# Antimicrobial Property of Silver Nanoparticles Synthesized from Spirullina SP Against Infectious Diseases

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Spirulina platensis has been used to biosynthesize crystalline silver nanoparticles (SNPs) in an aqueous medium. To produce SNPs, a live biomass of Spirulina platensis was added to an aqueous solution of silver ions. The plasmon resonance of SNPs is consistent with the absorption peak that these nanoparticles displayed in the UV-visible spectrum at 430 nm. Spirulina platensis produced SNPs, with an average particle size of roughly 12 nm, according to transmission electron micrographs of the nanoparticles in an aqueous solution. This paper investigates the biological synthesis of silver nanoparticles (AgNPs) utilizing cell-free extract from Spirulina platensis. Following characterization using UV-Vis spectroscopy, SEM, TEM, and FTIR analyses, the antibacterial activity of the biosynthesised AgNPs was assessed.Using an aqueous extract of S. platensis, extracellular synthesis of well-dispersed, very stable, spherical AgNPs with an average size of 30–50 nm was accomplished. TEM and SEM studies verified the nanoparticles' size and form. AgNP production and stability are mostly the result of biomolecules, more especially proteins and peptides, as indicated by FTIR and UV-Vis spectra.

**Keywords:** Silver nanoparticle (SNPs), Spirulina platensis, Biosynthesis, XRD (X-ray diffraction), SEM.

## 1. Introduction

Spirulina is the name for the multicellular, filamentous blue-green algae. It is a member of the Spirulina and Arthrospira genera, two distinct genera. About fifteen species are found in spirulina. Arthrospiraplatenesis is the most prevalent species, and it was easily accessible. It is easily harvested and processed, and it grows well in freshwater environments. The content of macro and micronutrients in spirulina is high. It is harvested from natural water sources, dried, and used as food in many African nations. It is also a significant source of protein. Spirulina is increasingly being added to aqua feeds as a protein and vitamin supplement, as well as a supplemental food component for poultry.

Gram-negative A filamentous cyanobacterium is called Arthrospira platensis. It is a photoautotrophic bacterium that does not fix nitrogen. It has been found solitary in subtropical alkaline lakes, East African soda lakes, and China's Chenghai Lake. High carbonate and bicarbonate concentrations have been reported to harbor Arthrospira platensis. Because of its resistance to both salt and alkali, it can also be found in high quantities of salt. This creature thrives best at a temperature of about 35°C. Culture media often contains a high concentration of bicarbonate, inorganic salts, and a pH between 9 and 10, depending on the surrounding conditions.[1]

A type of blue-green algae known as cyanobacteria that is edible to both humans and animals is called spirulina. Arthrospira fusiformis, Arthrospira maxima, and Arthrospira platensis are the three species. Worldwide, Arthrospira is grown and consumed as a whole food or nutritional supplement (blue green algae, 2021). It is also used as a feed ingredient in the poultry, aquarium, and aquaculture industries. Free-floating, filamentous cyanobacteria with a left-handed helix consisting of cylindrical, multicellular trichomes are the hallmark of Arthrospira species. They naturally occur in high-pH, high-carbonate and bicarbonate-concentration tropical and subtropical lakes. A. platensis, also known as "Spirulina," is used in a variety of ways as a food supplement and in current and historical contexts [8]. Spirulina is sold as a nutritional supplement in powder or pill form due to its high concentration of vitamins, dietary minerals, antioxidants, and essential and unsaturated fatty acids. Because of its antioxidant qualities, spirulina was administered to Chernobyl victims to help prevent the harmful effects of reactive oxygen species. [2]

Fig 1: Microscopic observation of Spirulina

- Phytonutrient Value

Worldwide, spirulina is cultivated and fortified with food and feed in the form of pills, powder, and flake. Phospholipids and pigments found in spirulina are abundant and are used in pharmaceuticals, food, medicine, and animal feed. It is thought to be an extremely nutrient-dense diet that is low in toxicity and has the ability to treat viral infections, tumor growth, and alopecia[11].

