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Antimicrobial Activity of Silver Nanoparticles by Green Synthesis from *Ficus benghalensis* and *Ficus religiosa*

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ABSTRACT:
Biologically synthesized silver nanoparticles (SNPs) are being widely used in the field of medicine. Extracellular biosynthesis of silver nanoparticles was carried out by using medicinal plant extracts for the reduction of aqueous silver ions in a short period. The silver nanoparticles were synthesized from *Ficus benghalensis* leaf extract and leaf extract of *Ficus religiosa*. The silver nanoparticle formation was confirmed by the colour change of plant extracts (SNPs) and further confirmed with the help of UV-Vis spectroscopy. These silver nanoparticles were tested for antibacterial and antifungal activities using the disc diffusion method. The antimicrobial property of silver nanoparticles was analyzed by measuring the zone of inhibition. The highest inhibition was observed against *S. aureus* with a diameter of 12 mm for the silver nanoparticles synthesized from *Ficus benghalensis* leaf extracts. The lowest inhibition was observed for *S. cerevisiae, E. faecium,* and *K. pneumonia*, with a diameter of 5 mm for the silver nanoparticles synthesized using *Ficus benghalensis* and both the mixture of *Ficus religiosa* and *Ficus benghalensis* leaf extract respectively. The result indicates that the silver nanoparticles may have important advantages over conventional antibiotics.

Keywords:
Silver nanoparticles, *Ficus religiosa, Ficus benghalensis,* Antibacterial

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Introduction:

The synthesis of metal nanoparticles is a vast and rapidly growing field because of their potential applications in electronics, chemistry, energy, and the creation of new medical treatments. The size, shape, and distribution of nanoparticles can reveal new or enhanced capabilities.[1-2] Researchers are employing green synthesise different metal nanoparticles in order to meet the increasing need for environmentally safe nanoparticles.

Ficus religiosa, commonly known as the sacred fig or peepal tree, and holds significant scientific importance due to its various properties and uses. Here are some key scientific aspects of *Ficus religiosa*, it has been used extensively in traditional medicine in Ayurveda. Different parts of the plant, including leaf, bark, and roots, possess medicinal properties. They are known to exhibit anti-inflammatory, analgesic, antimicrobial, antidiabetic, antioxidant, and immunomodulatory effects.[3-4] The plant extracts have been investigated for their potential in treating various ailments and diseases. *Ficus religiosa* is rich in bioactive compounds, including flavonoids, tannins, alkaloids, phenols, and glycosides. These phytochemicals contribute to the plant's medicinal properties and provide antioxidant and anti-inflammatory effects. Studies have focused on identifying and characterizing these compounds, which may have applications in drug development and health promotion. *Ficus religiosa* extracts have demonstrated antimicrobial activity against a wide range of bacteria, fungi, and viruses. This antimicrobial effect is attributed to the presence of bioactive compounds that inhibit the growth of microorganisms. This property is of significant interest in the development of natural antimicrobial agents and potential alternatives to conventional antibiotics.

Ficus benghalensis, commonly known as the banyan tree, has several scientific importance and notable features. Here are some key scientific aspects of *Ficus benghalensis*: Medicinal Properties: *Ficus benghalensis* has been used in traditional medicine systems for its various medicinal properties. *Ficus benghalensis* is rich in phytochemicals such as flavonoids, tannins, phenolics, alkaloids, and glycosides. [3-4] These bioactive compounds contribute to the plant's medicinal properties and provide antioxidant and anti-inflammatory effects. Research focuses on identifying and characterizing these compounds, which may have applications in drug development and health-related industries. The aim of this study, synthesized silver nanoparticles with the help of *Ficus religiosa* and *Ficus benghalensis* leaf extract and investigated the antibacterial activity of nanoparticles against pathogenic bacteria and fungi.

Materials and methods:

Fresh leaf of two different plants that were, *Fiscus religiosa* and *Fiscus benghalenisis*, free from all disease were collected and then washed thoroughly 2-3 times with tap water and then distilled water. 20 grams of both the plants' leaf were chopped finely and add it to 100ml of distilled water and continuously stirred at 60° to 80° on the hot plate for 1 hr. After boiling the mixture let it cool down then filtered it with the help of Whattsman filter paper 1 and filter was collected.

