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Exploring the Synthesise and Potential Application of Silver Nanoparticle from Physalis Minima

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I. INTRODUCTION

Physalis minima

Medicinal plants may provide chemicals with unique and intricate structures that can interact with biological systems [1]. The Solanaceae family's fifth biggest genus, Physalis, includes a significant number of plants that are utilized as food and natural treatments [2]. Almost 100 genera and 2500 species, spread across the globe, make up the Solanaceae, or nightshade, family [3]. The leaves are soft and smooth, without any hairs, and have either intact or slightly serrated edges. They typically range in length from 2.5 to 12 cm. The flowers are a delicate cream to yellowish colour. The fruit has a flavour similar to cherry tomatoes and tastes delicious when fully ripe [4]. Physalis minima A tiny herbaceous annual plant, linn is cultivated as a weed in agricultural areas. The plant, which has a bitter flavour, is used as a laxative, diuretic, tonic, and to treat ascites, inflammation, splenic enlargement, and bladder ulcers [1].

1.1 Taxonomical classification

Kingdom: Plantae
Division: Spermatophyta Subdivisions: Dicotyledonnae Class: Angiosperms
Order: Solanales Family: Solanaceae Genus: Physalis
Species: Physalis minima

Binominal name: Physalis minima Linn [4].

Fig: 1 Physalis Minima

Fig:2 Physalis Minima

1.2 Therapeutic activity:

It is known to have a variety of pharmacological characteristics [5] ,[6]

Pharmacological Activity	Description	Bioactive Compounds in Physalis minima
Anti-inflammatory	Reduces inflammation and swelling	Flavonoids, Alkaloids, Saponins
Antipyretic	Reduces fever	Glycosides, Phenolics
Analgesic	Relieves pain	Alkaloids, Terpenoids
Cytotoxic	Toxic to cells, used in cancer treatment	Steroids, Alkaloids
Antibacterial	Inhibits bacterial growth	Essential oils, Tannins
Anti-ulcer	Prevents or heals ulcers	Saponins, Flavonoids
Antifertility	Reduces fertility or affects reproduction	Phytosterols, Alkaloids

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Antioxidant	Prevents oxidative stress and free radical damage	Phenolic compounds, Vitamin C
Antimicrobial	Inhibits microbial growth (bacteria, fungi, viruses)	Terpenoids, Alkaloids
Anticancer	Prevents or treats cancer by inhibiting cell growth	Flavonoids, Polyphenols
Antidiuretic	Reduces urine output	Tannins, Glycosides
Anti-diabetic	Controls blood sugar levels	Alkaloids, Flavonoids, Polyphenols

II. NANOTECHNOLOGY

One of the key areas of modern science that enables researchers to learn about extraordinary nanoparticle (NP) size advancements is nanotechnology [7]. NPs are defined as particles with a diameter of less than 100 nm. To create metal nanoparticles (NPs) as tiny as feasible, many techniques are employed. In general, the approaches may be divided into four categories: chemical, physical, photochemical, and organic [8]. Since more than a century ago, silver has been utilized to treat medical conditions because of its inherent antibacterial and antifungal qualities. The bacteria and fungi that cause illness, Odor, itching, and sores are prevented from growing and multiplying by the nano silver. A variety of different medical goods, including bandages for burns, scalds, skin donor and recipient sites, sores from acne and cavities, and feminine hygiene items including trousers, sanitary towels, and panty liners, can be made with nano silver [9].

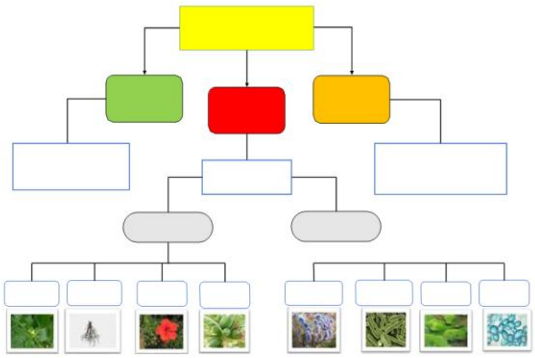
2.1 Green synthesis

A silver metal ion solution and a reducing biological agent are essential for the environmentally friendly production of AgNPs. It is not necessary to introduce capping and stabilizing agents from outside since reducing agents or other components found in the cells often function as these functions [10].

