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Sargassum swartzii: A source of silver nanoparticles, synthesis and its antibacterial activity

*Anita D. Solanki** and *Illa C. Patel*

Address:
Department of Life Sciences, Hemchandracharya North Gujarat University, Patan, Gujarat, India
*Corresponding author: ***Anita D. Solanki***, anitaba2901@gmail.com

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ABSTRACT

In current trends of green synthesis of nanoparticles is rapidly shifting from plants based to marine algae as it is widely available as well as highly explore for pharmaceutical work. Presented work focuses on synthesising silver nanoparticles using marine algae *Sargassum swartzii* and its characterization through multiple authentic methods like UV-Vis spectrophotometer, X-Ray Diffraction, Fourier transform infrared spectroscopy, Scanning Electron Microscopy and Transmission Electron microscopes.The primary confirmation was done by the visible appraisal of the color difference from the light yellow-brown to dark brown colour. The UV-Visible absorbance spectra verified the formation of silver nanoparticles and spectra increased with incubation time. The Surface Plasmon Resonance (SPR) absorbance peak was observed at 439nm. SEM and TEM confirmed particles' surface morphology and size of AgNPs from 14 to 30nm. XRD approved particles' face-centric cubic and crystal structure and the size (15.33 nm) calculated through the Scherer equation. FTIR analysis reflected the various functional groups associated with the algal extracts, which help in the bindings of Ag molecules during AgNPs synthesis. The synthesized silver nanoparticles revealed significant antibacterial activity against *Bacillus subtilis* (27.17±0.73mm) and *Staphylococcus aureus* (23.53±0.29mm). The work reported that *Sargassum swartzii* widely available brown macroalgae, could be used as an alternative source for synthesis of AgNPs without destroying high plants and the produced AgNPs have efficient antibacterial activity against both gram positive and gram negative bacteria, which can be explore in curing several human diseases.

Keywords: Seaweed, *Sargassum swartzii*, Silver nanoparticles, Antibacterial activity

INTRODUCTION

Nanobiotechnology is an interesting field of current materials science (Roco and Bainbridge, 2005). Plant-based Metallic nanoparticle synthesis has acquired broad interest due to its exquisite physicochemical features and a vast range of biological uses. AgNPs have triggered many studies' interest in nanoparticles because of their optical, electrical, and antibacterial properties (Beyene *et al.,* 2017; and Kora *et al.,* 2010). It has attracted a lot of interest in the pharmaceutical industry due to its extraordinary therapeutic potential, including anti-bacterial, anti-cancer, anti-diabetic, antioxidant, and anti-tumor potential (Stashans *et al.,* 2011; Han *et al.,* 2015; Heo *et al.,* 2009; Lakshmanasenthil *et al.,* 2014). Besides this, AgNPs were also extensively utilized in the agriculture and horticulture field as growth stimulators, fertilizers, pesticides, herbicides, and seed germination promoters (Yan and Chen, 2019**;** Jasim *et al.,* 2017; Elmer and White, 2016; Alavi and Dehpour, 2009; Worrall *et al.,* 2018; Maruyama *et al.,* 2016; Parveen and Rao, 2015). It has many environmental applications, such as water treatment, purification, and dye degradation (Zahoor *et al.,* 2021). Chemical and physical methods are used to synthesize AgNPs, but several drawbacks, such as the use of toxic material, high energy, high temperature, and pressure, create health and environmental issues (Saha *et al.,* 2017). So, the green synthesis approach suggested for nanoparticle synthesis is a straightforward step method that does not need any special conditions. The Green approach to nanoparticle synthesis appears to be an essential alternative to chemical synthesis methods by choosing environmentally friendly stabilizing and reducing agents (Kathiraven *et al.,* 2015; and Annamalai and Nallamuthu, 2015). Various plant biomolecules have participated in the active production of metal nanoparticles (Dahl and Hutchison, 2007; and Wei *et al.,* 2009). The microbes, fungi, plants and plants portion were employed for the biological synthesis of nanoparticles (Sinha *et al.,* 2009). Green synthesis from plant material is beneficial, but the source of terrestrial plants is limited; on the other hand, marine algal biomass is abounded and discarded as weeds in many countries. Thus, using the marine resource for the betterment of human life through nanotechnology is our in-depth desire.

