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Green synthesis characterization, and anti-bacterial properties of Acacia nilotica bark extract

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ABSTRACT

Acacia nilotica, a flowering tree, is used in traditional medicine for its anti-microbial, anti-plasmodium, antioxidant, and therapeutic properties. It is also used in agroforestry systems as a green fertilizer, lumber tree, and fodder tree. Acacia nilotica bark is used for various ailments, including biliousness, toothaches, diarrhea, wound ulcers, leprosy, leucoderma, smallpox, skin conditions, cardiovascular diseases and seminal weakness. It also acts as an antibacterial, antioxidant, anti-mutagenic, and cytotoxic agent. Silver nanoparticles (AgNPs) are useful in nanobiotechnology, diagnosis, drug delivery systems, prostheses, and implants. The study investigated the antimicrobial activity of silver nanoparticles in Acacia nilotica extract using XRD and SEM analysis. The nanoparticles have a spherical shape with an average sliver size of 32.15 nm. The extract has potential medicinal applications, including antibacterial properties, and green synthesis techniques. Further research is needed to understand the mechanisms of action and develop secure and efficient formulations for human use.

KEYWORDS: Acacia nilotica, Silver nanoparticles, antibacterial activity, Public health, well being, novel cardiovascular disease.

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INTRODUCTION

Acacia nilotica is a flowering tree in the Fabaceae family. It is also referred to by the common name babul. It was found in the Indian subcontinent . Height ranges from 3 to 5 meters. Traditional medicine employs *A. nilotica* for its anti-microbial, anti-plasmodium, antioxidant, and therapeutic properties to treat cancer, hepatitis C, and human immunodeficiency virus infections (Al-Gubory & Laher, 2018; Swamy, 2020). It is used in agroforestry systems around the world as a green fertilizer, lumber tree, and fodder tree. In Niger, certain tree species are used in urban forestry to provide shade. *Acacia nilotica* can assist farmers with climate change adaptation through the use of agroforestry systems. For instance, in Saudi Arabia, it was discovered that *Acacia nilotica* had considerable benefits for amending soil, enhancing crop development, and increasing yield performance (Zubair et al., 2022). For instance, it has been found that *Acacia nilotica* has significant impacts on soil amendment, improving crop growth and production, and creating biomass in a specific environment, all of which result in the sequestration of carbon dioxide. Leguminous crops provide non-nitrogen-fixing organisms with nitrogen, which is crucial for ecosystem productivity and so promotes carbon sequestration (Amadou et al., 2020; Zubair et al., 2022). South-east Asia, the Indian subcontinent, and other regions employ a toothbrush manufactured from the small twig of this plant. *A. nilotica* leaf extract has been used to treat a variety of conditions, including strength loss, chest discomfort, fever, malaria, pneumonia, chest pain, back pain, stomach ulcers, coughing, painful joints, and spermatorrhoea (Kh, 2020). Fresh seed pods are helpful in treating acute gonorrhea and are also used to cure sex abnormalities (Kh, 2020). The bark of Acacia nilotica is used to cure a variety of ailments, including bleeding, wound ulcers, leprosy, leucoderma, small pox, skin disorders, biliousness, burning, toothaches, leucoderma, diarrhea, and seminal weakness. It is also employed as a cytotoxic, antimicrobial, antioxidant, and anti-mutagenic agent. For the treatment of biliousness, bleeding piles, leucoderma, diarrhea, bronchitis, and other conditions (Atif Ali*, Naveed Akhtar, Barkat Ali Khan, Muhammad Shoaib Khan, Akhtar Rasul, Shahiq-UZ-Zaman, Nayab Khalid, Khalid Waseem, Tariq Mahmood and Liaqat Ali, 2011).

