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Silver Nanoparticles Synthesis from Sargassum Linearifolium Algae and To Study the Growth of Plants

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ABSTRACT

This study presents a novel approach for the synthesis of silver nanoparticles (AgNPs) using extracts derived from the marine algae species Sargassum linearifolium. The green synthesis method demonstrated herein offers a sustainable and eco-friendly alternative to conventional chemical synthesis routes. Characterization of the synthesized AgNPs was carried out using various spectroscopic and microscopic techniques, confirming their size, shape, and stability. Furthermore, the synthesized AgNPs were employed to investigate their impact on the growth and development of mung bean plants (Vigna radiata). The study revealed notable enhancements in seed germination, root and shoot length and plant height in AgNP-treated mung bean plants compared to control groups. These findings suggest a potential application of Sargassum linearifolium-mediated AgNPs in agriculture as a promising nanomaterial for promoting plant growth and productivity, while concurrently offering a sustainable and environmentally benign synthesis method.

Keywords: Silver nanoparticles, green synthesis, Sargassum linearifolium, Vigna radiata, plant growth, eco-friendly synthesis, nanomaterials, sustainable agriculture.

I. INTRODUCTION

The use of nanoparticles in various fields has gained significant attention in recent years due to their unique properties and potential applications. One such type of nanoparticle is silver nanoparticles (AgNPs), which have shown promising results in various fields, including agriculture. In this project, we will focus on the synthesis of silver nanoparticles using the algae species Linearifolium and their potential effects on plant growth. This study focuses on the synthesis of silver nanoparticles using Sargassum linearifolium algae extract, providing a sustainable and cost-effective method for nanoparticle production. Green synthesis methods are of paramount importance in reducing the environmental impact associated with conventional chemical approaches, which often involve hazardous reagents and by-products. Furthermore, this research aims to investigate the potential of the synthesized AgNPs to enhance plant growth. Understanding the impact of AgNPs on plant physiology and development is crucial for harnessing their benefits in agriculture. However, it is imperative to conduct comprehensive studies to ascertain the optimal concentration and application methods to ensure maximum benefits without adverse effects. In this context, this research endeavors to fill the existing gap in the literature by elucidating the growth-promoting effects of AgNPs synthesized from Sargassum linearifolium algae extract. The study will employ a range of analytical techniques to characterize the synthesized nanoparticles and evaluate their potential as a sustainable tool for agricultural enhancement. The utilization of natural resources for the synthesis of nanoparticles has gained significant attention in recent years due to its eco-friendly and sustainable approach. Among these resources, marine algae, such as Sargassum linearifolium, have emerged as promising candidates for nanoparticle synthesis. Silver nanoparticles (AgNPs) derived from S. linearifolium offer a unique avenue for green nanotechnology. This study aims to explore the potential of S. linearifolium in synthesizing AgNPs and subsequently evaluate their impact on the growth of mung bean plants (Vigna radiata). The findings of this research hold significant promise for sustainable agriculture, offering a viable and eco-friendly approach to enhance plant growth and crop yield, ultimately contributing to global efforts towards food security and environmental conservation.

II. METHODOLOGY

- Collection of algae sargassum linearifolium
- Preparation of aqueous extract from sargassum linearifolium
- Synthesis of silver nanoparticles from algae extract using chemical method
- Characterization of synthesized silver nanoparticles using SEM & UV
- Collection of green gram seed
- Spray the synthesized nanoparticles in mung bean
- Measuring the plant parameters like root length, and shoot length.

III. MATERIAL AND METHODS

ALGAE COLLECTION AND PREPARATION

The samples of the seaweed, Sargassum Linearfolium, were taken in commercially from a reputable supplier. The seaweed were rinsed with tap water and washed thoroughly with deionized water in three times. To remove impurities and then air-dried in one day. And cut into the small pieces.

ALGAE EXTRACT PREPARATION

In a 250ml flask, 10g of dried and chopped algae were added to 100ml of distilled water. The mixture was kept in a water bath at 50 degree Celsius, then filtrate the algae extract solution with Whatmann filtrate paper (pore size 25mm) to get a pure algae aqueous extract.

PLANT MATERIALS

Healthy looking and uniform sized seeds of Mung bean (variety: Vigna radiata) were obtained from a supermarkets.

