Synthesis of silver nanoparticles using Cassia obtusa extract for skin infections

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Abstract

Bio nanotechnology has emerged up as integration between biotechnology and nanotechnology for developing biosynthetic and environment friendly technology for synthesis of nanomaterials. Development of environment friendly technique for the synthesis of nanoparticles has emerged as a significant step in the field of nanotechnology. Nanotechnology is the branch of science that deals with the framing of materials at atomic level to achieve unique properties, which can be then manipulated for desired applications. Out of all the metallic nanoparticles silver nanoparticles grabs more attention because of its unique physical, chemical and biological properties. Silver has been known to have effective bactericidal properties for centuries. Nowadays, silver based dressings have been widely used for the treatment of infections like burns, open wounds and chronic ulcers. As the pathogenic bacteria getting evolved day by day due to mutation and gaining antibiotic resistance, an important industrial sector of nanoscience deals with the preparation and study of nanoparticles in antibacterial clothing, burn ointments, and coating for medical device. The purpose of the study is to synthesize and characterize the plant mediated silver nanoparticles using Cassia obtusa. Cassia obtusa contains natural essential oils, antibacterial, tannins, acetone and ethanol compounds which help to make skin healthy and glowing. Essential oils and tannins are beneficial to treat skin inflammations and their antibacterial compound helps to heal wounds, cuts and burns. Cassia leaves have anti-inflammatory and laxative properties. The leaves contain a chemical called sennosides which cause a laxative effect on the body. The present review explores the synthesis of silver nanoparticles through a natural product of Cassia obtusa plant extract for curing skin infections.

Keywords: Cassia obtusa, Silver Nanoparticles, Skin infections.

1. Introduction

Nanotechnology is emerging as a rapidly growing field with its application in science and technology. Nanobiotechnology is a field that inter relates both biological sciences and nanotechnology. It provides a platform for the development of ecofriendly and the green synthesis of nanoparticles with the help of biological sources like plants and microorganisms (*Najimu Nisha et al.,2014*). Silver nanoparticles (AgNPs) represent a potential therapeutic tool for treatment of many diseases and parasites because of their antiplasmodial, antibacterial, and antifungal activity (Sandhanasamy Devanesan et.al.,2016). *Cassia angustifolia,* a member of the family *Fabaceae* is one of the important herbs used in Allopathic, Ayurvedic and Unani systems of medicine. Cassia is valued in medicine in many ways. Cassia leaves and pods are a powerful laxative and are described in many pharmacopoeias. Cassia species have been keen interest in phytochemical and pharmacological research due to their excellent medicinal values. The medicinal properties of Cassia species are due to their contents of hydroxyanthraquinone derivatives (*Shyamala Viswanathan and Thangaraju Nallamuthu et.al., 2012*). The extract of *Cassia* species leaves has been found to posses significant hepatoprotective activity and anti-inflammatory activity (*Shivjeet Singh et al.,*). The aim of this present paper is to extract the leaves of *Cassia obtuse* for curing skin infections and novelty of the work is scaffold formations for curing skin infections.

Fig 1. Cassia Obtusa

1.1. Properties of leaves

The leaves showed mainly the presence of Anthraquinone glycosides and Flavanoids. The Anthraquinone glycoside includes rhein, emodine, physion, chrysophanol (marker), Obtusin, chryso-obtusin, chryso-obtusin-2-O-beta-D-glycoside, obtusifolin and chryso-obtusifolin-2-O-beta-D-glycoside (*Shivjeet et.al.,*)

2. Materials and methods

2.1. Materials

Cassia obtusa plant samples were obtained from the neighbourhood. Only the leaves of the plant were utilized and completely rinsed with the tap water to eliminate the dust present in the leaves and then washed once more with the distilled water for improved results.

2.2. Methods

In order to extract the essence of the leaves, 5g of cassia obtusa plant powder was added in 100 ml distilled water and kept in the magnetic stirrer at 1200 rpm over 1 hour at 80°C . Then the mixture is filtered with the help of What-Man filter paper and used to create silver nanoparticles.

