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Green Synthesis of Cucumber Tree Leaf Extract's Silver Nanoparticles

M.Jeevitha[1], Manisha Masih Singh[2], Shabi Zehra[3], Bhoite Rupali Prashant[4], Bijander Kumar[5], Rajeev Ranjan[6], Raman Kumari[7], Nihar Ranjan Kar [8], Vinay Kumar Pathak[9]*

[1]*Professor and Head, Shri Venkateshwara College of Pharmacy, Pondicherry University, Ariyir, Puducherry, 605102*
[2]*Associate Professor, School of Pharmacy CEC, Lal khadan masturi jairamnagar road Bilaspur CG – 495004*
[3]*Associate Professor, Ankerite College of Pharmacy, vill.parver purab, post Mohanlalganj, LKo. 226301*
[4]*Assistant Professor, Yspms Ytc ,Faculty Of Pharmacy , Satara*
[5]*Professor, Mahaveer College of Pharmacy, Meerut*
[6]*Assistant Professor, University Department of Chemistry, DSPM University, Ranchi 834008*
[7]*Associate professor, Atam institute of pharmacy, Hisar, Haryana-125001*
[8]*Assistant Professor, Centurion University of Technology and Management, Gopalpur, Balasore, Odisha, India, pin-756044*
[9]*Associate Professor, Rajarshi Rananjay Sinh College of Pharmacy, Amethi - Uttar Pradesh 227405*

Corresponding: Vinay Kumar Pathak

Email id: vinaypathaks@gmail.com

Affiliation: Associate Professor, Rajarshi Rananjay Sinh College of Pharmacy, Amethi - Uttar Pradesh 227405

Abstract

The synthesis of silver nanoparticles (AgNPs) was effectively achieved in the laboratory by employing Cucumber Tree Leaf extract as a reducing agent. The extract shows the ability to decelerate and maintain the stability of the silver nanoparticles through the presence of phytochemical compounds. The nanoparticles were described in terms of their size, shape, and morphology using a range of techniques, such as UV-visible spectroscopy, Fourier-transform infrared spectroscopy (FT-IR), X-ray diffraction (XRD), and scanning electron microscopy (SEM). The findings indicated that the nanoparticles that were synthesised exhibited a spherical shape and were uniformly distributed. The stabilisation of silver nanoparticles has been observed through the utilisation of green extract, as shown by the stretching vibrations observed in the FTIR spectrum. In contrast, the nanoparticles in question were determined to be silver nanoparticles derived from the extract of the Cucumber tree, so-referred to as Cucumber Tree Leaf -AgNPs. The efficacy of silver nanoparticles can be enhanced through the utilization of the biological production process, as evidenced by previous studies. By optimising the necessary conditions, the effectiveness of Cucumber Tree Leaf -AgNPs in addressing cancer could potentially be enhanced, particularly in the context of lung cancer (A549 cell line) and breast cancer (MCF7 cell line). The A549 cells exhibited an IC50 value of 42.15 g

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mL-1, whereas the MCF7 cells demonstrated an IC50 value of 67.12 g mL-1. The researchers employed an MTT assay to assess the impact of AgNPs on both cell lines. The findings demonstrated a cytotoxic effect that depended on the dosage. The potential of the biosynthesized AB-AgNPs to exhibit anticancer activities is highly encouraging. The researchers achieved a successful synthesis, resulting in the production of nanoparticles that exhibited desirable features. This synthesis involved the use of Cucumber Tree Leaf extract as a reducing agent, leading to the formation of spherical nanoparticles that were uniformly distributed.

Keywords: Nanoparticles (NPs), Cucumber Tree Leaf -AgNPs, AB-AgNPs

Introduction

Nanoparticles (NPs) in the field of medicine are categorised into three main classes, namely metallic, non-metallic, and metal composite nanoparticles, based on their chemical composition, biological attributes, and medical utility. The user has requested a rewrite of their text to be more academic. However, since the Due to the unique characteristics exhibited by nanoparticles, they find extensive application across several high-technology sectors, with a particular emphasis on the realms of technology and medicine. The range of numbers being referred to is between six and eight. Reducing agents such as citrate, hydrazine, and sodium borohydride are commonly employed during the synthesis of NPs. However, it is important to note that these compounds possess the capacity to do harm to the environment and exhibit toxicity towards both human beings and animals. In contrast, the stabilisation and prevention of aggregation in nanoparticles (NPs) are achieved through the utilisation of capping agents. Capping agents such as surfactants, polymers, and proteins are frequently utilised[1].

The usage of dissolvable plant extracts has shown significant potential in the ecologically friendly manufacture of nanoparticles (NPs) due to their dual function as capping and reducing agents.The age range of individuals being referred to is between 15 and 18 years old. The aforementioned extracts encompass a diverse array of naturally occurring compounds, including terpenoids, phenolic acids, and flavonoids, all of which exhibit significant capabilities in terms of capping and decreasing. During the production of silver nanoparticles (AgNPs), a natural reducing agent, such as green tea, ginger, or garlic extract, is combined with silver nitrate. The extract functions as a capping agent, thereby stabilising the silver ions by their reduction to AgNPs in the course of this procedure. The many features shown by nanoparticles (NPs) produced by distinct plant species provide significant potential for applications in the fields of medicine, electronics, and catalysis[2]. The age range of individuals being referred to is between 19

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and 23 years old. In addition to its applicability in various fields, the investigation of green production methods for metallic nanoparticles holds significant academic importance[3]. Various methodologies, encompassing chemical, photochemical, electrochemical, radiation, and biological syntheses, can be employed for the production of silver nanoparticles. The topic of phyto-nanotechnology offers a promising approach for the production of nanoparticles that is characterised by its sustainability, environmental friendliness, and economic viability. This method holds significant advantages for various advanced applications, particularly in the field of medicine. [4] The utilisation of green chemistry principles and the incorporation of naturally derived reducing agents sourced from plants or microbes present a promising approach to simultaneously save the environment and enhance technological advancements. [5]

