GREEN SYNTHESIS OF SILVER NANOPARTICLES USING AQUEOUS EXTRACT OF LYCOPERSICON ESCULENTUM L. VAR. PKM 1

Abstract

Green synthesis is a low-cost and environmentally friendly method of producing silver nanoparticles on a big scale. Silver nanoparticles were created in this study using an aqueous leaf powder extract of Lycopersicon esculentum L. var PKM 1. Characterization of silver nanoparticles at optimum condition was done using SEM analysis. This showed the presence of silver nanoparticles at a higher range in tomato plants treated with mixture of organic fertilizer and biofertilizer rather than the control plant. EDAX analysis showed the presence of various elements at different concentration levels. The elements present in the control tomato plant were Carbon, Oxygen, Silver, Chlorine and Gold. Apart from these elements, the mixture of organic fertilizer and biofertilizer treatment showed the presence of Silicon at 2% level. The percentage of silver in tomato plants treated with mixture of organic and biofertilizers was found to be higher (9%) when compared to the control plant (4%). The percentage of Gold was equal (2%) in both control plants and plants treated with mixture of organic and biofertilizers. The presence of silver in the tomato plants treated with mixture of organic and biofertilizer shows that the plant could be used for the production of particles at nano scale that has a wide range of application in industry.

KeyWords: Biofertilizers, *Lycopersicon esculentum* L., Organic, Silver nanoparticles, SEM

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I. INTRODUCTION

Nanotechnology involves the investigation and manipulation of minuscule objects, and it has rapidly gained prominence in an interdisciplinary field that amalgamates engineering, medicine, chemistry, and biology, effectively blurring the conventional boundaries among these disciplines (Ray et al., 2009). The term "Nanotechnology" was originally coined by Norio Taniguchi from Tokyo Science University in 1974. A nanometer, denoted as nm, is equivalent to one billionth (10^-9) of a meter, and "nano" pertains to a size range spanning from 1 nanometer to 100 nanometers. It has proven to be immensely valuable in enhancing the growth, yield, and health of fruit crops. A noteworthy development in this domain has been the emergence of Nano Diseases (NFs), marking a significant milestone in ongoing research within this field.

Due to their unique properties, nonmaterial’s are especially valuable in biosensing, natural labeling, catalysis, antiviral and antibacterial activity, drug delivery, antioxidant processes, DNA sequencing, and gene therapy (Bharathi et al., 2018). The most well-known types of nanoparticles are metallic and non-metallic. Carbon, silicon, nitric oxide, chitosan, fullerenes, and graphene oxide are examples of non-metallic nanoparticles. Cobalt, titanium, aluminum oxide, copper, silver, gold, palladium, magnesium, manganese oxide, platinum, and zinc oxide are examples of metallic nanoparticles. With an annual production of 500 tons of silver nanoparticles, silver is the most valuable of these metallic nanoparticles (Larue et al., 2014). Businesses are becoming more and more concerned about the potential harm that nanoparticles may cause to the environment.

While fertilizers enriched with nonmaterial’s improve the performance of conventional fertilizers, nano-fertilizers have additional components that improve plant development and output by providing one or more nutrients. Plant-to-plant variation exists in the impact of nanoparticles, which is contingent upon their size and manner of function. Fabrics, residential water elevation systems, medical bias, cosmetics, electronics, and domestic appliances all employ nano-silver. According to Nair et al. (2010), it exhibits potent bactericidal and broad diapason antimicrobial activity. It also lessens a number of plant illnesses brought on by fungi that produce spores.

Various techniques exist for the production of nanoparticles, and they can be broadly categorized as either "wet" or "dry" approaches. Wet synthesis, often termed a "bottom-up" method, entails the gradual formation of nanoparticles at the atomic level through nucleation processes. In contrast, dry synthesis, known as a "top-down" method, involves the breakdown of bulk compounds to yield nanoparticles (Rai, 2016).

The utilization of naturally occurring reagents such as sugars, biodegradable polymers, plant extracts, and microorganisms as reductants and capping agents has garnered considerable attention in nanotechnology (Ahmed and Ikram, 2015). This approach is particularly attractive due to its environmentally friendly and cost-effective nature, promoting human health and minimizing environmental impact by reducing waste production and ensuring product safety.

Among the various methods employed for nanoparticle synthesis, there is a growing interest in utilizing a biological green nanotechnology approach that employs plant extracts.