Synthesis of silver nanoparticles: After filtration of leaf extract pour the filter into the burette to use it as a reducing and capping agent. Then take 1M silver nitrate in 100ml of distilled water and put it on hot plate and set the temperature to 60°-70°C then add leaf extract drop-wise very slowly until the colour changes to light yellow to brown colour form. It shows Ag to AgNps. The mixture was then left to stand at room temperature for an entire night in a dark environment. Following the incubation period, the green hue turned brown, indicating that Ag0 had been formed by the reduction of Ag+ ions.

Analysis using UV-Visible Spectroscopy

Using a UV-Vis spectrophotometer (Systronics double beam spectrophotometer), the optical absorption of green synthesised silver nanoparticles was measured at room temperature in the wavelength range of 200–800 nm.

Antibacterial and antifungal activity of AgNPs: Antibacterial activities of the synthesized AgNPs were determined using the agar disc diffusion assay method against *Escherichia coli, Staphylococcus aureus, Enterobacter faecium, Klebsiella pneumoniae* and antifungal activity were tested against *Aspergillus niger, Candid albicans, Candida krusei,* and *Saccharomyces cerevisiae.*

Fig 1 Biosynthesis of silver nanoparticles from leaf extract

Results and Discussion:

Synthesis of AgNPs using *F. religiosa* and *Ficus benghalensis* leaf extract

Even before civilization emerged, humans made considerable use of plants for various purposes. These plant items were eaten in the past even if people were unaware of their medical benefits. This human action opened the door for the use of herbal items made from plants as traditional remedies, which continue to have their own merits.[5] Plant-based products have become increasingly popular in nanobiotechnology in recent years.[6-8] *Ficus religiosa* and *Ficus benghalensis* has long been associated with mythology, religion, and medicine in Indian culture. This plant demonstrates a wide range of biological activities in almost every portion, including anti-inflammatory, anti-asthmatic, anti-ulcer, anticonvulsant, anti-amnesic, antibacterial, anti-anxiety, and anti-diabetic effects.[3-4]

Therefore, an attempt is made here to synthesise *F. religiosa* and *Ficus benghalensis* in order to create AgNPs and use them as a potent antibacterial and antifungal treatment alternative.

Naturally occurring *F. religiosa* and *Ficus benghalensis* leaf have been shown to extend life expectancy and exhibit promising antioxidant and anticancer activities and includes a variety of bioactive substances with a wide range of biological activities, including antitumor, antibacterial, antioxidant, and anticancer properties.[3] In the present studies by observing the shift in the solution's colour, the production of AgNPs in the filtrate was examined. AgNP production was indicated by the reaction vessels taking on a brownish-orange colour. Under the same testing settings, neither the filtrates nor the silver nitrate showed any signs of brownish-orange colour. It takes 15 minutes for the coloure to change from colourless to brownish orange when the extract is present during incubation fig 1. The present study reports an environmentally friendly and rapid method for synthesis of silver nanoparticles was applied. Although several articles have been reported for the synthesis of silver nanoparticles from plant extract, here we have performed a green synthetic method for silver nanoparticles using *Ficus benghalensis* and *F. religiosa* leaf extract

UV-Visible spectral analysis

The change in colour (brownish orange) that results from the excitation of the metal nanoparticles' surface plasmon resonance made it easy to identify the creation of nanoparticles. At 450 nm, the silver colloid's UV Visible spectral peak appeared for leaf extract concentrations of both plant. The UV/Vis spectrum of the silver nanoparticles synthesized from mixture of *Ficus religiosa* and *Ficus benghalensis* leaf extract were found at 450 nm fig 2. These spectrums of both plant leaf extract were confirmed to the synthesis of AgNPs. Ramesh et al., [9] has been discovered that 10 millilitres of Ag+ ion extract is the ideal concentration for the synthesis of AgNPs. Ahmad et al., [10] observed at 432-436 nm, the silver colloid's SPR bands appeared for varying fruit extract concentrations. Jain and Mehata [11], investigated the absorption spectra measured at regular intervals for the development of silver nanoparticles. The absorption spectra of artificially generated AgNPs for the reaction of silver salt by Tulsi extract at various time intervals were studied in the range of 250–600 nm. Similarly, using quercetin as a reducing agent was used during the synthesis of AgNPs and the absorption spectra in the 250–700 nm region that were obtained at various time intervals.