CHEMICAL USED

Silver nitrate ($AgNO_3$), we have purchased silver nitrate from chemical store in Chennai.

PREPARATION OF SILVER NITRATE SOLUTION

Prepare the Silver nitrate solution by weighing the crystal form of $AgNO_3$ for 0.01mm for 100ml of distilled water. Then leave the sample in a dark room for 24 hours to synthesize the silver nanoparticles at room temperature.

SYNTHESIS OF SILVER NANOPARTICLES FROM SARGASSUM LINEARIFOLIUM ALGAE

Preparation of silver nitrate extract involves the addition of 1.6987g/m of silver nitrate to 100ml of water. Add 30ml of aqueous extract with 20ml of silver nitrate solution and keep the solution in the dark room for 2 days. We observe the colour change in the solution from pale yellow to reddish brown. Color change indicates the formation of silver nitrate from the solution.

UV-VISIBLE SPECTROSCOPY

UV-visible spectroscopy measures the absorption of light in the UV and visible regions. It can be used to determine the presence of nanoparticles based on their characteristic absorption spectra. Sample Preparation: Take a small sample of the AgNP solution (after UV irradiation) and place it in a UV-transparent cuvette. Spectrophotometer Setup: Set up the UV-visible spectrophotometer and ensure it is calibrated.

Baseline Correction: Use distilled water as a reference and perform a baseline correction to eliminate any interference from the solvent. Measurement: Insert the cuvette containing the AgNP solution into the spectrophotometer. Record the absorption spectrum in the range of interest (typically around 200-800 nm). Analysis: Observe and analyze the absorption peaks in the spectrum. The presence of characteristic peaks indicates the formation of nanoparticles.

SCANNING ELECTRON MICROSCOPE

SEM allows researchers to determine the size, shape, and surface characteristics of nanoparticles. This is crucial for understanding their physical properties and potential applications. Insert the sample stub into the SEM chamber, ensuring that the sample is properly positioned for analysis.

SEM IMAGING AND ANALYSIS

Electron Beam Setup**:** Adjust the acceleration voltage (typically 5-30 kV, depending on the sample and desired resolution) and beam current to appropriate levels. Focus and Aperture Adjustment: Use the SEM controls to focus the electron beam on the sample's surface. Adjust the aperture size to control the depth of field and resolution.

Imaging Modes: SEM offers various imaging modes, including secondary electron imaging (SEI) and backscattered electron imaging (BEI). SEI provides surface topography information, while BEI provides compositional contrast. Image Acquisition: Capture SEM images at different magnifications and areas of interest to visualize the nanoparticle distribution and morphology. Analysis and Measurement: Use SEM software to measure particle sizes, calculate size distributions, and quantify surface features of the nanoparticles.

PROCEDURE OF PLANT GROWTH

STEP - 1

Soak the seeds a day before experimenting. This plays an important role in bringing about faster results.

STEP – 2

Drain the water from the seeds before placing them in the bag. Damp a paper towel or fold it into a bag, seal it tightly, and hang the bag in a window.

STEP – 3

In approximately 24 hours, you will be able to observe the seeds opening up and sprouting.

STEP – 4

1. Prepare pots for both the control and sample groups. Make sure they are of the same size and have proper drainage.
2. Prepare potting soil for both groups separately. Ensure the soil composition is the same for consistency. You can use a commercial potting mix.
3. Spread 200 Mung bean seeds in both the control and sample pots. Label each pot accordingly.
4. Place both groups of pots under the same light conditions in natural sunlight. Ensure they receive the same amount of light.
5. We grew the plant by spraying water and AgNPs synthesized from S.linearifolium extract for seven consecutive days in control and sample plant.
6. After completing the experiment we took the plant and measured its growth.
7. Analyze the data to conclude the effects of AgNPs synthesized from Sargassum linearifolium on mung bean plant growth.