Nanomaterials are useful in nanobiotechnology, particularly in diagnosis, drug delivery systems, prostheses, and implants. Nanoscale materials blend in well. The relevance of nanotechnology has shown promise by opening the door for several medicinal

applications. Chemical processes are the most common, but despite their popularity, they are usually dangerousand process-dependent since they depend on stabilizing and reducing agents (Galatage et al., 2021; Sreenivasagan et al., 2023)

A form of nanomaterial called silver nanoparticles (AgNPs) is composed of clustered silver atoms. They feature a special set of characteristics that make them helpful in a range of applications, such as antibacterial activity, biosensing, optoelectronics, and electronics. AgNPs are effective against a wide range of microorganisms, including parasites, fungus, viruses, and bacteria. They can therefore be used in a wide range of goods, including disinfectants, antiseptics, and wound dressings. They may also be used to make biosensors that can identify certain molecules, such DNA, proteins, or viruses, in the environment. Due to this, they are helpful in both environmental monitoring and medical diagnosis (Zhang et al., 2016);(Garapati et al., 2022)(Palani et al., 2025)

MATERIAL AND METHODS

Preparation of extract Acacia nilotica

The *Acacia nilotica's* aerial parts had three thorough washes with water, followed by a rinse with deionized water to remove any remaining dust. The plant's leaves were then dried completely for seven days to remove any remaining moisture, and they were finally crushed to a powder. 50 ml of double distilled water (DDW) and 10 g of powdered sample were combined, and then the mixture was allowed to incubate while being stirred occasionally. Whatman filter paper was used to filter the sample after it had been boiled for an hour.

Phyto-based fabrication of silver nanoparticles

Then we add 5g AgNPs to the sample . We kept it in the Centrifuge machine at 3000 rpm for 10 minutes. The sample is settled down. We removed the supernatant, and we dried it in a hot air oven. The sample transformed into a powder.

Preparation of bacteria culture plate

A Petri dish that includes a growth medium (usually agar nutrients) used to cultivate microorganisms is called a bacterium culture plate. You will require the following supplies to make a bacterium culture plate: A Petri dish, Nutrient agar, Distilled water, A hot plate or microwave, stir bar, sterile pipette, sterile inoculating loop, and Bunsen burner.

Into a clean beaker, 5g of nutritional agar and 250 mL of distilled water. If using a hot plate, swirl the agar and water mixture continually while heating it over medium heat until the agar dissolves fully. Until the agar is completely dissolved, autoclave the agar medium in the autoclave equipment for 20 minutes. When adding the agar and water mixture to the Petri dish, tilt it to disperse the agar uniformly. At room temperature or in the fridge, let the agar cool and harden. Use a sterile pipette to transfer a small amount of the bacteria culture to the plate's center once the agar has solidified. Spread the microbial culture of candida uniformly throughout the agar's surface using a sterile L-rod. Set the plate's incubator to the right temperature for the bacteria. In 24 hr bacteria grow rapidly.

RESULTS

Figure 1: Microbial plate for antimicrobial activity of silver nanoparticles in *Acacia nilotica* extract.

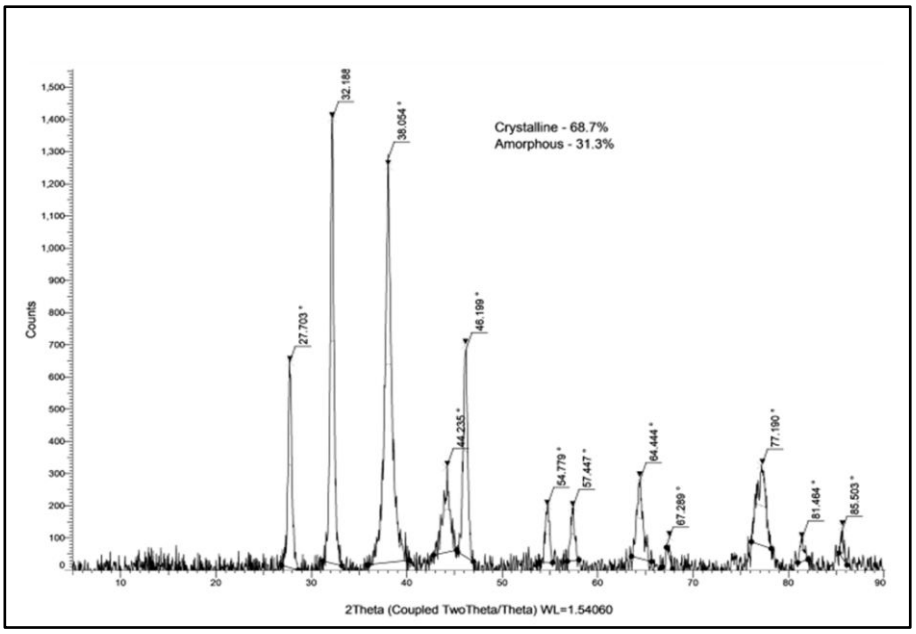

Figure 2 represents XRD pattern of silver nanoparticles in *Acacia nilotica* extract.