2.3.Synthesis of silver nanoparticles

A beaker containing 10 ml of freshly obtained leaf extract (aqueous extract) and 90 ml of 0.02 M silver nitrate was held on a thermostatically controlled magnetic stirrer while being gently stirred at 50 rpm at 80ºC temperature. The beaker was wrapped in aluminium foil to maintain the dark environment, and the synthesis of nanoparticles was seen. The reaction mixture received 10 ml of 0.02 M tri-sodium citrate, which was added drop by drop. The creation of silver nanoparticles was confirmed by continuing this reaction until a dark brown color was obtained. After that, the colloidal dispersion was centrifuged for 20 minutes at 10,00 rpm. The pellet was created, then was rinsed with distilled water three times. It was lyophilized to preserve the sediment pellet for further characterization.

2.4.Preparation of biodegradable band-aid

2.4.1.Materials

- Poly vinyl alcohol-3.75 gm
- Plant extract(aqueous extract)-5 ml
- Glycerol-5 ml
- Distilled water-50 ml

2.4.2. Solvent Casting Method

50 ml of distilled water is added into the beaker and kept in the magnetic stirrer to boil, then 3.75 gm of poly vinyl alcohol was added in little amounts rather than all at once. Which might have caused clusters to develop. Finally, the magnetic bead was added for spinning the solutionto make it dissolved at a rate of dispersion. The mixture was heated to 80ºC for two hours on the stirrer to achieve a clear solution. The 5 ml of glycerol is added to the mixture following that. Once clear solution is achieved. At that point 5 ml of plant extract was added and mixed thoroughly and stored in a centrifuge tube.

2.4.3. Making of Band-Aid with hydrogel

For comparative study, a 15 ml of unloaded hydrogel liquid solution were poured into the petri dishes, along with the 15 ml of loaded samples in other petri dish. The petri dishes were placed in a hot air oven at 70ºC for three hours which was then formed into a Band-Aid like structure and stored them for anti-microbial studies of them.

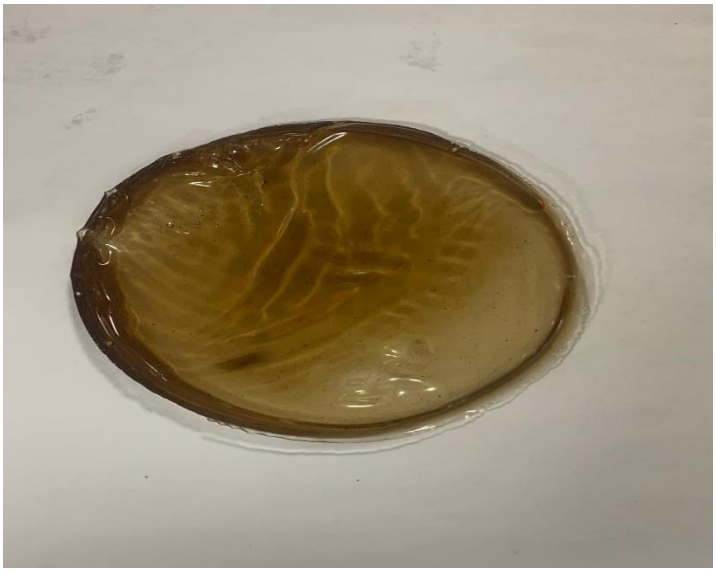


Figure 2. Loaded Bio-degradable Band-aid with synthesized nanoparticles infused

3. Results

3.1. UV-vis spectrophotometer

The AgNP optical properties were identified using the UV-vis spectroscopy (Perkin Elmer Inc., Waltham, MA, USA) with a 100 λ scanning range from 100 to 800 nm. UV-vis spectra were recorded perodically until light yellow colour turned into a brown colour.