Fig. 1: Cucumber tree leaves with fruit

Typical applications of AgNPs encompass signal enhancers, visual receptors, battery intercalating materials, polarising filters, catalysts, sensors, bio-labelling materials, as well as agents with anticancer, antioxidant, and antibacterial properties. [6] Silver nanoparticles (AgNPs) have been shown to mitigate toxicity, enhance surface plasmon resonance, and augment electrical resistance in the context of combating cancer. Silver nanoparticles (AgNPs) possess unique properties that render them very suitable for use in water purification, as well as in the development of therapeutic medicines targeting cancer, inflammation, and microbes. Silver nanoparticles have emerged as a potential therapeutic option in the context of cancer

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due to their ability to selectively target and accumulate at higher concentrations within the tumour site. Furthermore, the precise manipulation of nanoparticle size may be achieved throughout the synthesis process in order to enhance their accumulation at the designated location. The utilisation of silver nanoparticles as an anticancer drug offers a significant advantage due to their pronounced cytotoxicity towards cancer cell lines, particularly when smaller-sized particles are employed. Research findings have indicated that the cytotoxicity of silver nanoparticles is more severe in smaller particles than to larger ones.[7] The nanoparticles also exhibit unique chemotherapeutic properties, including the capacity to induce apoptosis-dependent programmed cell death in cancer cells lacking the p53 gene. In contrast to conventional cancer therapies, which lack the ability to induce cell death in these specific cells, this presents a significant advantage. Recent studies have indicated that silver nanoparticles within the size range of 5 to 35 nm have the ability to induce apoptosis via mitochondrial pathways and targeted drug delivery systems. These findings highlight the potential of silver nanoparticles as a viable therapeutic option for cancer therapy. The use of silver nanoparticles holds promise in the development of precise and effective cancer treatments that minimise damage to healthy cells. The present study aimed to assess the efficacy of ecologically sustainable phyto-synthesis for silver nanoparticles (AgNPs) by the utilisation of Artemisia tschernieviana extract (ATE). The HT29 colon cancer cells exhibited significant cytotoxicity when exposed to the silver nanoparticles synthesised from the extract. tschernieviana, therefore inducing apoptosis. The findings of this study indicate the possibility of plant-derived AgNPs as a promising approach for anticancer therapy. Furthermore, the introduction of chromium (Cr) into zinc oxide (ZnO) nanostructures resulted in a significant shift towards shorter wavelengths in the ultraviolet (UV) emission spectrum, together with the effective reduction of emission from deep energy levels. The band gap exhibited an expansion as a result of the decrease in size and the influence of doping with chromium. The nanostructures that were produced also shown promise in terms of eradicating bacteria. In the present study, silver nanoparticles (AgNPs) were synthesised using a bio-reduction method including the utilisation of cucumber tree leaves extract. The nanoparticles that were synthesised exhibited stability and were within the nanoscale scale, while the methodology employed for their production was straightforward to implement. [8] Limited research has been conducted on the possible anticancer and antibacterial properties of silver nanoparticles (AgNPs) synthesised utilising wild and indigenous species. This is in contrast to the extensive body of literature exploring the green synthesis of AgNPs exploiting leaf extract. Cucumber tree leaves, a plant, shrub, or small tree belonging to the oxaloacetates family, is predominantly found in the tropical and subtropical regions. In India, a total of 12 species have been found, which are known to create beverages derived from their leaves. These beverages are purportedly utilised for their antibacterial and antiscorbutic properties, as well as for the treatment of diabetes and rectal irritation. Furthermore, a concoction derived from the foliage is employed for the treatment of syphilis, coughs, colds, pruritus, and dermatological eruptions. [9]

The study on silver nanoparticles (AgNPs) has significantly broadened the potential uses of nanoparticles across several fields. The conventional methods of synthesising nanoparticles may exhibit a more pronounced adverse effect on the environment as compared to the environmentally friendly approach of using plant extracts for the green synthesis of silver nanoparticles. The present study focuses on the utilisation of cucumber tree extract in the bio-reduction process as a more convenient and feasible method for synthesising stable AgNPs on the nanoscale scale. Additional investigation into the potential anticancer and antibacterial properties of silver nanoparticles (AgNPs) utilising indigenous and untamed organisms might yield valuable insights. [10]

Experimental

Materials

Acetone and silver nitrite (AgNO3) had been purchased from Sigma-Aldrich, a reputable supplier known for providing chemicals of analytical reagent (AR) grade quality. The extraction process was conducted with a Soxhlet apparatus and double-distilled water. The instruments employed in the study included a digital centrifuge, microtiter plate, MCF-7 cell line, microscope, CO_2 incubator, and gyratory shaker, among others.

Preparation of aqueous extract from the leaves

The leaves of cucumber tree were meticulously collected from the Nav-anagar locality of Hubballi, Karnataka, India, and afterwards purified before to undergoing a process of shade drying. Approximately 50 gm of dry powder was obtained via a comprehensive drying process and subsequent pulverisation using a mortar and pestle. The powder was introduced into the thimble subsequent to the thorough cleansing and drying of the Soxhlet extractor. The extraction process was conducted at a temperature of 80 °C in a later phase following the heating of 100 mL of acetone to its boiling point. The heated acetone was then transferred into a round-bottom flask. A minimum of 20 iterations were required for the transfer of the extract from the round-bottom flask to the thimble apparatus. The colour of the material that was extracted,

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specifically green, served as an indicator for the presence of phytochemicals. The cucumber tree leaves extract was subjected to filtration using Whatman No. 1 filter paper in order to remove any impurities. Subsequently, the filtered extract was stored under controlled low temperature conditions to maintain its effectiveness. The meticulous protocol ensured that the cucumber tree leaves extract attained the utmost quality and was suitably processed for use in further investigations or practical implementations. [11]