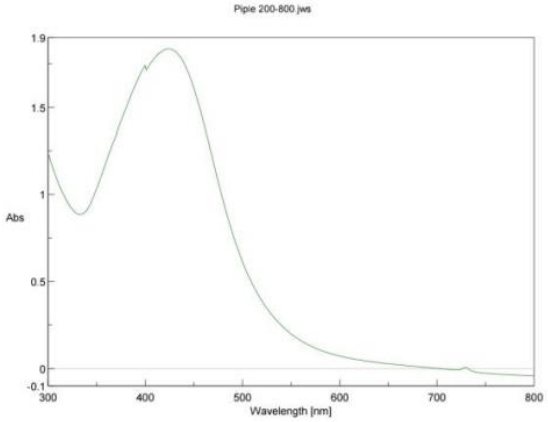
Anti-Bacterial Activity

When it comes to both gram-positive and gram-negative bacteria, including types that are resistant to multiple drugs, silver nanoparticles appear to have potent antibacterial action. Figure 4-5 illustrates the antibacterial activity of the biosynthesised AgNPs against several human diseases in the current investigation. It appears that the AgNPs exhibited an inhibitory zone in relation to nearly every test organism. When compared to the leaf extract, the synthesised AgNPs were found to have a stronger inhibitory activity. Furthermore, when compared to gram-positive bacteria *S. aureus*, AgNPs demonstrate an efficient zone of inhibition against gram-negative bacteria *K. pneumonia* but not against *E. coli Ficus benghalensis* leaf extract was very effective against *S. aureus.*

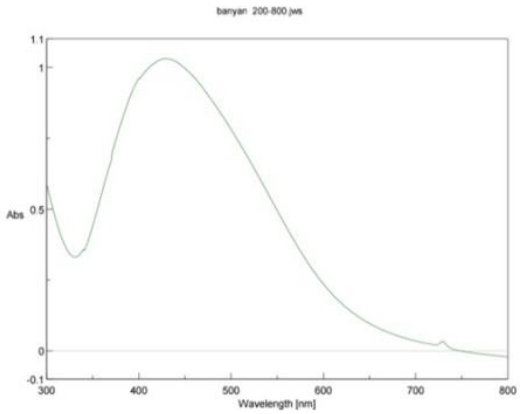
AgNPs have the capability to adhere to the surface of cell membranes, disrupting permeability and respiration processes, which could be the cause of silver's antibacterial activity. Compared to bigger AgNPs, smaller AgNPs would have a greater antibacterial impact due to their increased surface area accessible for interaction. AgNPs may potentially be able to enter bacteria and interact with their internal structures in addition to their membrane surface.[12]

Antifungal activity

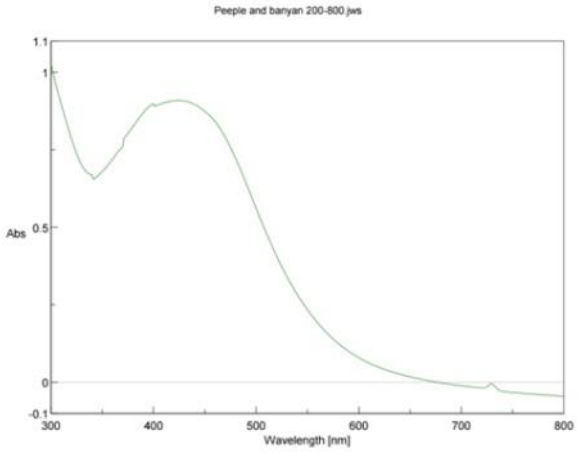
When it comes to fungi, silver nanoparticles appear to have potent antifungal action. Figure 4-5 illustrates the antifungal activity of the biosynthesised AgNPs against several human diseases in the current investigation. It appears that the AgNPs exhibited an inhibitory zone in relation to nearly every test organism except *Candida krusei*. When compared to the leaf extract, the synthesised AgNPs were found to have a stronger inhibitory activity. *Ficus benghalensis* leaf extract was very effective against *Saccharomyces cerevisiae* while *Ficus religiosa* were effective against *A. niger.*