Marine brown algae are available in high quantities in the coastal area of Gujarat, India (Jha *et al.,* 2009). Also, the process of collection is easy and affordable. Moreover, it has a significant source of primary and secondary metabolites and high metal uptake ability compared to the plants (Rico *et al.,* 2017; Yu *et al.,* 1999), which may help in the utilization of minerals and synthesis of AgNPs. So, in many present research works, seaweeds were represented as a potential source of silver nanoparticles. The several previous works on the number of marine algae which were utilized as a source of nanomaterials are *Padina pavonia*, *Pyropia yezoensis*, and *Sargassum* species such as *Sargassum angotifolium*, *Sargassum muticum, Sargassum cinereum, Sargassum cinctum*, *Sargassum polycystum*, *Sargassum vulgare*, *Sargassum tenerrium, Sargassum wightii* (Singaravelu *et al.,* 2007; Krishnan *et al.,* 2022; Ballesteros *et al.,* 2022; Mohandass *et al.,* 2013; Roy and Anantharaman, 2017; Thangaraju *et al.,* 2012; Govindaraju *et al.,* 2015; Kumar *et al.,* 2012; Govinddaraju *et al.,* 2009). The single report on *Sargassum swartzii* for AgNPs synthesis is given by Kala *et al.,* (2015). So, this species was selected for the silver nanoparticles in the present work.

Sargassum swartzii belongs to the Phaeophyceae family. It was reported as a dominant species on the shivrajpur beach (Okha coast) of Gujarat, India (Jha *et al.,* 2009) and is also distributed in the many regions of Asia, which include a broad range of active substances such as polysaccharides, terpenoids, fucoxanthin, steroids, flavonoids, proteins and polyphenols (Suganya *et al.,* 2020). The brown algae *Sargassum* is known as the *Sargassum* bank, because of the prevailing distribution and vast biomass in the coastal regions. Marine macroalgae *Sargassum* can be a significant bio factory for producing AgNPs due to its high stability, safety, no toxicity, and ample biological activity and a large number of bioactive compounds (Liu *et al.,* 2008 and 2014). This genus's economic potential is concentrated in alginate production, which is used as a gelling agent, emulsifier and stabilizer in industries similar to red algae. Marine algae are good and cost-effective sources of phytochemicals that can be used to synthesize metallic nanoparticles due to their abundance and quick availability. Looking at the above review work, abundant availability and limited work have been done on *Sargassum swartzii*, so this work has been aimed to synthesize silver nanoparticles using *Sargassum swartzii.*

MATERIAL AND METHODS

Collection of Marine Brown algae and Aqueous Algal Extract Preparation:

The marine macroalga *S.swartzii* was collected from shivrajpur beach (District: Dwarka) (22̊ 19'40''N 68̊ 56'37''E) from the okha coast, Gujarat, India. Algal materials were brought to the laboratory in plastic zipper bags after being rinsed using seawater. The residue and associated biota were removed after cleaning the marine algal materials with tap water and then distilled water (Deepak *et al.,* 2018). Fresh algae species were collected and taxonomically identified using a standard handbook (Jha *et al.,* 2009). Afterward, the species was thoroughly dried and powdered in an electric grinder before being stored at 4̊C for future study. Next,10 g of fine powder was combined with 100 mL filtered Double distilled water and heated at 60°C for 10-15 minutes (Daphedar *et al.,* 2020). Whatman No. 1 filter paper was used to filter the aqueous extract (Narayanan *et al.,* 2021).

Bio-Synthesis of Silver nanoparticles:

Pure $AgNo_3$ was purchased from Himedia, Bangalore, India. Separately, the aqueous algal extract was treated with 9 ml of $AgNO_3$ (1mM) for a reduction in Ag^+ ions. The formed medium was gradually heated to 60°C in the water bath for 15-20 min and kept at ambient temperature in the dark condition for 24 hrs. The solution colour difference was monitored by the visual assessment. After 24 hrs of incubation, the produced particles were used for further characterization.