IV. RESULT

CHARACTERIZATION OF SILVER NANOPARTICLES – UV

- The UV visible Spectrabsorptionoscopy carried out for the synthesized silver nanoparticle showed the peak at 463 nm and 0.672AU
- This data indicates that the silver nanoparticles are capable of absorbing light at a specific wavelength (463nm) and the absorbance value (0.672AU) suggests the intensity of this absorption.
- The profile showed the compounds separated at the nm of 200, 258, 300, 350, 400, 430,463, 500, 530, 618, 677, 700, 750, 883 and 900 with the absorption and 0.004 respectively 2.865, 1.012, 0.046, 0.395, 0.053, 0.611, 0.672, 0.525, 0.399, 0.103, 0.057, 0.039, 0.103, 0.057, 0.039, 0.025, 0.035 and 0.036.

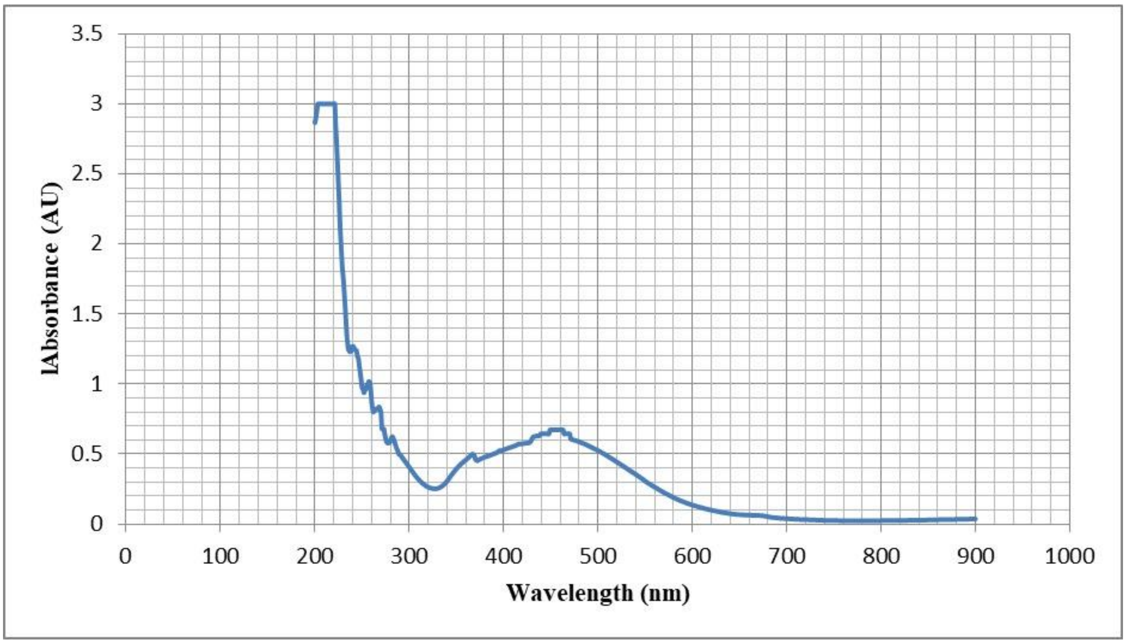


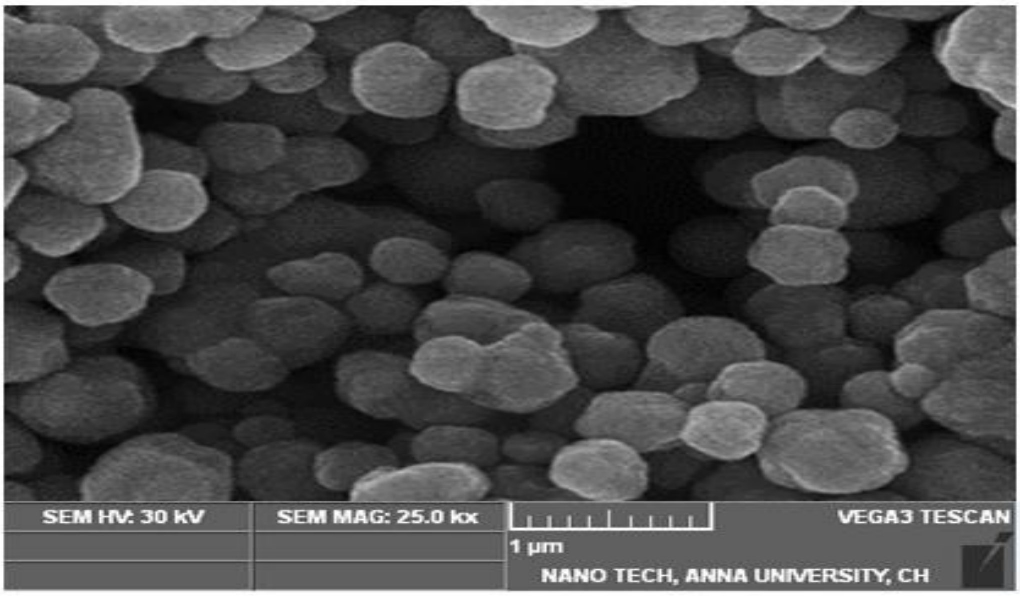
Figure 1: UV of synthesized silver nanoparticle