Due to its many uses in biomedicine, silver nanoparticles are becoming more and more prevalent. Silver nanoparticles differ from their bulk parent materials in terms of their physical, chemical, and biological characteristics. They are typically smaller than 100 nm and contain 20–15,000 silver atoms. The size and form of silver nanoparticles have a significant impact on their optical, thermal, and catalytic capabilities. Silver nanoparticles are the most commonly utilized sterilizing nanomaterial in consumer and medical products, such as clothing, food storage bags, refrigerator surfaces, and personal care items, because to their broad-spectrum antibacterial properties. [4]

## 1.1. Properties

- Optical Properties

When silver nanoparticles are exposed to a specific wavelength of light, the free electrons collectively undergo a coherent oscillation, which results in a dipole oscillation that forms along the direction of the oscillating electric field of the light. In relation to the ionic lattice, this results in a charge separation. The maximal amplitude of the oscillation happens at a certain frequency called surface plasmon resonance (SPR). [5]

- Antibacterial Effects

Silver nanoparticles' antibacterial properties have been applied to stop the growth of bacteria in a number of settings, such as biomedical equipment, dentistry, surgery, and burn and wound treatment [13]. It is commonly known that silver ions and compounds containing silver are extremely poisonous to bacteria. When bacterial cells are exposed to silver nanoparticles, they may experience significant morphological and structural alterations, which may ultimately result in the cells' demise. Research has shown that the prolonged release of free silver ions from the nanoparticles—which operate as a transport for silver ions—is the primary mechanism responsible for the antibacterial activity of silver nanoparticles. [10]

## 1.2. Applications

- Sensors

The majority of recent studies on peptide-capped silver nanoparticles for colorimetric sensing have concentrated on the peptide's impact on the nanoparticles' formation as well as the nature of the interaction between the peptide and silver. Furthermore, fluorescence sensors based on silver nanoparticles have the potential to surpass detection limits in terms of efficiency.

- Optical probes

Silver nanoparticles are widely used as surface-enhanced Raman scattering (SERS) and metal-enhanced fluorescence (MEF) probes. Compared to other noble metal nanoparticles, silver nanoparticles offer more benefits for probing, such as stronger field enhancements, better extinction coefficients, and sharper extinction bands.

- Antibacterial agents

The most popular sterilizing nanomaterial in consumer and medical products is silver nanoparticles; examples of these products include fabrics, food storage bags, refrigerator surfaces, and personal care items. It has been established that the persistent release of free silver ions from the nanoparticles is what gives silver nanoparticles their antibacterial properties.

- Catalyst

It has been shown that silver nanoparticles can catalyze the redox of chemical and biological substances, including benzene and dyes. The catalytic capabilities of nanoparticles are significantly influenced by their chemical environment. It's also crucial to realize that complex catalysis happens when reactant species adsorb onto the catalytic substrate. If stabilizers like polymers, complex ligands, or surfactants are introduced, either to prevent the nanoparticles from coalescing or to function as a stabiliser, the catalytic activity is usually lowered because of the decreased adsorption ability. Silver nanoparticles and titanium dioxide are commonly used as catalysts in chemical reactions.[7]

## 2. Literature Review

Spirulina platensis are filamentous, multicellular cyanobacteria with a high carbonate and bicarbonate concentration. It thrives in water, is easily harvested and processed, and contains a high concentration of macro- and micronutrients [3]. Although Spirulina platensis Maxima is found in Central America, Spirulina platensis can be found in Africa, Asia, and South America near Lake Chad, as well as at Lake Texcoco in Mexico. It is one of the planet's original inhabitants. Its scientific name is Arthrospira platensis. Five years ago, the government and business sector invested a substantial amount of money in the development of blue green algae since it was 20 times more prolific than other algae, with the goal of extracting biodiesel.[12].
A French scientist found evidence of Spirulina platensis harvesting in 1940, close to the small Lake Chad in Africa. However, not enough Spirulina platensis food is launched. Recovering the health benefits of spirulina would take many years. Spirulina platensis was recognized by the International Association of Applied Microbiology in 1967 as the “Ultimate source of food.” Upon examining its nutritional characteristics, it was discovered that Spirulina platensis has a high protein content [6]. This information was enough to launch studies that would generate cheap protein. Spirulina platensis, yeast, and bacteria are examples of microorganisms that directly produce single-cell proteins.[9].