Characterization techniques:

According toThe Primary characterization of AgNPs was observed by UV- Visible spectroscopy employing a spectrophotometer Shimadzu spectrum in the range of 300 to 700 nm (Kathiraven *et al.,* 2015). The XRD analysis of powder samples of AgNPs was performed in a 2 theta range of 0 to 80 with an advanced diffractometer (Cu k ά radiation, where wavelength λ = 1.5406 Å) (Suganya *et al.,* 2020). AgNPs production and clarified from *S.swartzii* were analyzed for the existence of biomolecules utilizing FTIR study following the standard procedure (Sivaraman *et al.,* 2009). The samples were examined using a Shimadzu spectrophotometer ranging from 4000 to 800 cm^{-1}. The SEM analysis is done by Nova nano SEM 450 model. This study is used to define the distribution and surface morphology of nanoparticles (Vasquez *et al.,* 2016). The size and morphological details of nanoparticles were confirmed through the TEM analysis using HRTEM (200 kV) (Singarvelu *et al.,* 2007).

Bacterial strains and Culture media:

Streptomycin was utilized as a positive control to assess the antibacterial activity of synthesized AgNPs from *S. swartzii* against Gram-positive and Gram-negative bacterial cultures (Srivastava and Bhargava, 2022). Bacterial cultures were obtained from Hemchandracharya North Gujarat University's Life Sciences department in Patan, Gujarat.

Antibacterial activity:

The antibacterial effect of the produced AgNPs was tested using the well diffusion technique against Gram-positive and Gram-negative bacteria (Daphedar *et al.,* 2020). The Nutrient agar (N-agar) substrate was prepared, the pH was maintained at 7.4, and it was autoclaved for 15 minutes at 121°C and 15 lbs of pressure to sterilize it (Kathiraven *et al.,* 2015). 20 mL autoclave medium was placed on sterilised Petri plates and allowed to cool to room temperature. Each tested organism from the 24 hrs inoculated broth is smeared equally on the N agar plates with a sterile cotton swab and permits for thorough absorption of the inoculums by leaving for a few minutes (Kathiraven *et al.,* 2015). The 6 mm sterilized cork borer was used for well preparation of the plate *S.swartzii* AgNPs at various concentrations were applied to corresponding wells in Nutrient agar (N-agar) plates. As a positive control, a solution of streptomycin (mg/ml) was exploited. *S.swartzii* AgNPs or streptomycin-loaded plates were incubated for 24 hours at 37̊C (Alshaibani *et al.,* 2016). Behind incubation, the existence of antibacterial activity was specified by a definite inhibition zone enveloping the well. An antibiotic zone measuring scale was used to determine the zone of inhibition (Bauer *et al.,* 1996). The results were observed in triplicate.

Statistical analysis:

DMRT (Duncan's Multiple Range Test) was used to do the statistical analysis. The data were presented as mean±standard error. The significance level was set at $P<0.05$ (Nguyen *et al.,* 2019).

RESULTS

Visual observation:

Figure. 1. Panicles naturally infected with rice false smut disease (**A**) and rice false smut balls (RFSbs) (**B**).The synthesis of AgNPs was established through visual examination. The *S.swartzii* aqueous extract transformed from yellow-brown to dark brown after adding 1mM $AgNO_3$ (Figure 1) at 60°C after 24h incubation. After adding aqueous $AgNO_3$ solution to the marine algal extract, the colour changed to cloudy, signalling the start of the response. The vigour of the brown colour improved in direct ratio to the time duration (Figure 2).

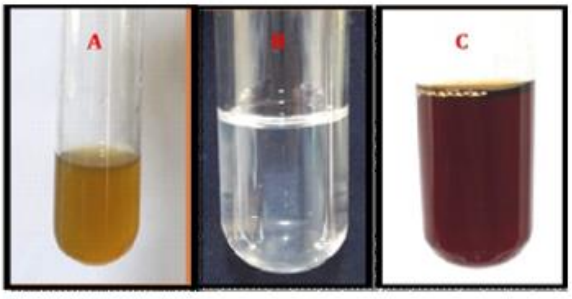

Figure 1: (A) Algal extract. (B) Silver nitrate solution ($AgNO_3$) (C) Synthesized silver nanoparticles (AgNPs)