2.2 Principle of green synthesis

The relationship between "green chemistry" and "sustainable development" has been the subject of much research worldwide for less than 15 years. Development that meets present needs while preserving the ability of future generations to fullfill their own needs is one definition of sustainable development. For businesses that rely on chemistry, sustainable development is especially important as it addresses evidence of contamination and inappropriate use of natural resources. Chemistry has traditionally been seen as a hazardous discipline, and the word "chemical" is frequently associated with toxicity and danger. Generally speaking, there are several ways to lower risk by employing what is referred to as protective gear; but, when safety procedures are not followed, the chance of exposure and dangers increases. Significant hazards combined with little exposure can have disastrous consequences, including injury or even death. Therefore, while creating safe, sustainable chemicals and processes, it is essential to minimize inherent risks and reduce the likelihood of accidents and damage [11].

2.3 Material and Method



III. COMPARITATIVE ANALYSIS

Physalis minima and AZADIRACHITA INDICA for the green synthesis of silver nano particle

3.1 Collection of Sample

Neem leaves were picked fresh from the surrounding region. After a thorough washing, the leaves were let to air dry at room temperature [12].

3.2 Preparation of Leaf Extract

10 g of fresh curry leaves were collected in three different beakers each to make neem leaf extract. After being carefully cleaned with tap water and then distilled water at least twice, it was chopped into little pieces. The chopped leaves were individually cooked for three minutes in the first beaker, five minutes in the second, and ten minutes in the third beaker in 75 milliliters of distilled water. After cooling, the leaf broth underwent filtration. For later usage, the beaker was covered with aluminum foil and kept at 4°C. The light green curry leaf extract that was produced was kept at 4°C for further use [13].

3.3 Synthesis of silver nano particle

An aqueous solution of 1 mM silver nitrate was mixed with 10 ml of plant extract. After then, the sample was left in the dark for a full day. UV-Visible spectrophotometry was used to assess the sample's maximum absorbance after a 24-hour period. To get the produced silver nanoparticles for characterisation, the sample was subsequently heat- dried [14].

3.4 Mechanism

Silver nitrate ($AgNO_3$) interacts with plant biomolecules to produce silver nanoparticles (AgNPs) from plants. Ion reduction, cluster formation, and nanoparticle development are the three stages of the process. Hydroxyl (OH) groups found in biomolecules such as proteins, amino acids, alkaloids, flavonoids, polyphenols, enzymes, tannins, carbohydrates, and saponins aid in the reduction of Ag^+ to Ag^0. For instance, kaempferol, naringin, and glycosides found in Punica granatum peel extract aid in the synthesis of AgNP. Similarly, Tulsi leaf extract's quercetin promotes Ag^+ decrease while inhibiting agglomeration. However, different plants have different mechanisms for stabilizing and reducing Ag^+, therefore further study is needed to determine the most important stabilizing and capping agents [15].

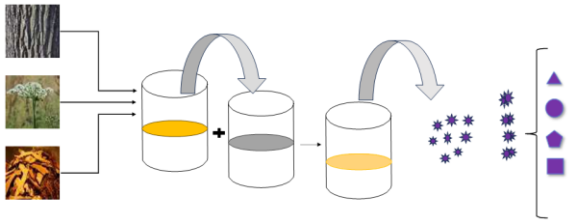


Fig:3 Synthesis-of-AgNPs-through-Green-synthesis-method

IV. CHARACTERIZATION OF SILVER NANOPARTICLES

The size, shape, surface area, and dispersity of the nanoparticles were determined by characterization. UV-visible spectra, scanning electron microscopy (SEM), energy dispersive X-ray analysis (EDX), transmission electron microscopy (TEM), Fourier transform infrared spectroscopy (FTIR), and powder X-ray diffraction (XRD) are the typical methods utilized in this work to characterize nanoparticles [16].

Some of them are above:

4.1 UV-visible spectra

UV-vis spectroscopy is a rapid, simple, useful, sensitive, and targeted technique for characterizing various NP kinds. It is very effective and reliable for the first characterization of produced nanoparticles [17]. The optical properties of the biosynthesized silver nanoparticles were examined by collecting one milliliter of the colloidal silver nanoparticle solution in a test tube and diluting it with two milliliters of deionized water. After that, the material was scanned using a UV-Visible Spectrophotometer between 350 and 750 nm. Certain light wave lengths can interact intensely with AgNPs due to their unique properties [18].

4.2 Fourier transform infrared spectroscopy (FTIR)

Indicates that chemicals and metabolites contribute to the reduction and capping of Ag NPs as well as the presence of chemical residue on their surface. This interaction occurs when infrared (electromagnetic radiation) interacts with molecular bonding to produce stretching and bending vibrations (in the

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4000-400 cm-1 region). It is quick, cheap, non-destructive (when used with the attenuated total reflectance accessory), and very repeatable, but it only provides qualitative data and is less sensitive to nanoscale investigation [19].

