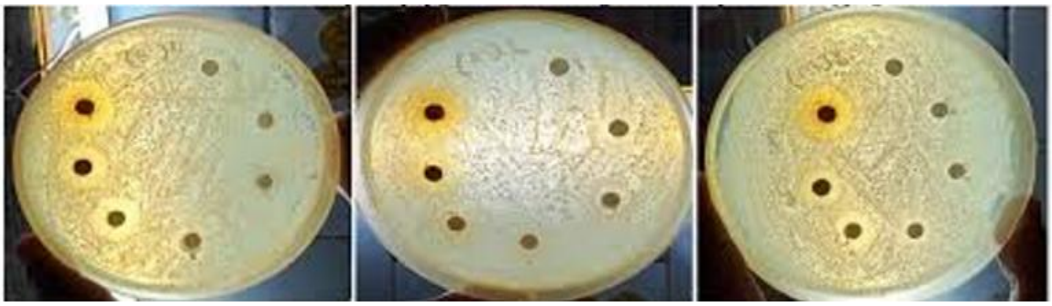


Figure 10: "Antimicrobial activity of Azadirachta indica methanolic s extract"

RESULTS

PHYTOCHEMICAL SCREENING

A phytochemical study found that the leaf extract of *Azadirachta indica*, often known as Neem, has a variety of important bioactive chemicals. Flavonoids, alkaloids, phenols, tannins, saponins, and terpenoids are all examples of compounds that fall under this group. These phytochemicals not only help the extract fight germs, but they also help reduce and stabilise silver nanoparticles.

Table 2: "Preliminary phytochemical analysis of different extract of Azadirachta indica"

S.N.	Phytochemicals	Methanolic extract
1.	Reducing Sugar	- -
2.	Polyphenols	++
3.	Alkaloids	++
4.	Glycosides	++
5.	Quinones	- -
6.	Flavonoids	++
7.	Saponins	- -
8.	Cumarins	++
9.	Terpenoids	++

Note: "++"presence, "- -" absence

As part of an antimicrobial susceptibility test, a 6-millimeter-diameter-well was created using the agar well diffusion technique. To accomplish the negative inhibition, 50% DMSO was used. Click here to see Table, which displays the length of the inhibitory zone for the methanolic extract.

Table 3: "Antibacterial analysis showing Diameter of Zone of inhibition (nm)"

	Neomycin*	Sample (methanolic extract)
E. coli	16	-
S. aureus	22.5	19
K. pneumoniae	15	20
S. typhi	12	-

Please take note that "-" denotes the absence of an inhibitory zone, "*" indicates a positive control, and the concentration is 50 µg/mL in every well. The data above demonstrate that the extract can stop both S. aureus and K. pneumonia. There are no indicators of inhibition in either *S. typhi* or *E. coli*. In the field of biomedicine, the methanolic extract of *Azadirachta indica* shows a lot of promise since it can kill germs. The agar well diffusion method was employed in a previous study to find out whether the plant extracts being studied have antibacterial characteristics. It was found, nonetheless, that it had a wide range of effects on many different types of bacteria that were resistant to more than one treatment (MDR). This study examined the activity of the seed extracts by looking at the zones of inhibition. The findings indicated that the seed extracts exhibited lower activity compared to the leaf extracts. According to the findings presented above, the extract may possess antibacterial characteristics that are effective against *S. aureus* and *K. pneumoniae* infection. Both *Salmonella typhi* and *E. coli* do not exhibit any signs of inhibition. The antibacterial activities of the methanolic extract of *Azadirachta indica* have caught the attention of the biomedical community, which is particularly interested in the extract. In a previous study, the antibacterial activity of plant extracts was evaluated using the agar well diffusion method.

DISCUSSION

This study's results show without a doubt that silver nanoparticles can be made in a way that doesn't hurt the environment. The results of this investigation were documented in a report and delivered to the audience. The utilisation of the leaf extract from the *Azadirachta indica* plant made these findings possible. The nanoparticles that were made showed characteristics that were both desirable and sought for. They showed these capabilities via their optical, structural, and electrical properties. These traits were shown by the nanoparticles. People wanted the nanoparticles in question because they possessed traits that were considered as good. There was a lot of silver on the surface of the crystalline and stable AgNPs that were made throughout the characterisation procedure. Also, it was revealed that these AgNPs had a lot of silver on their surface. The findings also showed that the AgNPs were stable, which was another interesting fact. The inclusion of biomolecules derived from plants significantly facilitated the reduction and stabilisation processes of the drug. The existence of organic molecules was the direct cause of this contribution becoming possible. During the examination, it was discovered that these biomolecules exist in the surrounding environment. Many different kinds of businesses might benefit from using silver nanoparticles that are mediated by neem. Some examples of industries that come under this group include biomedicine, catalysis, and electronics. The fact that this technology is good for the environment brings all of these subjects to light.

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