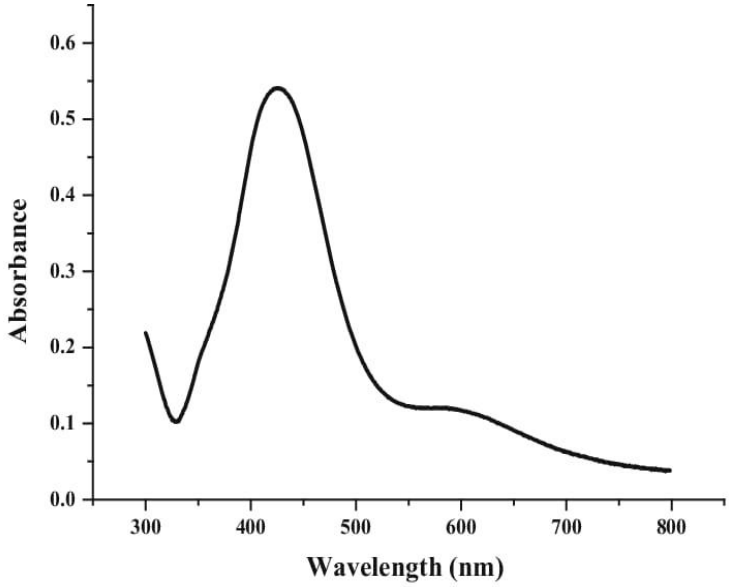


Figure 3. UV-vis Spectrophotometer

3.2. X-ray diffraction

X-ray diffraction (XRD) can be utilized to analyze the crystalline structure of silver nanoparticles synthesized using Cassia obtusa extract for skin infections. XRD can reveal the crystallographic phases present in the nanoparticles providing information on their purity and crystallinity. The X-ray diffraction (XRD)-Rigaku miniflex II pattern was obtained and operated at a voltage 20 kV to 80 kV/2 mA to 50 mA. The reduction of Ag+ ions using Cassia obtusa leaf extracts and aqueous silver nitrate produced crystalline nanoparticles, as seen by the XRD patterns.

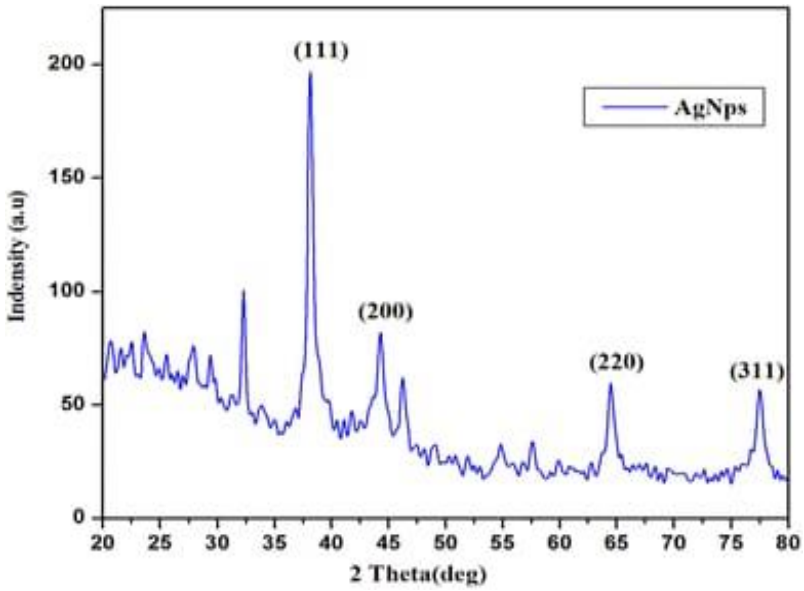


Figure 4. X-ray diffraction

3.3.Anti-bacterial Assay

Antibacterial activity assays were carried out using the agar well-diffusion method. The sterile swab was moistened with the fresh bacterial suspension and spread on a solid sterile Muller Hinton agar plate. Five wells (5 mm diameter) were made on the agar plate. Different concentrations (10,20,30,40 and 50 µL) of the synthesized nanoparticle suspension were poured into each consecutive well. All plates were incubated a 37ºC for 24 hours. A zone of inhibition was measured (mm) around each well in every incubated plate. For each experiment, three replicates were maintained.

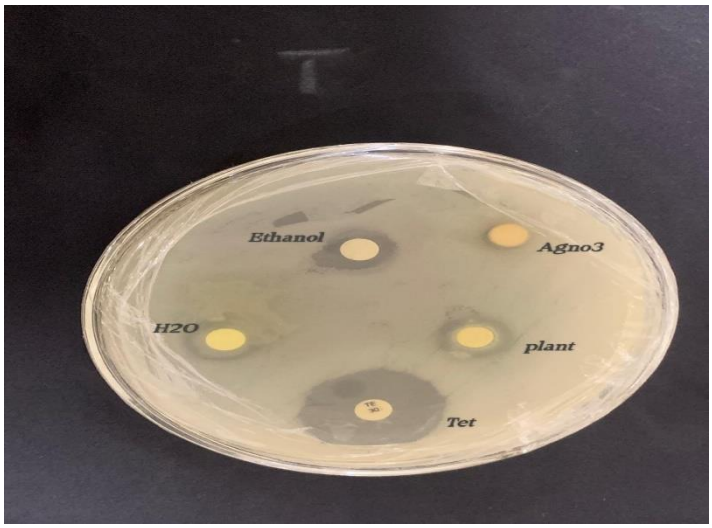
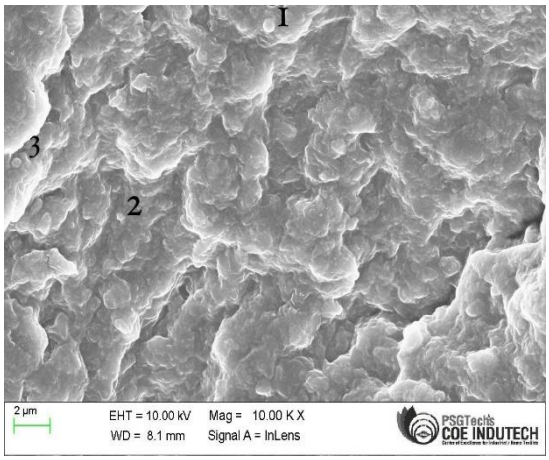