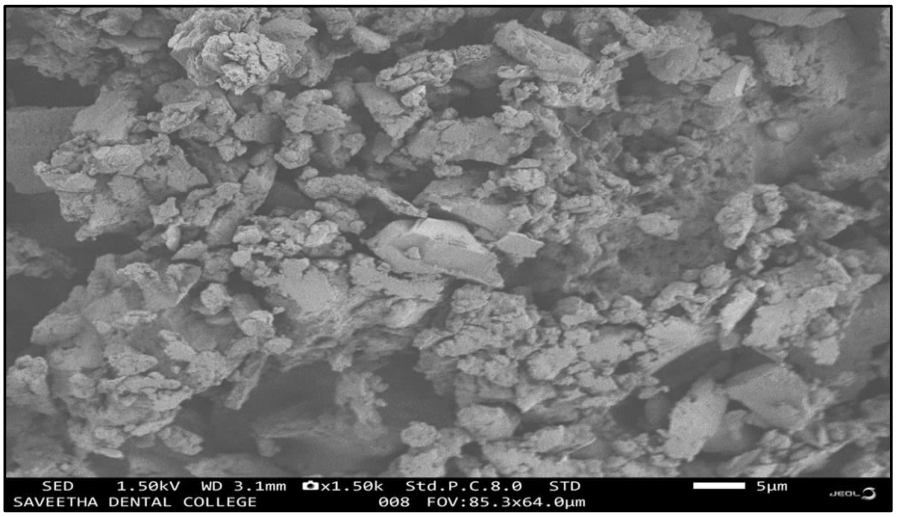

Figure 3 represents SEM study of silver nanoparticles in an extract from *Acacia nilotica*.

Silver nanoparticle form and size have been determined using scanning electron microscopy analysis. The average Ag nanoparticle size, according to a SEM study, is 32.15 nm, and it has a spherical form.

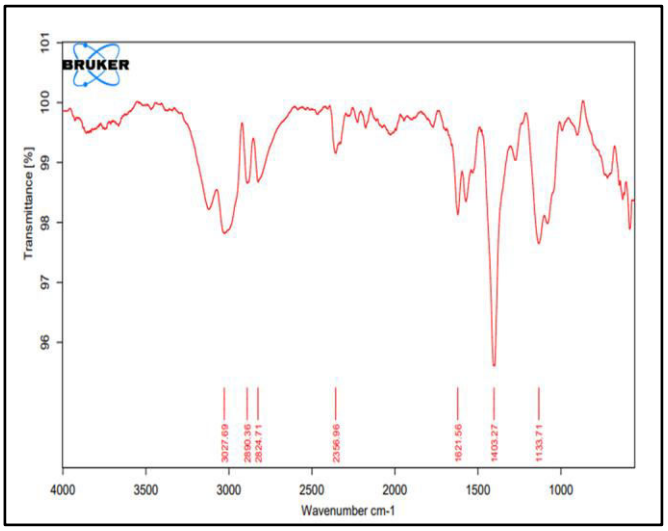

Figure 4. FTIR-pattern of Silver Nanoparticles from *Acacia nilotica* Extract

The nanoparticles were capped with FTIR, which was used to check for possible bioactive chemicals. Usually, the reduction process of bark extract results in the phytochemical substances acting as a capping agent. The bioactive chemicals that coated the nanoparticles in this study's peak regions were visible. Results from the FTIR indicated 3027.6, 2890.3, 2824.7, 2356.9, 1621.56, 1403.27, and 1133.7 cm-1.

DISCUSSION

The well-known medicinal herb *Acacia nilotica* has been used for many years in traditional medicine. Numerous substances with possible biological action may be found in the plant's bark, including triterpenes, flavonoids, and tannins. Numerous effects of these substances, including antibacterial, antifungal, anti-inflammatory, and antioxidant activities, have been demonstrated (Alshehri & Abdella, 2023; Zubair et al., 2022) .

The use of Acacia nilotica bark extract to treat bacterial infections has gained popularity recently. The extract exhibits high antibacterial action against microbial pathogens, according to several investigations. According to one research, the extract inhibits the growth of numerous microorganisms, including Staphylococcus aureus, Escherichia coli, and Pseudomonas aeruginosa.(Ghazzi, 2017; Naidoo, 2006).