UV- Visible Spectrum of Aqueous Extract of Sargassum Linearifolium:

Aqueous	
430	0.611
463	0.672
618	0.103
700	0.039
750	0.025
900	0.036

Table1: UV-Visible spectrum of aqueous extract of Sargassum linearifolium

CHARACTERIZATION OF SILVER NANOPARTICLES - SEM



Particle size: 72.49 nm

Figure 2: SEM of synthesized silver nanoparticle

To evaluate the surface morphology, a Scanning Electron Microscope (SEM) analysis of synthesized Silver Nanoparticles can be performed. To eliminate moisture content, Silver Nanoparticles were prepared and dried and the images were taken by using FEI Quanta at 250 SEM which will be operating at 30KV. Particle size was found to be 72.49nm.

EFFECT OF AgNPs ON MUNG BEAN PLANT GROWTH:

The application of synthesized AgNPs to mung bean plants demonstrated a significant enhancement in various growth parameters compared to the control group. AgNPs could influence the uptake of essential nutrients by plants. Researchers should assess nutrient levels in plant tissues to determine if AgNPs affect nutrient uptake and transport. Environmental factors such as soil type, pH, and water availability can influence the interaction between AgNPs and mung bean plants. These factors should be controlled and monitored.

GROWTH CHARACTERISTICS OF MUNG BEAN PLANT

Measurement	Control Plant	Sample Plant
Shoot Length (cm)	6.3	11.1
Root Length (cm)	9.1	13.4
Full Length (cm)	15.5	24.5
Number of Seeds	150	150
Growth Seeds	80	120
Pot Height (cm)	17.5	17.5

Table 2 Growth Characteristics of Mung Bean Plant

PLANT LENGTH

The mung bean plants treated with AgNPs exhibited a remarkable increase in shoot length, root length, and overall plant length when compared to the control group. The sample plants displayed a shoot length of 11.1 cm, root length of 13.4 cm, and full plant length of 24.5 cm, whereas the control plants showed significantly lower values of 6.3 cm, 9.1 cm, and 15.5 cm, respectively (Table 2).

Figure 3: Sample

Figure 4: Control

SEED GERMINATION AND GROWTH

The application of AgNPs positively influenced seed germination and growth. The number of seeds that germinated and subsequently grew into healthy seedlings was higher in the sample group compared to the control group. The sample group showed a higher number of growth seeds (120) compared to the control group (80), indicating an enhanced germination rate and early growth stages. The shoot system of the plant starts to develop. The shoot includes the stem and leaves. The conditions during seed germination, such as temperature, light, and humidity, can have a lasting impact on the plant's growth and development.

SHOOT LENGTH

The shoot height of mung bean plants treated with AgNPs was significantly higher than that of the control group. The control plants had an average shoot length of 6.3 cm, while the sample plants reached an average length of 11.1 cm. This suggests that the application of AgNPs positively influenced the vertical growth of the mung bean plants.

ROOT LENGTH

Similar to shoot length, the root of the sample plants treated with AgNPs was significantly greater than that of the control plants. The control group had an average root length of 9.1 cm, while the sample plants exhibited an average root length of 13.4 cm. This result indicates that the presence of AgNPs had a beneficial effect on root development.

FULL LENGTH OF THE PLANT

The combined measurement of shoot and root length, referred to as the full length of the plant, showed a remarkable difference between the control and sample groups. Control plants had an average full length of 15.5 cm, whereas sample plants reached an impressive average length of 24.5 cm. This finding further supports the idea that AgNPs promote overall plant growth.