4.3 Scanning Electron Microscopy

The development of several high-resolution microscopy techniques to learn more about nanomaterials employing a stream of very intense electrons to explore things on a very tiny scale has been fueled by the fields of nanoscience and nanotechnology. The ability to resolve varied particle sizes, size distributions, nanomaterial forms, and the surface morphology of the produced particles at the micro and nanoscales is one of the many electron microscopy techniques that SEM is a surface imaging approach [20].

4.4 Transmission electron microscopy

TEM allows for the numerical measurement of particle size, distribution, morphology, and shape of particles. TEM is a significant, extensively applied, and necessary technological advancement. The distance between the objective lens and its picture plane and the distance between the objective lens and the sample determines the TEM's magnification. Two major benefits of TEM over SEM are its higher resolution and capacity for more analytical research [18].

V. APPLICATION OF SILVER NANO PARTICLE

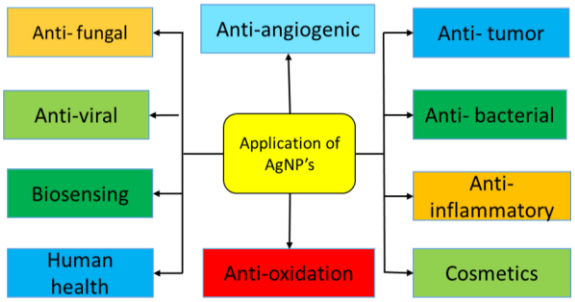

Fig:4 Application of silver nano Particle

5.1 Anti-bacterial

AgNPs' antibacterial properties against both aerobic and anaerobic bacteria are extensively researched by many scientists and research communities worldwide. AgNPs have a strong antibacterial impact because they produce free radicals on their surface that can pass through cell membranes and interfere with intracellular functions [21].

5.2 Antiviral effects

Emerging and re-emerging infectious illnesses caused by viruses, including SARS-CoV-2, influenza A/H5N1, influenza A/H1N1, Dengue virus, HIV, HBV, and novel encephalitis viruses, have been reported to have increased in recent years. Public health is at risk as these viral infections are likely to develop into highly contagious illnesses.

Researchers are still unsure about Ag-NPs' antiviral properties. There aren't many studies that look at how Ag-NPs work against viruses [22].

5.3 Antifungal activity

Silver nanoparticles have demonstrated antifungal efficacy against a variety of fungi. However, the underlying mechanism remains unclear. Silver nanoparticles have a propensity to alter the cell membrane's structure. It has been proposed that silver nanoparticles' antifungal action is due to their detrimental impact on membrane integrity and suppression of the budding process [8].

5.4 Anticancer activity

Silver nanoparticles demonstrated distinct anticancer properties against several cancer cell types [23]. Ag nanoparticles (Ag NPs) have great promise as an anticancer agent and are cytotoxic to cancer cells. Autophagy, a crucial cellular disintegration process, has been demonstrated to be induced by a range of nanoparticles, and in most cases, the increased autophagy leads to cell death. It is unknown if Ag NPs may trigger autophagy and how this could impact their anticancer properties [24].

VI. TOXICITY

AgNPs' size, shape, and coating agents all affect their toxicity. The coating agents for biogenic AgNPs are

crucial in determining their toxicity to human cells and immune response regulation. Evidence suggests that biogenic AgNPs are more biocompatible than those made chemically. However, each biogenic AgNP should be assessed separately to ensure its safety in humans and other animals because of the intricate interactions between the various coating agents and eukaryotic cells. Toxicology is also influenced by pharmacokinetics, exposure duration, and delivery method [25]

VII. FUTURE WORK

The potential of Physalis minima-based AgNPs for medication delivery is another crucial field. It is yet mostly unknown whether they can serve as carriers for targeted medicine delivery in infectious illnesses and cancer. Additionally, the creation of scalable, environmentally friendly manufacturing processes and the standardization of synthesis procedures are crucial for commercial applications.

In order to tackle medication resistance, studies should also examine how Physalis minima AgNPs work in concert with traditional antibiotics and antifungal drugs. Physalis minima-derived AgNPs will have new therapeutic uses in contemporary medicine if these research gaps are filled.

CONCLUSION

There is a lot of potential for pharmaceutical and biological uses of silver nanoparticles (AgNPs) made from Physalis minima, especially for drug delivery, antibacterial, and anticancer applications. But there are still a number of unanswered questions, such as the requirement for in vivo investigations and clinical trials to prove their safety and effectiveness. For their therapeutic use, more research into their mechanism of action, biocompatibility, and toxicity is necessary. Furthermore, their economic viability will be improved by improving standardized and eco-friendly synthesis methods. In order to address resistance, future studies should also concentrate on their potential for targeted medication delivery and synergy with conventional drugs. By filling in these gaps, Physalis minima-derived AgNPs will reach their full potential and become an important tool in contemporary medicine.