The tannins, flavonoids, and triterpenes in *Acacia nilotica* bark extract are assumed to be responsible for the extract's antibacterial properties. It has been demonstrated that these substances weaken the bacterial cell walls, interfere with their metabolism, and prevent them from producing proteins (Chen, 2021; Stankovic, 2020).
Acacia nilotica bark extract has been demonstrated to offer a variety of other possible health advantages in addition to its antibacterial action. For instance, the extract's anti-inflammatory, antioxidant, and antidiabetic properties have all been demonstrated (Khan et al., 2022).

Using a promising technique called green synthesis, it is possible to produce *Acacia nilotica* bark extract without the use of dangerous chemicals. Plant extracts are employed in this method to make silver nanoparticles by acting as stabilizing and reducing agents. The resulting Ag NPS have been shown to have strong antibacterial properties against a variety of microbes (Qi et al., 2023; Tariq et al., 2023).

A potential new technique for creating a secure and efficient antibacterial agent is the green synthesis of bark extract from *Acacia nilotica.* The extract has been demonstrated to possess strong antibacterial action against a variety of germs, in addition to having several other possible health advantages. Although more investigation is required to prove the extract's efficiency and safety, it has the potential to be an effective new therapy for bacterial infections (Mak et al., 2023).

Using plant extracts, a process called "green synthesis" may create nanoparticles (Zubair et al., 2022). The utilization of organic resources like plants, which are secure and include reducing and capping agents, as well as less hazardous chemicals overall, makes this process sustainable and ecologically beneficial (Fulekar et al., 2013; Muthu, 2014)

The plant *Acacia nilotica,* sometimes referred to as Garad or Sunt in Sudan, has a variety of therapeutic applications. Studies have revealed that oral bacteria, including *Streptococcus sobrinus* and *Porphyromonas gingivalis,* are resistant to the antibacterial effects of the bark of *Acacia nilotica.* By utilizing the minimum inhibitory concentration (MIC) and minimum bactericidal concentration (MBC) techniques, the antibacterial activity of *Acacia nilotica* bark extract was assessed. The findings demonstrated that the bark extract was highly effective in inhibiting these oral bacteria. *Acacia nilotica* bark extract has shown antioxidant activity in addition to its antibacterial characteristics (Kh, 2020). It also demonstrated inhibitory action against the glucosyltransferase (GTF) enzyme. Dental plaque, which can result in dental cavities, is created by the GTF enzyme. The bark extract's potential application in mouthwashes as an adjuvant antioxidant may also be influenced by its antioxidant properties (Amadou et al., 2020)(Chokkattu et al., 2022)

CONCLUSION

The plant *Acacia nilotica* has a variety of potential medicinal applications, including antibacterial properties.Recent years have seen an increase in interest in green synthesis methods as a means of producing nanoparticles with antibacterial properties. Environmentally friendly green synthesis techniques employ plant extracts or other natural substances as reducing and stabilizing agents. They are therefore a viable replacement for the hazardous compounds frequently used in traditional techniques for synthesizing nanoparticles. This work looked at the environmentally friendly manufacture of silver nanoparticles from the bark extract of *Acacia nilotica.* According to the findings, the extract may decrease silver ions to create nanoparticles that are typically 20–50 nm in size. Through the use of SEM, XRD, and FTIR, the nanoparticles were identified. The silver nanoparticles created by green synthesis were examined and The outcomes demonstrated that the nanoparticles were efficient against all of the germs examined, with Canbian showing the most activity.

A potential technique for creating antibacterial nanoparticles with low toxicity is the green production of Ag NPS using the bark extract of *Acacia nilotica.* To learn more about these nanoparticles' potential therapeutic uses, more research is required. *Acacia nilotica* bark extract has been demonstrated to have antioxidant, anticancer and antibacterial characteristics. Due to these characteristics, it may be used to treat a number of disorders. To completely comprehend the mechanisms of action of *Acacia nilotica* bark extract and to create secure and efficient formulations for human use, more investigation is required. The first findings of this study, however, are encouraging and indicate that *Acacia nilotica* bark extract could be a useful natural resource

for the creation of novel therapeutics.

Conflict of Interest
The author declares there is no conflict of interest

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