## 3. Materials and Methods

### 3.1 Preparation of spirulina platensis extracts

Put 5 grams of spirulina powder in a conical flask with 100 milliliters of distilled water, and let it sit in a boiling water bath for 15 minutes. The mixture was cooled and filtered using Whatsmann after 15 minutes. For additional analysis, the filtrate and No. 1 filter paper were kept at 4ºC.

### 3.2 Preparation of silver nitrate solution

Weigh 0.169 gm of silver nitrate powder and mix it with 1000 ml of distilled water and storedin brown bottle at room temperature.

### 3.3 Biosynthesis of silver nanoparticles

Add 5ml of pure spirulina extract into 100ml of 1mM silver nitrate solution. The mixture wasmixed thoroughly and stored in BOD bottle. The bottles were marked for nanoparticles synthesis. Periodical analysis of colour change was done for the sample. At normal temperature, the reduction of metal ions to nanoparticles was completed.

## 4. Result and Discussion

Muller Hinton agar was prepared and poured in sterile petri plate and allow to solidify. After solidification the isolated bacteria was swabbed on the MHA plate. After few minutes the four well was formed on an MHA plate using well cutter. In each well add the spirullina extract, silver nitrate, silver nanoparticle and control were used as distilled water. For a whole day, the plate was incubated at 370 C. Following the incubation period, the outcomes were noted and tallied in Table 6.

Table.1: Antimicrobial activity against Pseudomonas spp.

| Sl.no | Sample | Diameter |
|---|---|---|
| 1 | Spirulina extract | 17mm |
| 2 | Silver nitrate | 23mm |
| 3 | AgNP | 32mm |

In Scanning Electron Microscopy, it shows the size and shape of AgNP in differentmagnification power. The micrographs of nanoparticles obtained in filtrate showed that silvernanoparticle is spherical shaped well distribution without aggregation in solution.

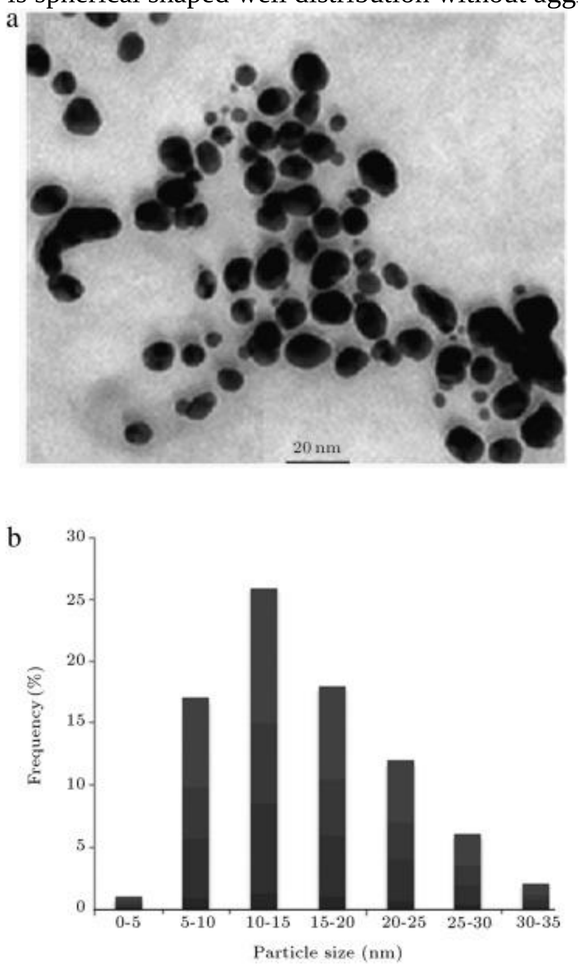


Figure 2. (a) SEM image of developed SNPs and (b) particle size distribution histogram of SNPs determined from SEM image.

## 5. Conclusion

Based on these findings, live algal biomass appears to be a practical and cost-effective method of creating SNPs. This implies that in the rapidly advancing field of nanobiotechnology, live algal biomass may also be valuable in the future for generating other advantageous nanostructures. Finally, a greener way of synthesizing SNPs was suggested, utilizing Spirulina platensis. By decreasing the amount of aqueous Ba ions in AgNPs, the spirulina extract creates stable AgNP. Spirulina platensis has many benefits when used, including availability and ease of cultivation. AgNP synthesis is a quick, safe, affordable, and non-toxic reduction process. There is a great deal of promise for producing medically useful nanoparticles from living things. The size of the nanoparticles will differ between simple bacteria and complicated species. The biological sciences make use of silver nanoparticles because of their various benefits. Spirulina offers a lot of benefits. It is used in our daily lives now to treat and manage illnesses.