Synthesis of silver nanoparticles (Cucumber tree leaves-AgNPs)

A conventional laboratory procedure was employed to produce a solution of silver nitrate with a concentration of 1 mM. Subsequently, this solution was utilised in the manufacture of silver nanoparticles through the utilisation of Averrhoa bilimbi extract. The silver nitrate solution and Cucumber tree leaves extract were subsequently mixed in a 1:5 proportion under thorough agitation. Following the amalgamation process, the colour of the combination underwent a rapid transition from a pale green hue to a vibrant chrome yellow shade, which then evolved into a brownish tint as time progressed. [12] The cucumber tree leaves-AgNPs were subsequently obtained in a desiccated, pulverised form for subsequent investigation following the establishment of stability under ambient conditions for a duration of 24 hours (refer to Figures 1 and 2). The initial inquiry provided a foundation for validating the synthesised cucumber tree leaves-AgNPs using nanometrological instrumentation. To ensure the nanoparticles have the necessary properties and characteristics for potential utilisation in biological contexts, such as anti-cancer and antibacterial applications, it was imperative to verify the synthesis of such nanoparticles. [13]

Results and discussion

The use of nanoparticles has lately experienced a surge in popularity within the medical domain, particularly in relation to the management of cancer. Silver nanoparticles have garnered significant attention in the scientific community owing to their distinctive characteristics and possible use in cancer therapy. The present investigation examined the process of manufacturing synthetic silver nanoparticles derived from cucumber tree leaves extract (referred to as cucumber tree leaves-AgNPs) and evaluated its potential effects on cancer cell lines. [14]

Phytochemical analysis

Several phytochemicals were identified in the aqueous leaf extract of cucumber tree leaves, and they were found to have a significant role in reducing and stabilizing AgNPs. A qualitative study led to the discovery

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of a variety of secondary metabolites that exhibit potential for a wide array of biological and commercial applications. The first section of the ESI provides a comprehensive summary of the aforementioned findings. The Ag+ ions underwent a conversion process, resulting in the formation of Ag0 atoms, which played a crucial role in the biosynthesis of AgNPs using the cucumber tree leaves extract. The extract's unique combination of phytochemicals exhibits properties of both reducing agents and stabilizers, hence effectively inhibiting the nanoparticle's degradation. Aggregating and facilitating their uniform dispersion in an aqueous medium. This study highlights the potential of Aver-rhoa bilimbi leaf extract as a sustainable and eco-friendly alter- native to conventional chemical methods for the synthesis of silver nanoparticles. Natural plant extracts can reduce the environmental impact from the synthesis of nanoparticles and provide a cost-effective and scalable approach for synthesizing nanoparticles with desired properties. [15]

Nanometrology of silver nanoparticles

The progression of the synthesis was monitored using UV-visible spectroscopy, and data was acquired using a UV-160V spectrophotometer. The utilisation of this methodology facilitated the quantification of the absorption spectra of the samples' electromagnetic spectrum within the ultraviolet and visible regions. This enabled the acquisition of valuable insights into the electronic transitions and chemical composition of the synthesised nanoparticles[16].

Following the synthesis process, the desiccated cucumber tree leaves-AgNPs specimen was subjected to Fourier Transform Infrared (FTIR) examination in order to ascertain the presence of any biomolecules utilised during the synthesis. The Fourier Transform Infrared (FTIR) spectra provided insight into the functional groups and chemical bonds responsible for the synthesis and stability of the nanoparticles. The nanoparticles underwent further characterization by the use of several techniques, such as X-ray diffraction (XRD), scanning electron microscopy (SEM), energy-dispersive X-ray spectroscopy (EDX), and transmission electron microscopy (TEM). The size, shape, and distribution of the nanoparticles were seen through the utilisation of scanning electron microscopy (SEM) and transmission electron microscopy (TEM), while their elemental composition was analysed by energy-dispersive X-ray spectroscopy (EDX). The crystalline structure of the nanoparticles was ascertained by an analysis of the crystallographic orientation and lattice spacing. The comprehensive characterisation of the cucumber tree leaves-AgNPs, which were synthesised using the aqueous leaf extract of cucumber tree, was achieved by the integration of several analytical methodologies. [17] The aforementioned discoveries provide insight on the fundamental

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principles that govern the process of synthesising AgNPs using natural extracts, and highlight their potential applications in many industries such as medicine, electronics, and catalysis. [18]

UV-visible spectroscopy analysis

Noble metal nanoparticles, such as silver, gold, platinum, and copper, exhibit distinct optical features attributed to the phenomenon of surface plasmon resonance (SPR). Nanoparticles possess the ability to absorb light energy through a collective oscillation response to specific frequency light radiation. The proximity of the conduction and valence bands in metals facilitates the facile movement of electrons between them, hence explaining why this phenomenon is exclusively observed in metal nanoparticles. As a result, the absorption peak of surface plasmon resonance (SPR) serves as a distinctive feature of synthetic noble metal nanoparticles. [19] The production of metal nanoparticles necessitates meticulous manipulation of their dimensions, structure, and configuration. The Mie theory provides an explanation for the dependence of the SPR absorption peak on several factors such as particle size, the dielectric medium in which the particles are situated, and the prevailing chemical conditions. As the size of the nanoparticle decreases, there is a shift in the SPR peak towards the shorter wavelength side. The aforementioned phenomena holds significant ramifications in the realm of metal nanoparticle development and utilisation, as it has been substantiated via both theoretical and empirical investigations. [20]