This approach is favored for its energy efficiency, cost-effectiveness, and its capacity to safeguard both human health and the environment, resulting in reduced waste and safer products. These nanoparticles are typically distinguished by their size, surface area, shape, and dispersity characteristics. Common techniques for their characterization include UV-visible spectrophotometry, Fourier transform infrared spectroscopy (FTIR), scanning electron microscopy (SEM), transmission electron microscopy (TEM), atomic force microscopy (AFM), and X-ray diffraction (XRD).

AgNPs capped with chitosan are a crucial class of nanomaterial for a variety of medicinal applications. Studies on the genotoxicity and cytotoxicity of AgNPs have revealed potential dangers to human health. The genotoxic potentials of green produced AgNPs with chromosomal abnormalities have been documented in the Allium cepa assay (Yekeenet al., 2017).

Objective of the Study

To synthesize silver nanoparticles and characterize them in the test plant using Scanning Electron Microscope

II. MATERIALS AND METHODS

Green Synthesis of Silver Nanoparticles Using Leaf Extract

1. **Preparation of Leaf Extract:** Two samples were taken for testing silver nanoparticle synthesis. About 5g of control plant and tomato plants treated with mixture of organic and biofertilizers were taken for the extract. The samples were transferred into 250 ml conical flask containing 100ml of distilled water and boiled at 60^0C for half an hour. After that, the extract was run through Whatmann No. 1 filter paper to get rid of the particles and obtain a clear solution.

2. **Preparation of Silver Nitrate Solution:** 1mM silver nitrate solution was freshly prepared in distilled water.

3. **Synthesis of Silver Nanoparticles:** For the purpose of analyzing silver nanoparticles, a one millimeter aqueous solution of silver nitrate was produced. A sterile conical flask containing 20 ml of a 1 mM aqueous solution of silver nitrate (AgNO3) was filled with one milliliter of plant extract. For a short while, the solution was heated. Later, the reduction of silver ions was shown by a change in the solution's color from yellow to brown.

4. **Characterization of Silver Nanoparticles:** Different approaches were used to characterize silver nanoparticlessuch as SEM, UV-Vis and FTIR analysis.

   - **SEM Analysis:** Characterizing silver nanoparticles is a common application of scanning electron microscopy methodology. A very little amount of material was applied on a carbon-coated grid to create a thin layer of sample, which was then allowed to dry before being examined under a SEM.

- **EDAX Screening:** The SC7620 Sputter Coater was used to sputter the sample in a nitrogen atmosphere. The aluminum stub was covered with a small strip of carbon tape, and a pinch of sample was placed on the tape. The elemental analysis and particle dispersion were performed with EDAX and the SUTW-SAPHIRE model detector.

III. RESULTS AND DISCUSSION

Green synthesis of silver nanoparticles using control and combined organic and biofertilizer treatment were tabulated with SEM image.

1. **Synthesis of Silver Nanoparticles :** To synthesize silver nanoparticles, a noticeable change in color was observed during the visual examination of tomato leaf extract when it was mixed with a silver nitrate solution that lacked water (Plate 1). The solution was agitated for duration of 2 minutes. The transformation of Ag+ into AgO nanoparticles was tracked through the alteration in the solution's color, transitioning from a light brown to a brownish-red hue, indicating the successful formation of silver nanoparticles. Over time, there was a gradual increase in the intensity of absorption peaks, and this color intensity intensified as the incubation period extended.

   In their study, Farghaly and Nafady (2015) employed Rosemary leaf extract in the biosynthesis of silver nanoparticles (AgNPs). This extract served a dual purpose, acting as both a reducing agent and a stabilizing agent. Their findings demonstrated that the eco-friendly and cost-effective green synthesis of AgNPs from Rosemary leaves was achievable. Furthermore, they investigated the impact of AgNPs on the growth of wheat and tomato plants.

Plate 1: Photograph showing synthesized AgNPs In Solution

2. **Characterization of Silver Nanoparticles:** Generally, nanoparticle synthesis involves physical, mechanical and chemical styles. But these are actually precious and dangerous (Mali *etal.,* 2018). So, with a goal to develop a clean, non-toxic andeco-friendly technologies, different natural sources has been used for nanoparticle formation. The

presence of amino groups, proteins, carbohydrates and carboxylic groups play a vital part in the formation of nanoparticles. Synthesized nanoparticles are important in different fields and so could avail humankind.