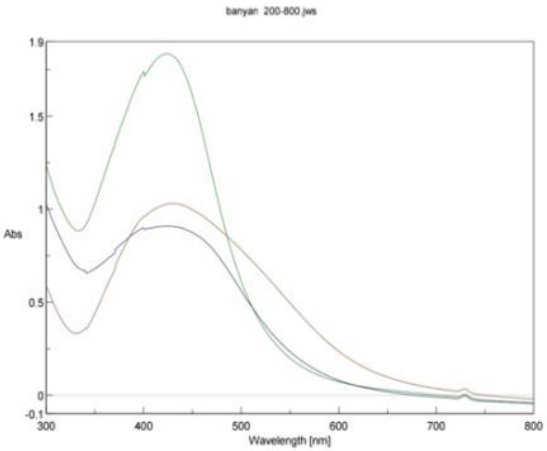
The UV/Vis spectrum of the silver nanoparticles synthesized from *Ficus religiosa* leaf extract



The UV/Vis spectrum of the silver nanoparticles synthesized from Ficus benghalensis leaf extract



The UV/Vis spectrum of the silver nanoparticles synthesized from mixture of *Ficus religiosa* and Ficus benghalensis leaf extract



The UV/Vis spectrum of the silver nanoparticles synthesized from *Ficus religiosa*, *Ficus benghalensis*, and both leaf extract

Fig 2. The UV/Vis spectrum of the silver nanoparticles synthesized from *Ficus religiosa, Ficus benghalensis* leaf extract