In recent studies, the SPR absorption peak of noble metal nanoparticles was observed in the visible range at 460 nm, which is a promising result compared to theoretical predictions (Fig. 3). This finding suggests that the synthesis and control of noble metal nanoparticles can be optimized to achieve specific optical properties. Furthermore, the SPR phenomenon offers a unique platform for developing novel optical sensing and imaging applications, including bioimaging and biosensing. The surface plasmon resonance phenomenon exhibited by noble metal nanoparticles is a fascinating field of research that offers significant potential for developing new technologies and applications. The ability to control the size, shape, and morphology of metal nanoparticles, and their optical proper- ties, provides opportunities for designing advanced materials with tailored properties for specific applications. [21]

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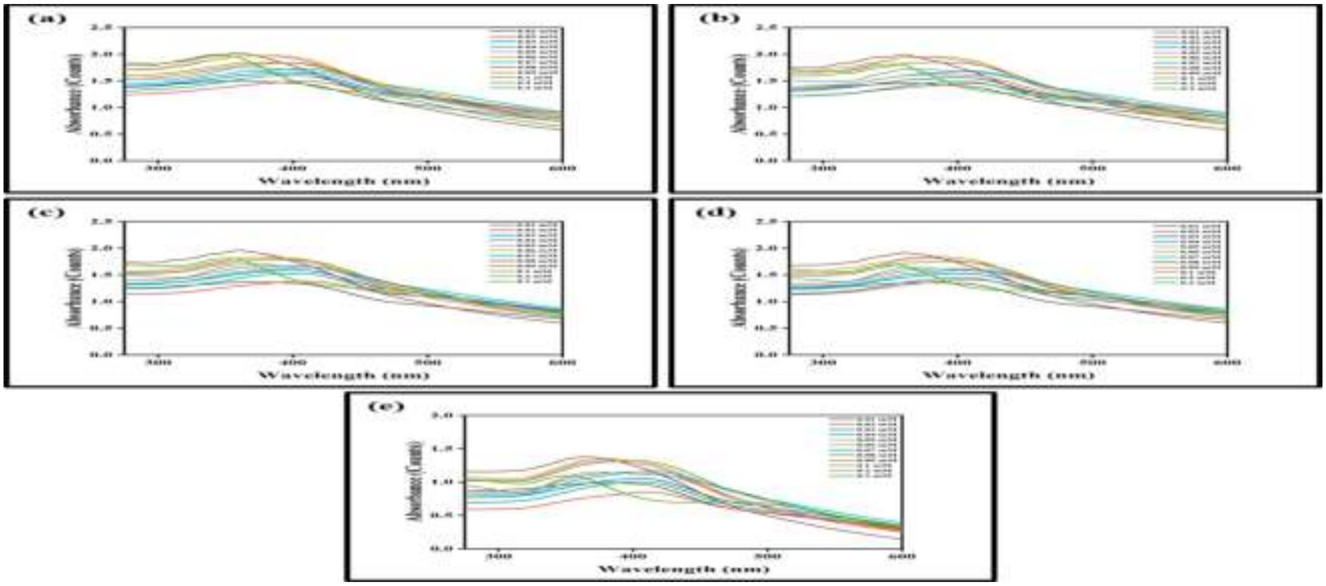

Fig. 3 UV-visible spectrum of cucumber tree leaves-AgNPs.

X-ray diffraction analysis

The composition and crystalline properties of cucumber tree leaves-AgNPs were investigated using X-ray diffraction (XRD) analysis. The aforementioned technique is frequently employed for the purpose of investigating the organisation of various compounds, such as nanoparticles, inside their respective crystalline frameworks. The utilisation of X-ray diffraction (XRD) analysis facilitated the identification and quantification of the unique crystallographic structure of the material found in the AB extract, as well as the determination of the dimensions of the synthesised AgNPs. The X-ray diffraction (XRD) spectra revealed the presence of a crystalline structure in the cucumber tree leaves-AgNPs. Additionally, an investigation was conducted to examine the variations in the oxidation status of the particles as time progressed. Figure 4 depicts the presence of silver nanoparticles, which are postulated to exist at the nanoscale. The determination of the average particle size was conducted utilising the Debye-Scherrer formula, which takes into consideration the prominent peaks detected at 45.1° and 64.7°. The X-ray diffraction (XRD) pattern exhibited a clear correspondence with the crystallographic planes (117), (221), (132), (311), and (220). The study of transmission electron microscopy (TEM) pictures revealed comparable peaks in the silver nanoparticles (AgNPs) that were synthesised using cucumber tree leaves extract. The X-ray diffraction (XRD) peak patterns exhibited notable sensitivity to variations in nanoparticle size, underscoring the imperative of maintaining precise control over particle size over the entirety of the production process. [22]

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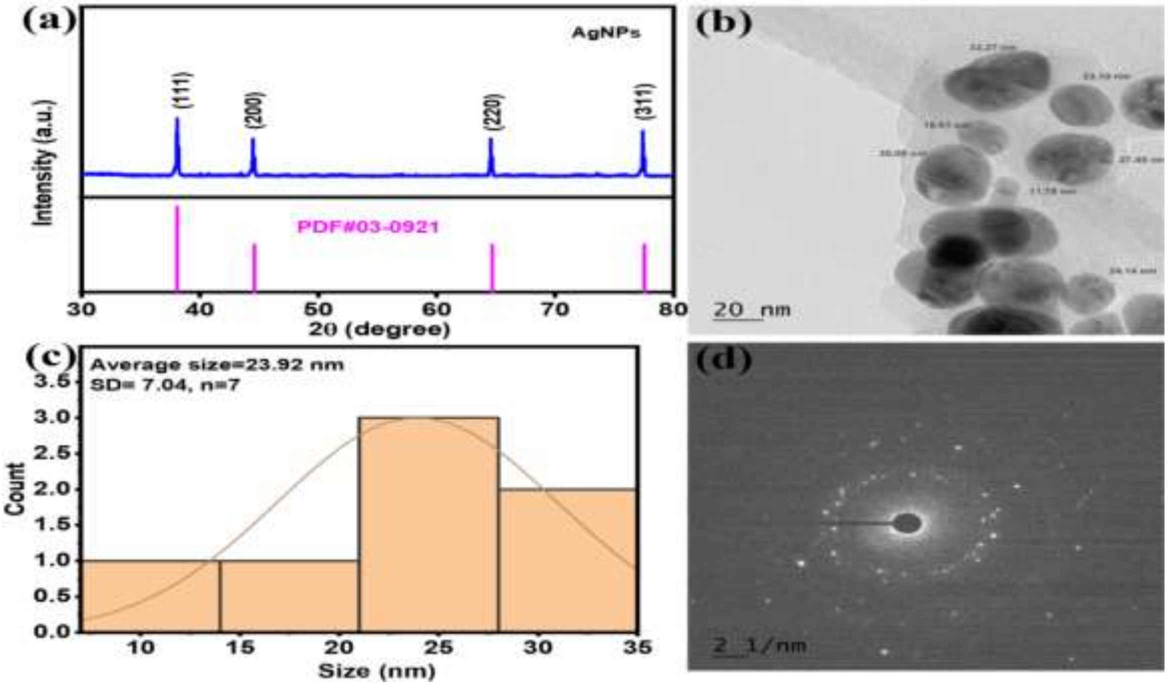