Nanoparticles are characterized based on theirshape, size, surface area and distribution (Jiang *et al,* 2009). The common ways of characterizing nanoparticles are as follows.

- **SEM Image:** SEM was used to view the morphology and size of silver nanoparticle. SEM image showed the high viscosity nanoparticle synthesized by tomato plant extract and were fairly globular in shape. This certified the development of silver nanostructures.

  SEM image (Plate 2) of the sample of control tomato plant confirms the actuality of really small and slightly globular nanoparticles. It showed that the silver nanoparticles(AgNPs) were globular in shape with an average size between13.16 nm to33.49 nm. This SEM HV is 25kV that implies stability and spark further conductivity in the view field of2.08 µm.

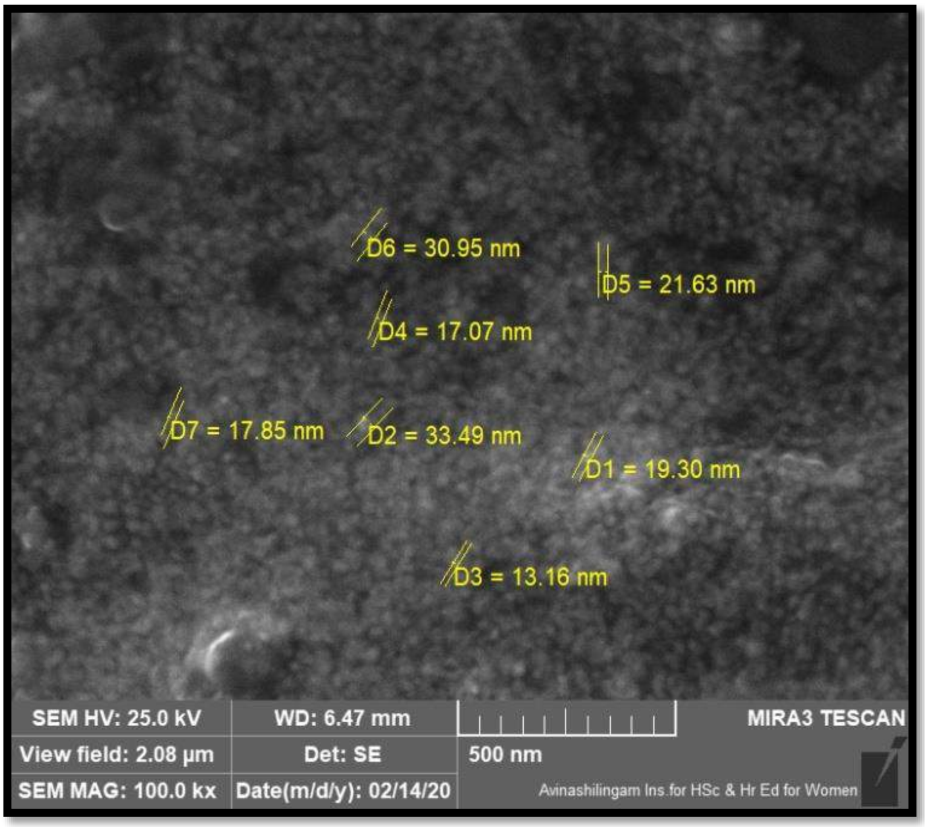

Plate 2: SEM Image of the Sample of Control Tomato Plant

The SEM image (Plate 3) of tomato plant treated with mixture of organic and biofertilizers showed the nanoparticle in the range of 14.03nm -64.22 nm. The SEM HV is 30.0 kV that implies spherical in shape and high conductivity. This size of particle confirms the presence of nanoparticle.