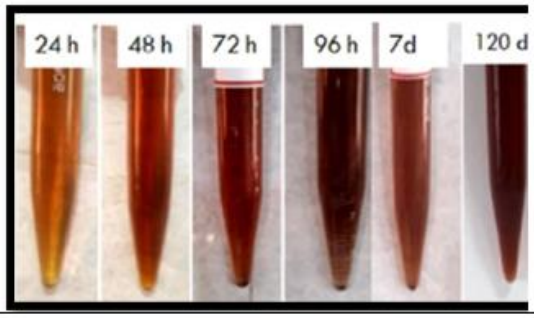

Figure 2: Showing colour intensity of AgNPs synthesized using S.swartzii extract at various incubation periods (24h, 48h, 72h, 96h, 7days,120days)

UV- Visible spectra:

The UV-Visible spectra of synthesized AgNPs were examined at various incubation times at 24hrs, 48hrs, 72hrs, 96hrs, 7day, and 120day (Figure 3). The AgNPs' spectral absorption band occurred at 427 nm, and the vigour of spectra raised continuously with the incubation period. The higher absorption of particles was obtained at 439 nm wavelength after 120 days (at room temperature 28°C). UV-Visible spectroscopy is an effective method for specifying the morphology and stability of AgNPs. The characterization of AgNPs established on the vibration of SPR (Surface Plasmon Resonance) was detected at 430 nm and confirmed AgNPs production using an aqueous extract from marine algae (Narayanan *et al.,* 2021). The silver band appeared at 420 to 450 nm, indicating a persistent enlargement in absorbance through 120 days (Figure 3). The expansion of the peak predicated the nanoparticles were polydispersed. Also, the vigour of the peak raised with a lengthier duration.

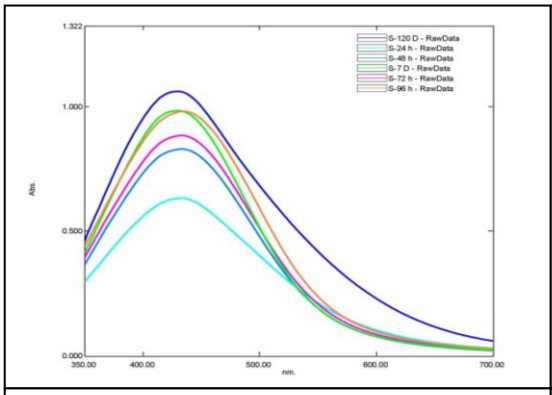

Figure 3: UV-Visiblespectra of synthesized Ag nanoparticles produced from aqueous extract of *S. swartzii* after 24 hours, 48 hours, 72 hours, 96 hours, 7 days, and 120 days.

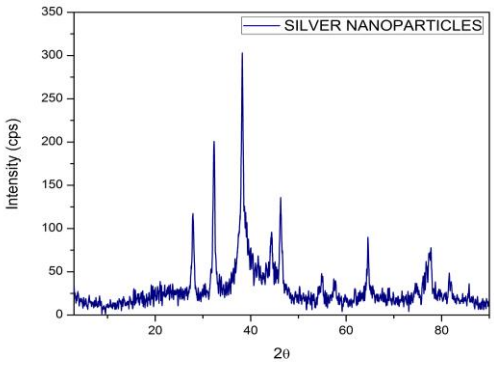

Figure 4: XRD patterns of AgNPs synthesized using *S.swartzii* extract

XRD analysis:

The XRD design of AgNPs exhausted from $AgNO_3$ employing brown seaweed *S.swartzii* behind 24 hrs of incubation. We marked the existence of six elevated diffraction peaks at 27.84, 32.315, 38.17, 44.29, 46.28 and 77.56, indexing the reflection planes of Bragg's at (46), (90), (248), (56), (62) and (63) respectively (Figure 4). The obtained pattern shows the crystalline nature of synthesized AgNPs in a face-centred cubic arrangement and is consistent with the JCPDS file database (Cullity, 1978). The intermediate size of the produced AgNPs was computed using the Scherer equation of debye and was found to be around 15.33nm (Arokiyaraj *et al.,* 2014; and Krishnaraj *et al.,* 2010). D=(kλ/β cos θ), where K (Scherer constant value (0.9)), D (Particle size), λ (X-ray wavelength (0.1542 nm)), β (diffraction peak half-width in radians), and cos θ (Diffraction angle peak of the most intense peak).