Fig. 4 XRD the cucumber tree leaves-AgNPs

Fourier transform infrared spectroscopy

The utilisation of FTIR spectroscopy is crucial for the examination of the role played by plant extracts in the reduction of silver. The methodology entails the examination of the surface chemistry of nanoparticles derived from plant extracts by the use of infrared light. The identification of a sample and the determination of the functional atoms and chemical bonds of the phytochemicals present may be achieved via the analysis of absorption and transmittance values of infrared light. Figure 5 illustrates the process of synthesising cucumber tree leaves-AgNPs through the use of plant extracts as reducing agents. The FTIR spectra of the cucumber tree leaves-AgNPs exhibited absorption peaks at 3111.1, 2728, 1821, 1250, and 683 cm^{1}, which suggest the existence of phytoconstituents acting as capping agents. Subsequent measurements conducted at wavelengths of 3321cm^{1}, 1832 cm^{1}, 1621 cm^{1}, 1388 cm^{1}, 1256 cm^{1}, and 847 cm^{1} validated the presence of the aforementioned peaks. The absorption peak seen at a wavenumber of 3325 cm^{-1} corresponds to the stretching mode of the "polymeric" hydroxyl group, whereas the peak observed at 1722 cm^{1} signifies the presence of the characteristic aldehydic functional group. The prominent peaks seen at 1055 cm1 were attributed to the stretching vibrations of aliphatic compounds containing -C]C and -C]F functional groups. Conversely, the absence of a peak at 1832 cm^{1} indicated the presence of an amide molecule. The presence of peaks at 587 cm^{1} indicates that both alcohol and -OH

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groups exhibited out-of-plane bending. The majority of these peaks exhibited associations with phenolic chemicals, including polyphenols, triterpenoids, alkaloids, steroids, carbohydrates, and tannins. These compounds were shown to be present in sufficient proportions within the leaf extract. The presence of these phytochemicals may facilitate the synthesis of cucumber tree leaves-AgNPs by acting as both capping and reducing agents. Hence, the utilisation of FTIR spectroscopy in the present study to determine the mechanism by which the plant extracts effectively diminished the concentration of silver nanoparticles is deemed straightforward and appropriate. The absorption bands seen in the study provided valuable information on the surface chemistry of the synthesised nanoparticles. This data has the potential to optimise the manufacturing process and enhance the quality of the final product. [23]

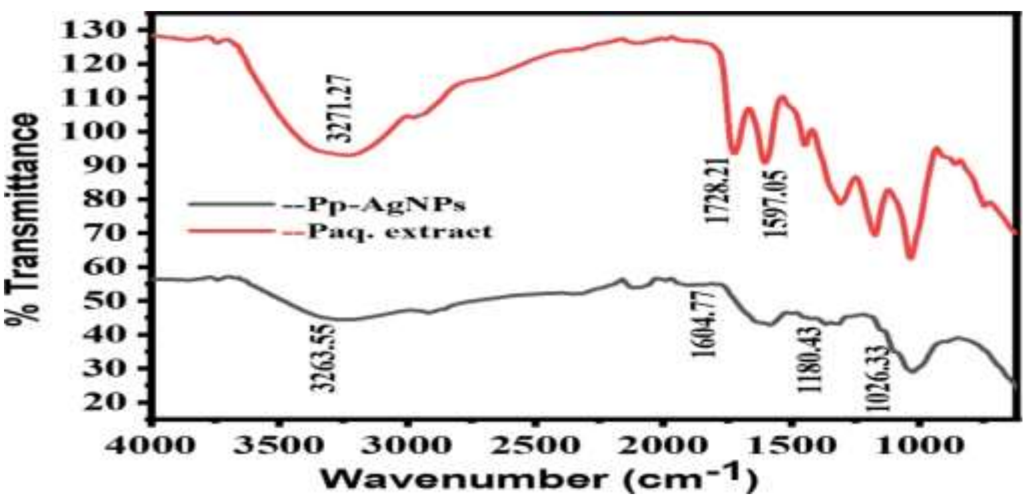

Fig. 5 FTIR spectrum of cucumber tree leaves-AgNPs

Scanning electron microscopy (SEM) analysis

The form of cucumber tree leaves-AgNPs plays a crucial role in determining their physicochemical properties and potential applications. The present study employed scanning electron microscopy (SEM) to meticulously examine the morphology of cucumber tree leaves-AgNPs. The results of our study indicate that the cucumber tree leaves-AgNPs exhibited a spherical morphology, displayed uniform dispersion, and exhibited a size distribution ranging from 3 to 5 nm. The potential applications of nanoparticles in the fields of nanotechnology and healthcare are contingent upon their minuscule size. Furthermore, an elemental investigation was conducted utilising energy-dispersive X-ray spectroscopy (EDX), revealing a prominent absorption peak at 3 keV corresponding to silver. The observed summit provided evidence of a substantial concentration of silver, which serves as the primary constituent of cucumber tree leaves-