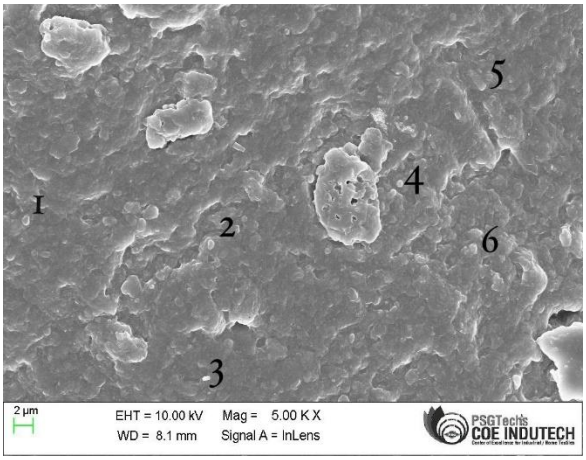
Figure 5. Anti-bacterial Assay

3.4.Scanning Electron Microscopy

Scanning electron microscopy was used to examine surface morphology and size distribution of the synthesized silver nanoparticles using Cassia obtusa extract. It would reveal the shape and surface characteristics, helping to assess their potential for treating skin infections. SEM analysis can elucidate the effectiveness of the synthesis process and the suitability of the nanoparticles for targeted applications in dermatology.

3.4.1.SEM Analysis of Silver Nanoparticles

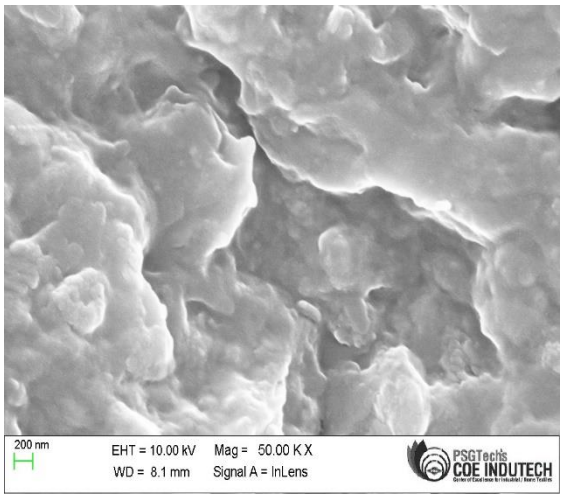


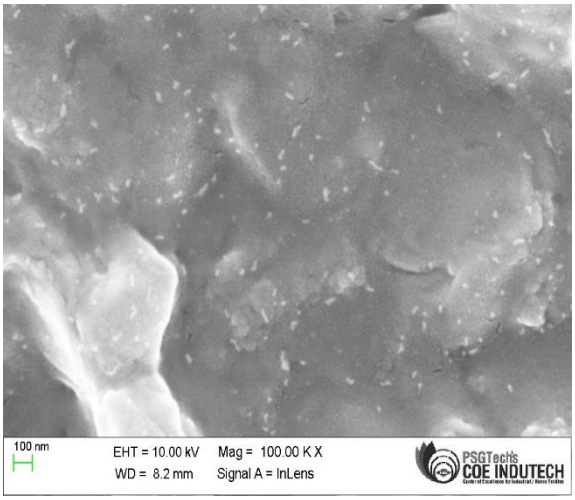


S.No	Nanometer (nm)
1	17 nm
2	18 nm
3	9 nm
4	10 nm
5	13 nm
6	16 nm

S.No	Nanometer (nm)
1	26 nm
2	11 nm
3	17 nm

3.4.2. SEM Analysis of Bio Film





3.5.Antioxidant Assay

The silver nanoparticle was tested using 1-diphenyl-2-picryl hydroxyl (DPPH) to ascertain the extracts capacity to scavenge free radicals. 1 ml of newly made 0.1 MM Methanoic DPPH and 1 ml of plant extract were ingested. After 15 minutes of incubation at room temperature, the mixture's absorbance was detected a wavelength of about 517 nm. Ascorbic acid served as the standard in this test.