FTIR analysis

The FTIR study was applied to specify the biomolecules or active groups attending during the biogenic production of silver nitrate to silver to the silver nanoparticles and ensure the removal and dispersal of chemical elements from the algal extract of *S.swartzii*. The IR analyses of AgNPs are shown in Figure 5. FTIR spectra of synthesized AgNPs from *S.swartzii* revealed bands at 2362.30, 2341.58, 2177.63, 1973.18, 1926.89, 1853.59, 1720.50, 1631.78, 1550.77, 1512.19, 1467.83, 1411.89, 1381.03 cm^{-1}. The peak values at 2362.30 and 2341.58 cm^{-1} correspond to OH and carbonyl groups and the phospholipids (P=0) band occurs at 1926.89 cm^{-1}. Another peak values observed at 1973.18, 1853.59, 1720.50, 1631.78, 1550.77, and 1512.19 cm^{-1} indicated the following groups C-H bend, C=O stretching acid anhydrides, C=O stretch ester, (N=H) N-O primary amines or nitro, Hydroxyl group and C=C chain respectively (Rahman *et al.,* 2021; Rupapara *et al.,* 2015; Packialakshmi and Naziya, 2014; Maity *et al.,* 2017; Kathirevan *et al.,* 2015; Rajathi *et al.,* 2012). The band at 1467.83 cm^{-1} reveals the aromatic group, 1411.89 cm^{-1} for –C-H bend and 1381.03 cm^{-1} (C-H) stretch (Kathiraven *et al.,* 2015) for alkenes which are responsible for the synthesis. The possible biomolecules of algal extract superintend for the stability of the nanoparticles.

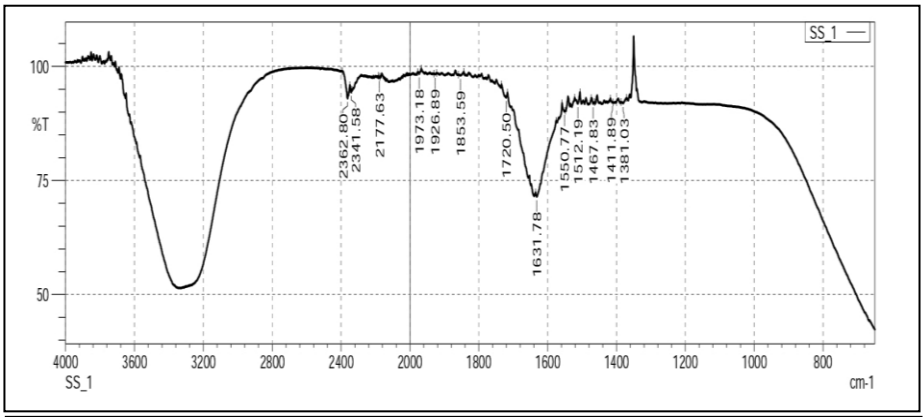

Figure 5: FTIR spectral analysis of *S. swartzii* synthesized AgNPs

SEM analysis:

Scanning electron microscopy study has provided more insight into the morphology and size of AgNPs using *S.swartzii* extract. SEM results indicated the synthesized AgNPs were spherical shaped and polydispersed, positively spread with accumulation (Figure 6). Size ranges of synthesized particles were 14 to 30 nm. The size divergence may be due to other organic ingredients in the polysaccharides, which are affected in reducing and stabilizing the AgNPs during their forming phase (Mittal *et al.,* 2013).