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AgNPs. The homogeneous distribution of the cucumber tree leaves-AgNPs was further established by microscopic scanning electron microscopy (SEM) inspection, as shown in Figure 6. The synthesised cucumber tree leaves-AgNPs exhibited favourable properties and shown potential for utilisation in several fields, such as medical imaging, biosensing, and pharmaceutical delivery. [24]

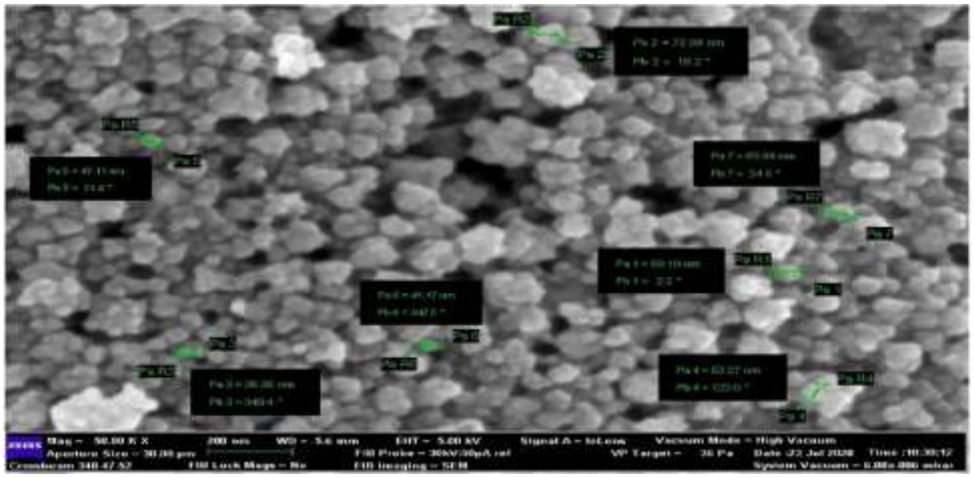

Fig. 6 SEM images of the cucumber tree leaves-AgNPs samples

Transmission electron microscopy (TEM) analysis

Transmission electron microscopy (TEM) is a commonly employed advanced scientific technique for the examination of the form and size distribution of silver nanoparticles (AgNPs). The identification of nanoparticles is made possible by the high resolving power of transmission electron microscopy (TEM), which is achieved by the interaction of nanoparticles with an electron beam and the subsequent imaging on a photographic plate. The morphological properties of AgNPs may be accurately determined by the use of transmission electron microscopy (TEM), enabling the measurement and characterization of their size and shape. In order to facilitate electron transmission, a sample of exceedingly small thickness is required for transmission electron microscopy (TEM) analysis. [25] The use of this instrument facilitates the determination of the size, shape, and morphology of nanoparticles, as well as the exploration of their topographical structure. Based on the findings of the transmission electron microscopy (TEM) analysis, it was observed that the cucumber tree leaves-AgNPs exhibited a spherical morphology and possessed a crystalline structure. The utilisation of Image software for imaging purposes unveiled that the size of these nanoparticles was found to be less than 5 nanometers. The transmission electron microscopy (TEM) image of the cucumber tree leaves-AgNPs revealed the presence of several crystals characterised by distinct

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boundaries. The crystallinity of the synthesised cucumber tree leaves-AgNPs was verified by the examination of the lattice pattern and selected area electron diffraction (SAED) pattern, as seen in Figure 7. These patterns demonstrated that each grain exhibited a distinct lattice plane orientation in various directions. [26] The SAED design included a multitude of concentric bright-colored rings, including rings (111), (200), (220), and (311). The observed rings in the X-ray diffraction (XRD) study were found to be consistent with the planes, so providing confirmation of the existence of a face-centered cubic lattice (fcc). Transmission electron microscopy (TEM) is a very effective technique utilised for the analysis and characterisation of nanoparticles, specifically in terms of their morphology, size, and form. The high-resolution transmission electron microscopy (TEM) technique was employed to observe the polycrystalline structure of the cucumber tree leaves-AgNPs. This enabled researchers to gain a deeper understanding of the features shown by these nanoparticles. Comprehending these concepts is of utmost importance in the development of innovative nanoparticle applications across diverse sectors, including environmental research, electronics, and medicine. [27]