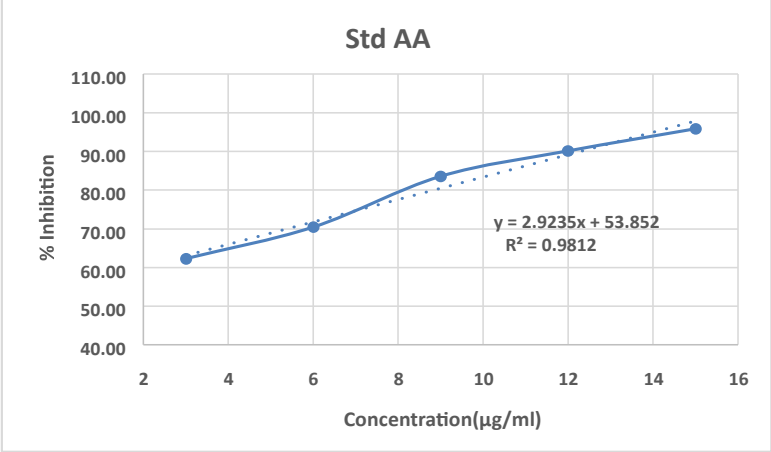


Figure 6. Anti-oxidant Assay

3.6. Fourier Transform Infrared Spectroscopy

The attenuated total reflection crystal was placed with the investigated dried samples. The plant extract is used as a reducing and capping agent during the production of silver nanoparticles. The reducing and the capping agents or the groups preventing the aggregation of silver nanoparticles are shown by the FTIR examination. Buffer-subtracted transmission spectra with wave numbers between 400 and 4000 cm-¹ were captured.

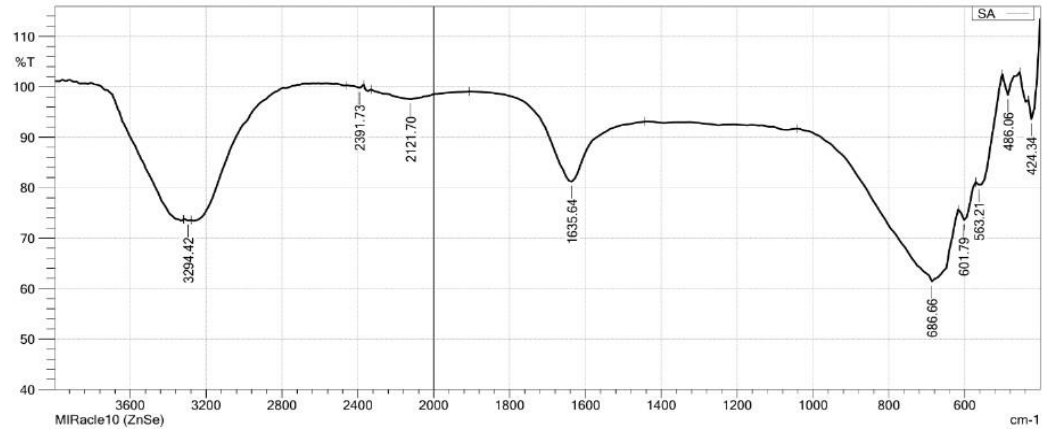


Figure 7. FTIR Analysis

4. Discussion

In conclusion, the synthesis of silver nanoparticles using Cassia obtuse extracts presents a promising strategy for addressing skin infections. Through various tests and analysis, including UV-vis spectroscopy, X-ray diffraction (XRD), Scanning Electron microscopy (SEM), Antioxidant Assay, Antibacterial Assay, Fourier Infrared Spectroscopy (FTIR), it has been demonstrated that the nanoparticles possess potent antimicrobial activity against a range of pathogens commonly associated with skin infections. Further research is warranted to optimize synthesize parameters and explore the full spectrum of applications in skincare and medical treatments.

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