## References

1. IRAVANI H.K., MIRMOHAMMADI S.V. & ZOLFAGHARI B. 2014. Synthesis of silver nanoparticles: chemical, physical and biological methods. Research in Pharmaceutical Science 9: 385–406.
2. AHMED S., ULLAH S., AHMAD M., SWAMI B.L. & IKRAM S. 2015. Green synthesis of silver nanoparticles using Azadirachta indica aqueous leaf extract. Journal of Radiation Research and Applied Science 9: 1–7.
3. Paul, P. K., Sinha, R. R., Aithal, P. S., Aremu, B., & Saavedra, R. (2020). Agricultural Informatics: An Overview of Integration of Agricultural Sciences and Information Science. Indian Journal of Information Sources and Services, 10(1), 48–55.
4. SATYAVANI K., GURUDEEBAN S., RAMANATHAN T. & BALASUBRAMANIAN T. 2011. Biomedical potential of silver nanoparticles synthesized from calli cells of Citrullus colocynthis (L.) Schrad. Journal of Nanobiotechnology 9: 43.
5. Mohanpuria, P., Rana, N. K., & Yadav, S. K. (2008). Biosynthesis of nanoparticles: technological concepts and future applications. Journal of Nanoparticle Research, 10, 507–517.
6. Lee, H., Enriquez, J. L., & Lee, G. (2022). Robotics 4.0: Challenges and Opportunities in the 4th Industrial Revolution. Journal of Internet Services and Information Security, 12(4), 39-55.
7. Arti Khatana, Anupama Diwan, Rani Mansuri, and . 2022. AN OVERVIEW ON AUTOMATED IN VITRO RELEASE TESTING (IVRT) FOR TOPICAL FORMULATION. International Journal of Pharmacy Research & Technology, 12 (1), 12-18. doi:10.31838/ijprt/12.01.02
8. Naz, M., Nasiri, N., Ikram, M., Nafees, M., Qureshi, M. Z., & Ali, S. (2017). Eco-friendly biosynthesis, anticancer drug loading and cytotoxic effect of capped Ag-nanoparticles against breast cancer. Applied Nanoscience, 7, 793–802.
9. Angin, P., Anisi, M.H., Göksel, F., Gürsoy, C., & Büyükgülcü, A. (2020). Agrilora: a digital twin framework for smart agriculture. Journal of Wireless Mobile Networks, Ubiquitous Computing, and Dependable Applications, 11(4), 77-96.
10. Henrikson, R., 2010. Spirulina world food. Published by Ronore Enterprises, Inc. PO Box, 909.
11. TORNABENE G., BOURNE T. F., RAZIUDDIN S. & BEN-AMOTZ A. 1985. Lipid and lipopolysaccharide constituents of cyanobacterium Spirulina platensis (Cyanophyceae,

Nostocales). Marine Ecology Progress Series 22: 121–125

12. Ismail, G. A., Allam, N. G., El-Gemizy, W. M., & Salem, M. A. (2020). The role of silver nanoparticles biosynthesized by Anabaena variabilis and Spirulina platensis cyanobacteria for malachite green removal from wastewater. Environmental Technology. https://doi.org/10.1080/09593330.2020.1766576.
13. Shulman, A., Mazkereth, R., Zalel, Y., Kuint, J., Lipitz, S., Avigad, I. and Achiron, R., 2002. Prenatal identification of esophageal atresia: the role of ultrasonography for evaluation of functional anatomy. Prenatal Diagnosis: Published in Affiliation With the International Society for Prenatal Diagnosis, 22(8), pp.669-674.
14. tülay Çağatay, I., Özbaş, M., Yılmaz, H. E., & Ali, N. (2021). Determination of antibacterial effect of Nannochloropsis oculata against some rainbow trout pathogens. Natural and Engineering Sciences, 6(2), 87-95.