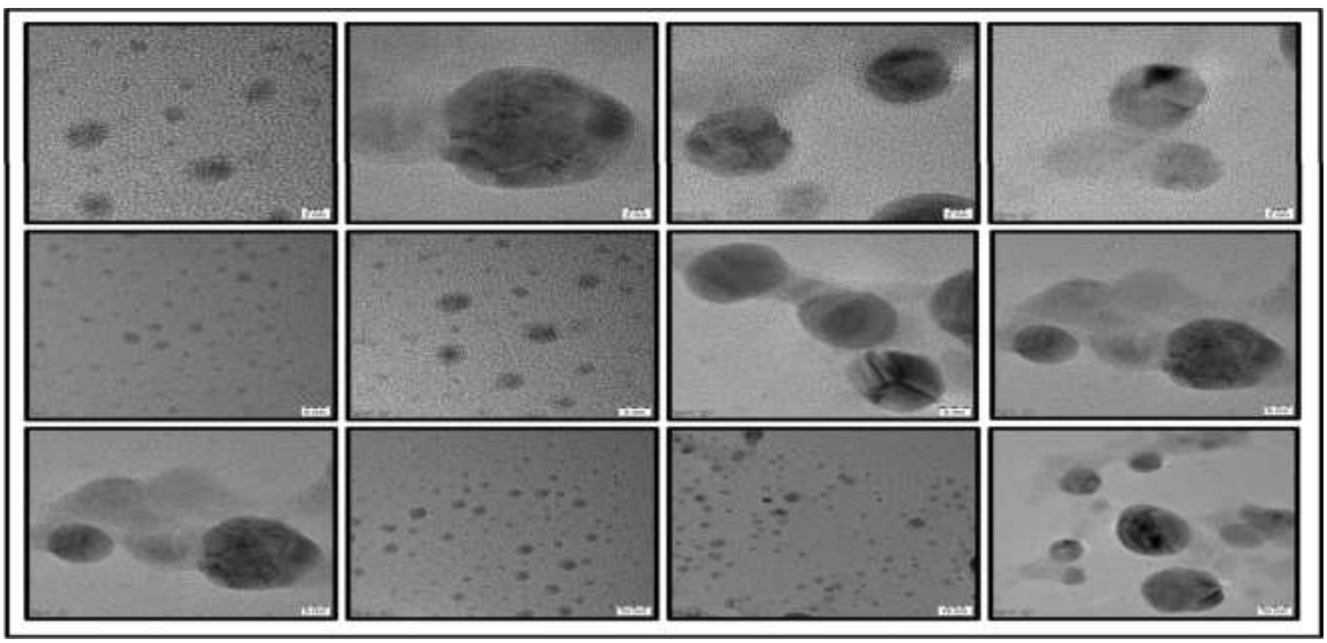

Fig. 7 TEM images of cucumber tree leaves-AgNPs.

MCF-7 and A549 cell lines Cytotoxicity analysis:

The investigation analysed the response of two cancer cell lines, namely A549 and MCF7, to silver nanoparticles synthesised using an extract derived from Averrhoa bilimbi leaves (refer to Figure 8).

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Previous research has reported that the silver nanoparticles derived from Anthemis atropatana have an average size ranging from 10 to 80 nm. These nanoparticles have demonstrated significant inhibitory effects against the MCF-7 cell line, with an effective IC50 value of 20 mg mL^{1}. Additionally, the HT29 cancer cell line has shown a notable response to these nanoparticles, as evidenced by an observed IC50 value of 63.2. The silver nanoparticles derived from Lavandula officinalis had a particle size of 100 nm when tested on U87MG cells. Similarly, Rhynchosia suaveolens and Artemisia nilagirica nanoparticles demonstrated particle sizes of 21.22 nm on MCF7 cells at a concentration of 0.15 mg mL1. The IC50 value of the substance under investigation is determined to be 7.53 mg mL^{-1}. The findings indicated that the nanoparticles had cytotoxic effects on both cell lines, leading to significant morphological changes in MCF-7 cells upon exposure. [28] The process of cell development was impeded due to the compromised structural integrity of the cell membrane. Furthermore, the presence of unique cell clumping and cytoplasmic shrinkage was observed, phenomena that were not observed in control cells treated without silver nanoparticles (AgNPs). The therapeutic potential of plant-based AgNPs against the MCF-7 and A549 cell lines was evaluated by assessing cell survival by the MTT assay following continuous treatment with varying doses of the nanoparticles for duration of 24 hours. [29] The phase-contrast microscope images captured the cell density and shape. The results indicated that increasing the quantities of AgNPs proved to be a very efficacious approach in inhibiting the growth of cancer cells. The inhibitory concentration (IC50) of the phyto-mediated silver nanoparticles (AgNPs) was determined to be 49.52 mg mL^{-1} for A549 cells and 78.40 mg mL^{-1} for MCF7 cells. The cell viability exhibited a reduction as the concentration of phyto-mediated AgNPs increased. Based on the findings of the research, it has been shown that silver nanoparticles have the potential to induce cellular harm and initiate the production of reactive oxygen species, so potentially affecting the process of apoptosis. The chemotherapeutic features of AgNPs include their ability to cause apoptosis-dependent controlled cell death, even in the absence of the tumour suppressor p53. In this particular methodology, silver nanoparticles (AgNPs) serve as a conventional therapeutic agent for cancer treatment, selectively inducing apoptosis in cancer cells characterised by the absence of the p53 gene. Furthermore, the targeted drug delivery activity of the silver nanoparticles (AgNPs) and their ability to induce apoptosis have been shown in nanoparticles with diameters ranging from 5 to 35 nm. These findings underscore the potential of plant-based silver nanoparticles (AgNPs) as a viable avenue for the development of anticancer therapeutics. However, further study is required prior to the potential use of these nanoparticles in clinical environments in order to evaluate their effectiveness and safety. In its whole, this study establishes a foundation for forthcoming investigations in this domain and

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provides valuable insights into the therapeutic efficacy of plant-derived silver nanoparticles in combating cancerous cells. [30-49]