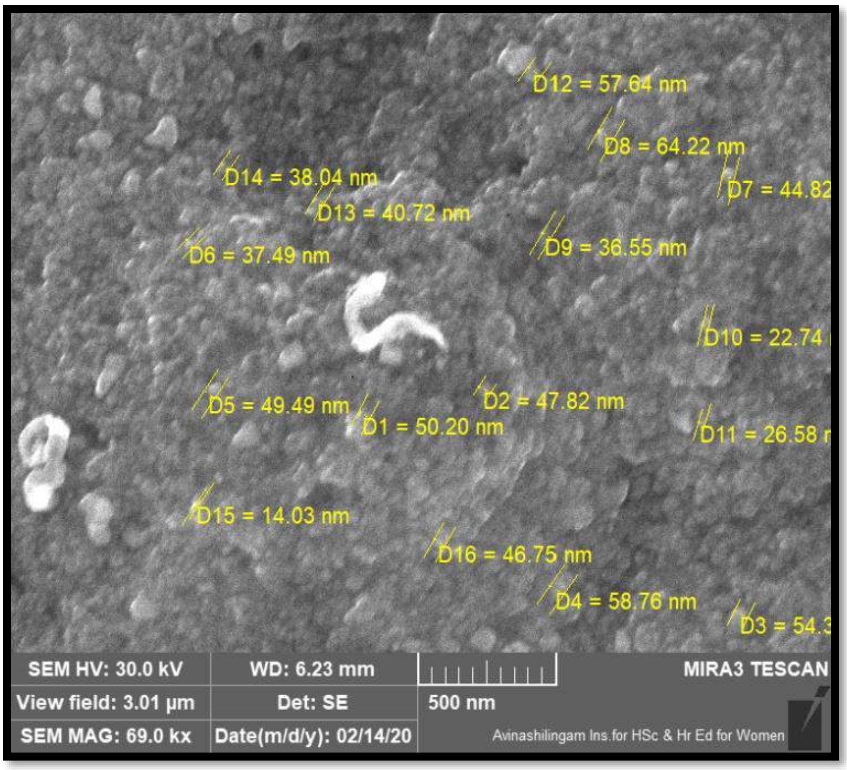

Plate 3: SEM image of tomato plant treated with mixture of organic and biofertilizers

EDAX

Elemental silver was detected and confirmed by examination using an Energy Dispersive X-ray (EDX) spectrometer. The number of X-ray counts is shown in vertical axis, whilst the horizontal axis showsthe energy (KeV). Sharp peaks are observed in EDAX spectrum and 4% elemental silver present in control plant (Fig1; Table 1).

Table 1 Elements present in *Lycopersicon esculentum* L. var PKM 1 of Control plant

Element	Weight%	Atomic%	Elements present in percentage
C	47.96	70.32	62%
O	21.81	24.00	20%
Ag	16.22	2.65	4%
Cl	4.64	2.30	6%
Au	1.37	0.61	2%

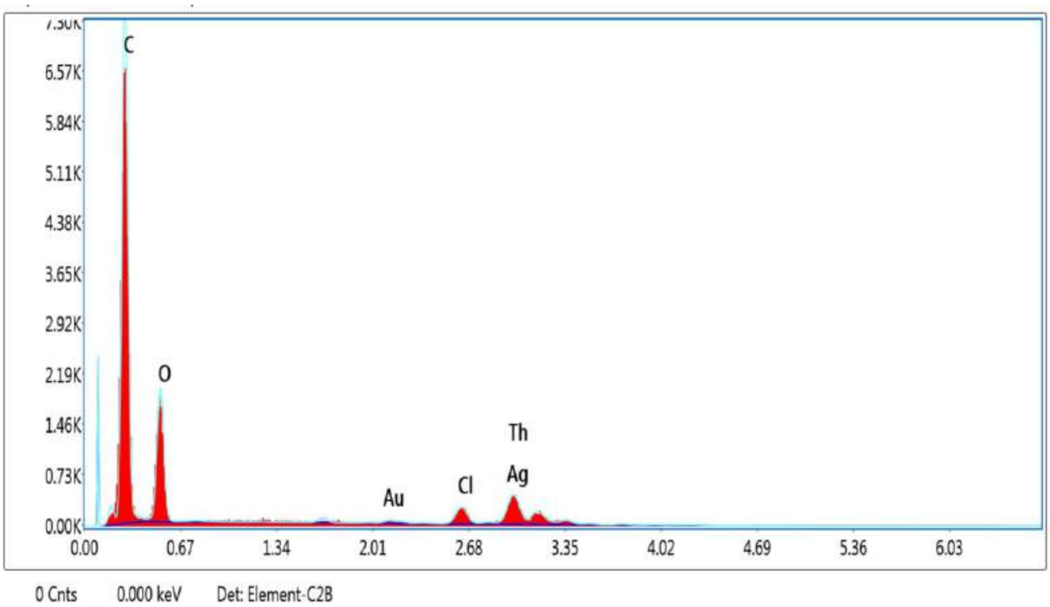

Figure 1: EDAX spectrum recorded showing sharp peak between 2.8 and 3.0 keV confirming the presence of silver in the sample of *L. esculentum* L. var PKM 1 of Control plant

Table 2 and Fig 2 shows the presence of silver ions and the amount of silver present in the sample.In tomato plant treated with mixture of organic and biofertilizers, 9% elemental silver was present indicating the importance of organic and biofertilizers.