V. DISCUSSION:

The results of this study clearly demonstrate the positive impact of silver nanoparticles synthesized from Sargassum linearifolium on the growth of mung bean (Vigna radiata) plants. The increased shoot length, root length, and overall plant length in the sample group indicate that AgNPs act as growth promoters. These findings align with previous studies that have shown the potential of silver nanoparticles to enhance plant growth by stimulating root development and nutrient uptake. The higher number of growth seeds produced by the sample plants also suggests that AgNPs may have a role in improving seed germination and early plant development. This could have significant implications for agriculture, as it may lead to increased crop yields.

VI. CONCLUSION

In conclusion, the growth study of mung bean plants (Vigna radiata) in the presence of synthesized AgNPs revealed notable effects on plant development. The parameters assessed included germination rate, shoot length, root length, and overall plant length. The results suggest that the application of AgNPs positively influenced the growth of mung bean plants, leading to enhanced germination rates, increased shoot and root lengths compared to the control group. The enhanced growth of mung bean plants in the presence of AgNPs may be attributed to the nanoparticles' potential as nanofertilizers. However, further comprehensive studies are recommended to elucidate the underlying mechanisms responsible for the observed growth enhancement. Moreover, the positive impact on mung bean plant growth demonstrates the potential application of these nanoparticles in agriculture for improved crop productivity and sustainability. This research lays the foundation for future studies exploring the broader implications of AgNPs in plant biology and agricultural practices. These results highlight the potential of AgNPs synthesized from marine algae as a sustainable and effective method to enhance plant growth. Further research is warranted to elucidate the underlying mechanisms and optimize application methods for agricultural and horticultural practices.

FUTURE PROSPECTIVE

In the future, the synthesis of silver nanoparticles from Sargassum linearifolium algae holds immense promise for sustainable nanomaterial production. This innovative approach not only offers an eco-friendly alternative to conventional chemical methods but also taps into the abundant and renewable resource of marine algae. The utilization of Sargassum linearifolium, known for its rich bioactive compounds, presents a unique opportunity to harness its inherent properties for nanoparticle synthesis. Researchers are likely to explore optimized extraction and processing techniques to enhance the yield and quality of silver nanoparticles. Additionally, advancements in characterization methods and surface modification techniques are anticipated to yield tailored nanoparticles with enhanced stability, dispersibility, and targeted applications. These silver nanoparticles derived from Sargassum linearifolium are poised to find applications in various industries, including healthcare, electronics, and environmental remediation, showcasing their potential to revolutionize nanotechnology on a global scale.

Furthermore, the future of this research extends into the realm of sustainable agriculture, with potential breakthroughs in enhancing plant growth and crop yield. Incorporating silver nanoparticles synthesized from Sargassum linearifolium into agricultural practices has the potential to revolutionize the way we approach plant nutrition and stress management. Preliminary studies suggest that these nanoparticles could serve as nanofertilizers, promoting nutrient uptake and stimulating metabolic processes in plants. Additionally, their antimicrobial properties may offer natural protection against pathogens, reducing the need for chemical pesticides. As researchers delve deeper into understanding the mechanisms underlying the interactions between silver nanoparticles and plants, we can expect tailored formulations to emerge, designed to optimize growth for specific crops. Ultimately, this research holds the promise of significantly contributing to sustainable agriculture practices, addressing global food security challenges, and minimizing the environmental footprint of conventional farming methods.

REFERENCE

[1]. Abbas, S.M. (2013). The influence of biostimulants on the growth and on the biochemical composition of Vicia faba CV. Giza 3 beans. Roma.Biotechnol. Lett.18(2).

[2]. Esraa E. Ammar, Ahmed A.A. Aioub, Ahmed E. Elesawy, Ali M. Karkour, Moustafa S. Mouhamed, Aliaa A. Amer d, Nouran A. EL-Shershaby et al, “Algae as Bio-fertilizers: Between current situation and future perspective”, Saudi Journal of Biological Sciences 29 (2022).