Anticancer activity of cucumber tree leaves-AgNPs

The process of cancer cell apoptosis is a multifaceted phenomenon that involves the use of several mechanisms. Reactive oxygen species (ROS) are a commonly implicated pathway in the progression of apoptosis. The size of the silver nanoparticles employed in the technique exerts an influence on the generation of reactive oxygen species (ROS). Illustrates a signal transduction process consisting of three sequential steps that ultimately lead to cellular demise. The cucumber tree leaves-AgNPs are capable of binding to the receptor protein known as p53, so facilitating the transmission of a chemical signal into the nucleus of the cell. This interaction represents the initial stage of the process. The protein p53, which exhibits anti-tumor properties, regulates the process of cell division and inhibits uncontrolled proliferation. Normal cells typically possess very low levels of p53 protein, but a significant proportion, around 50%, of human cancer cells exhibit p53 mutations. The subsequent stage involves the primary receptor proteins initiating the activation of supplementary second messenger proteins. The transmission of signals to the nucleus and other cellular components is also facilitated by these secondary messengers. The activation stage requires ATP energy, which then triggers the activation of enzymes involved in metabolic processes. Signal transduction pathways encompass a series of enzymatic activations. The final stage involves the cellular response to halt the activation process, leading to disruption of the mitochondrial transmembrane potential. [31] The suppression of a cell's respiratory system leads to its subsequent demise. An area of research that shows great potential is the use of silver nanoparticles for inducing apoptosis in cancer cells. The precise mechanism of action provides a customised approach for the treatment of cancer cells, with the aim of reducing potential damage to healthy cells. Further investigation is required in order to fully appreciate the effects of silver nanoparticles on healthy cells and their potential utility in therapeutic contexts. Recent research has yielded encouraging findings about the synthesis of silver nanoparticles (AgNPs) by the sustainable amalgamation of Mentha arvensis, a botanical species commonly referred to as 'corn mint'. Based on the findings of the investigation, it has been shown that the synthesised silver nanoparticles (AgNPs) has the ability to effectively eliminate breast cancer cells, specifically by triggering caspase-9-mediated apoptosis in MCF-7 cells 37. The targeted introduction of silver nanoparticles into cells, which is commonly referred to as targeted drug administration, serves as the fundamental mechanism for the selective eradication of cancer cells. The concentration of silver nanoparticles generated in normal

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and cancer cell types exhibits variation across different pH levels. A decrease in pH levels leads to a higher proportion of releases, suggesting a selective and effective targeting of cancer cells for elimination.The buildup of silver nanoparticles (AgNPs) within cancer cells in the range of 38-40 nm has been seen to result in increased cellular viscosity and disruption of vital biological processes, ultimately leading to cellular death. During the course of this technique, the activation of Caspase 9, an enzyme responsible for initiating the process of programmed cell death, is induced. The use of green synthesis methodologies, particularly those derived from plants, has many notable benefits when compared to conventional synthesis processes. These advantages encompass cost-effectiveness, environmental sustainability, and reduced levels of toxicity.[32] Moreover, this approach facilitates the development of personalised drug delivery systems, which provide significant benefits in the context of cancer therapy, where targeted cell eradication is crucial. Further investigation is necessary in order to have a comprehensive understanding of the possibility of environmentally friendly manufacturing of silver nanoparticles (AgNPs) in the context of cancer therapy. However, these findings present a promising advancement in the development of more effective and personalised cancer therapies, with a focus on mitigating the adverse effects on normal cells.[33]

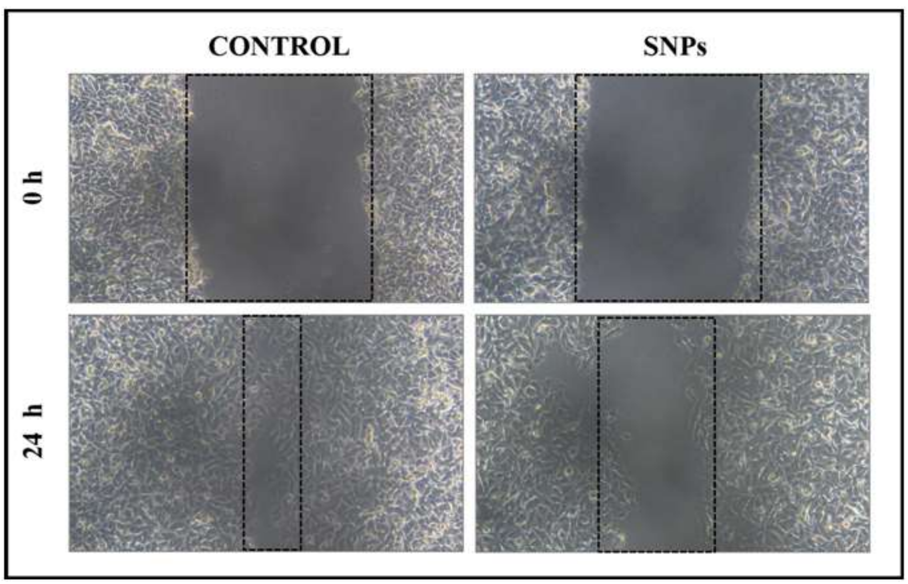

Fig. 8 Variation of the percentage viability vs. concentration of cucumber tree leaves-AgNPs.

Conclusions

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The utilisation of Cucumber Tree Leaf extract for the production of silver nanoparticles is considered a secure and ecologically sound methodology. Various analytical techniques, such as UV-visible spectroscopy (UV-vis), Fourier-transform infrared spectroscopy (FTIR), X-ray diffraction (XRD), and scanning electron microscopy (SEM), were employed to evaluate the synthesised Cucumber Tree Leaf -AgNPs. The Fourier Transform Infrared (FTIR) analysis indicated the presence of hydroxyl and carbonyl functional groups in the extract's phytochemicals. These groups were seen due to the surface plasmon resonance observed at a wavelength of 459 nm, as well as the phytochemicals' capacity to decrease and encapsulate the nanoparticles. The size validation of nanoclusters, ranging from 632 to 91 nm, was conducted by scanning electron microscopy (SEM) examinations. These findings were then compared with the results obtained from X-ray diffraction (XRD) analysis, which confirmed the presence of a face-centred cubic (fcc) structure. The validity of this structure was further verified by the customary Joint Committee on Powder Diffraction Standards (JCPDS) data. The present study aimed to evaluate the inhibitory potential of Cucumber Tree Leaf -AgNPs on the growth of breast cancer (MCF7) and lung cancer (A549) cell lines, under optimal conditions. The IC50 values against A549 and MCF7 cells at the lowest dosages of cucumber tree leaves-AgNPs were determined to be 49.52 mg mL^{-1} and 78.40 mg mL^{-1}, respectively. The dose-dependent cytotoxic effect of cucumber tree leaves-AgNPs on both cancer cell lines. The biosynthesized cucumber tree leaves-AgNPs have remarkable potential as future anticancer therapeutics. [34]

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