Nanotechnology applications in agriculture could be a gift to humanity. It makes better use of agricultural inputs and lowers byproducts that can harm the environment and the health of people (Bhagat *et al.*, 2015). Logeswari *et al.* (2015) investigated the creation of nanoparticles using readily available plant powders. The utilization of plant-based components for nanoparticle biogenesis is considered a Green technology because it does not include any hazardous chemicals and might be used extensively in the medical field because to their effective antibacterial activity.

Tomato is an important vegetable used in our day-to-da life. It can be used as a salad and for various food preparations like juice, soup, sauce, ketchup or puree. The processing by food industry for various products produces large amount of waste at different stages (Many *et al*., 2014) that could be effectively used to produce eco-friendly nanoparticles.

Table 2: Elements present in *Lycopersicon esculentum* L. var PKM 1treated with mixture of organic and biofertilizers

Element	Weight%	Atomic%	Elements present in percentage
C	59.58	73.03	65%
O	26.56	24.45	16%

Ag	10.45	1.43	9%
Cl	2.10	0.87	5%
Au	1.04	0.08	2%
Si	0.28	0.15	2%

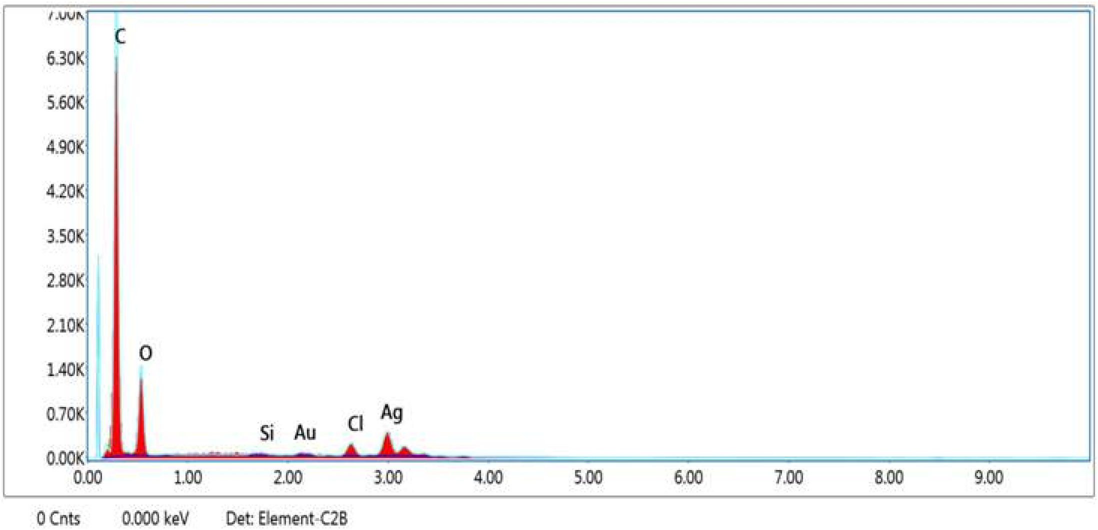

Figure:2 EDAX spectrum recorded showing sharp peak between 2.8 and 3.2 keV confirming the presence of silver in the sample of *L. esculentum* L. var PKM 1treated with mixture of organic and biofertilizers

Green synthesis of nanoparticles is an eco-friendly and economical approach (Sithara *et al*., 2017). Kholoud *et al*. (2010) have studied the synthesis and applications of AgNPs and found that nano-size particles (< 100 nm dia.) are gaining more attention currently for their wide range of application in various industrial fields.

Logeswari *et al*. (2015) have utilized silver nitrate solution for the synthesis of AgNPs from plant extracts.

Because of its applications in science and technology, nanotechnology is an area that is expanding due to the manufacturing of materials at the nanoscale level (Albrecht et al., 2006).

In an effort to better understand silver's presence in tomato plants and how it might be used in future therapeutic development, the current study on the green production of silver nanoparticles is being conducted.

Conflict of Interest

No conflict of interest

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