[3]. Gruyer. N, Dorais .M, Bastien. C, Dassylva. N and Triffault-Bouchet et al, "Interaction between Silver Nanoparticles and Plant Growth", Proc. IS on New Technol. for Env. Control, Energy-Saving, and Crop Prod. in Greenhouse and Plant Factory – GreenSys 2013.
[4]. Hediat M. H. Salama et al, "Effects of silver nanoparticles in some crop plants, Common bean (Phaseolus vulgaris L.) and corn (Zea mays L.)", International Research Journal of Biotechnology, December 2012.
[5]. John Peter Paul. J and Amster Regin Lawrence. R, et al, "Phytochemical analysis of Sargassum linearifolium (Turner) C.Ag. (Brown seaweed) using UV-VIS, FTIR and HPLC", International Journal of Herbal Medicine 2017.
[6]. John Peter Paul J, Shri Devi SDK. Phytochemical Screening of Padina Tetrastromatica Hauck, American Journal of Pharm Tech Research. 2013; 3(5):214-222.
[7]. Karthikeyan, S., Balasubramanian, R., Iyer, C.S.P. 2007. Evaluation of the marine algae Ulva fasciata and Sargassum sp. for the biosorption of Cu (II) from aqueous solutions. Bioresour, Technol.
[8]. Krishnaraj. C, Jagan. E.G, Ramachandran. R, Abirami. S.M., Mohan. N, Kalaichelvan. P.T., et al, "Effect of biologically synthesized silver nanoparticles on Bacopa monnieri (Linn.) Wettst. plant growth metabolism", Process Biochemistry 47 (2012).
[9]. Lin D, Xing B (2007). Phytotoxicity of nanoparticles: inhibition of seed germination and root growth. Environmental Pollution, 150: 243 - 250.
[10]. Mervat Sh Sadak et al., "Impact of silver nanoparticles on plant growth, some biochemical aspects, and yield of fenugreek plant (Trigonella foenumgraecum", Sadak Bulletin of the National Research Centre (2019).
[11]. Najafi S, Jamei R (2014) Effect of silver nanoparticles and Pb $(No_3)_2$ on the yield and chemical composition of mung bean (Vigna radiata). J. Stress Physiol Biochem.
[12]. Razzaq A, Ammara R, Jhanzab HM, Mahmood T, Hafeez A, Hussain S (2016) Anoval nanomaterial to enhance growth and yield of wheat. J of Nanoscience & Technology.
[13]. Salim BBM. Influence of biochar and seaweed extract applications on growth, yield and mineral composition of wheat Triticum aestivum L. under sandy soil conditions. Annals of Agricultural Sciences. 2016;61(2):257–65.
[14]. Savithramma. N, Ankanna. S, Bhumi. G, "Effect of nanoparticles on seed germination and seedling growth of Boswellia ovalifoliolata-an endemic and endangered medicinal tree taxon", Nano Vision, vol 47, no. (1,2&3), pp, 2012.
[15]. Soha Mohammed, Mostafa M. El-SheekhSaadia Hamed Aly, Maha Al-Harbi, Amr Elkelish and Aziza Nagah et al, "Inductive role of the brown alga Sargassum polycystum on growth and biosynthesis of imperative metabolites and antioxidants of two crop plants", Original Research PUBLISHED 24 February 2023.
[16]. Thirumaran G, Arumugam M, Arumugam R, Anantharaman P. Effect of seaweed liquid fertilizer on growth and pigment concentration of Cyamopis tetrogonolaba (L.) Taub. Am Euras J Agron 2009.
[17]. Vijayanand. N, Sivasangari Ramya. S, Rathinavel. S, et al, "Potential of liquid extracts of Sargassum wightii on growth, biochemical and yield parameters of cluster bean plant", Asian Pacific Journal of Reproduction 2014.
[18]. Yanebis Pérez-Madruga, Indira López-Padrón, Yanelis Reyes-Guerrero et al, "Algae as a natural alternative for the production of different crops", cultrop vol.41no.2 La Habana abr.-jun. 2020 Epub 01-Jun-2020.
[19]. Zainab M. Almutairi, Amjad Alharb et al, "Effect of Silver Nanoparticles on Seed Germination of CropPlants", International Journal of Nuclear and Quantum Engineering 2015.
[20]. Zheng L, Hong F, Lu S, Liu C (2005). Effect of nano – TiO2 on strength of naturally aged seeds and growth of Spinach. Biolo. Trace Element Res., 104 (1): 82 – 93.