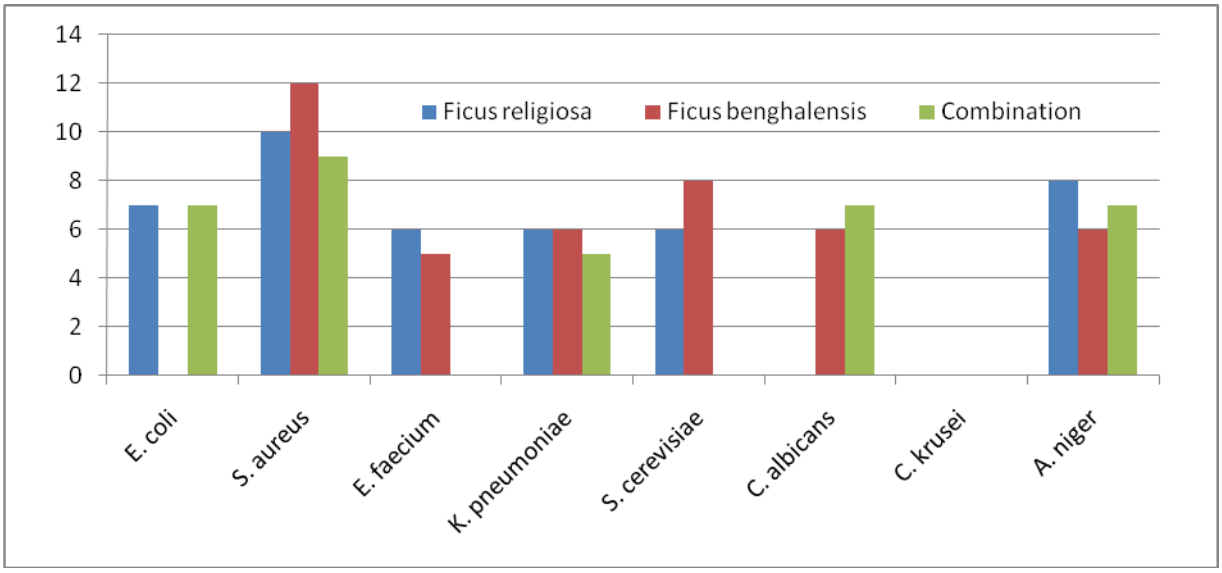
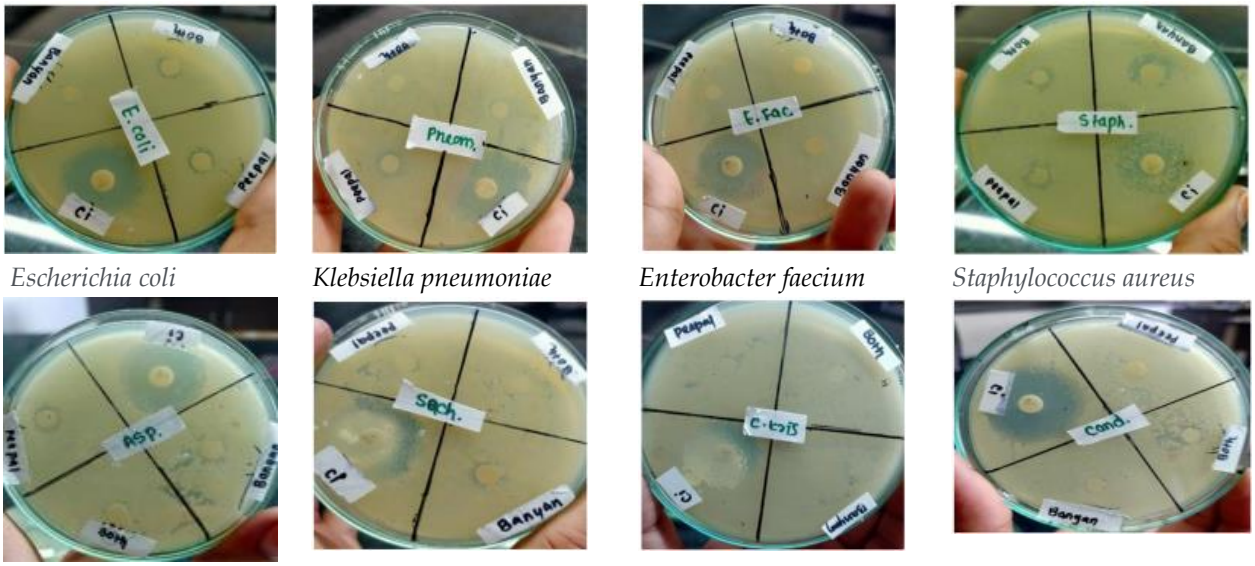


Fig 3: Antibacterial and antifungal activity of AgNP



Escherichia coli *Klebsiella pneumoniae* *Enterobacter faecium* *Staphylococcus aureus*

Aspergillus niger *S. cerevisiae* *Candida krusei,* *Candid albicans*

Fig 4 Antibacterial and antifungal activity of AgNP against tested organism

Conclusion:

At 450 nm, the silver colloid's UV Visible spectral peak appeared for leaf extract concentrations of both plant. The UV/Vis spectrum of the silver nanoparticles synthesized from mixture of *Ficus religiosa* and *Ficus benghalensis* leaf extract were found at 450 nm. When compared to the leaf extract, the synthesised AgNPs were found to have a stronger inhibitory activity. Furthermore, when compared to gram-positive bacteria *S. aureus*, AgNPs demonstrate an efficient zone of inhibition against gram-negative bacteria *K. pneumonia* but not against *E. coli* *Ficus benghalensis* leaf extract was very effective against *S. aureus*. *Ficus benghalensis* leaf extract was very effective against *Saccharomyces cerevisiae* while *Ficus religiosa* were effective against *A. niger*. Therefore, these kinds of green energy and low-cost synthesis techniques for the manufacture of nanomaterials would promote the industrial production of functionalized AgNPs. These findings imply that AgNPs can be applied to a variety of medical devices and antimicrobial treatments as efficient growth inhibitors in

tested microorganisms.

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Conflict of Interest: Authors declare that they have no conflict of interest

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