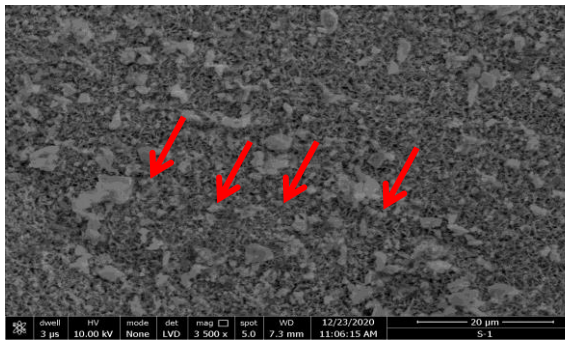

Figure 6: SEM images of AgNPs synthesized using *S.swartzii*

TEM analysis

TEM examination of the synthesized AgNPs reveals the size and form of the AgNPs produced extracellularly by *S. swartzii* extracts.The majority of the particles are spherical, as seen in Figure.7. However, AgNPs that are ellipsoidal and distinct can also be seen. The sizes of the particles ranged from 14 to 39 nm. No accumulations were noticed by visualization of the AgNPs within TEM images (Figure 7A), which signifies the virginity and uniformity of the colloidal solution of particles. The histogram analysis predicated the maximum particle size of AgNPs at 17nm (Figure 7B). The verification of planes of the crystalline, connected to the structure of the face-centred cubic component of silver, is reflected in the selected region electron diffraction design of AgNPs (111), (200), (220), and (311) (Figure 7 C)(Sathiyamoorthi *et al.,* 2018).The results revealed that the *S.swartzii* extract acts as a suitable neutralizing substance for forming polydisperse crystalline AgNPs.

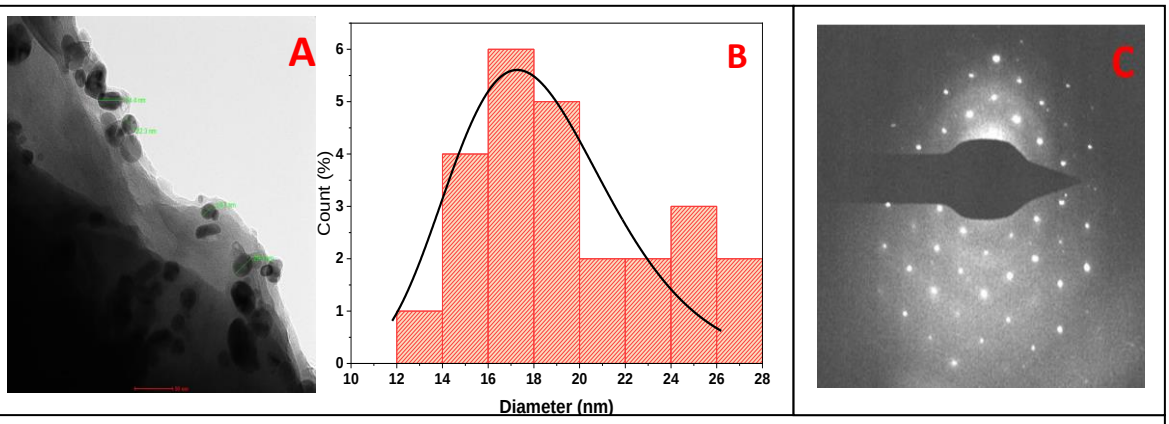

Figure7: (A) TEM images of synthesized AgNPs from *S.swartzii* extract.(B) Histogram graph of AgNPs through the TEM analysis using with image J software. (C) SAED pattern of AgNPs from *S.swartzii* extract

Antibacterial studies:

The antibacterial activities of algal-produced AgNPs were determined using the well agar diffusion method against gram-positive (*B. subtilis* and *S. aureus*) and gram-negative bacteria (*E.coli* and *P. aeruginosa*) (Nguyen *et al.,* 2019). After 24 h incubation, the positive control, $AgNO_3$ and AgNPs displayed the inhibition zone. The antibacterial activity demonstrated the maximum area of inhibition found in *B.subtilis* (27.17±0.73mm, 100 µl) followed by *S.aureus* (23.53±0.29 mm, 100µl), *P.aeruginosa* (22.33±0.33 mm, 100 µl) and *E.coli* (18.67±0.33 mm, 100µl) showed lower antibacterial activity in synthesized AgNPs. The results displayed that *S.swartii* synthesized AgNPs showed significant antibacterial efficacy against the selected bacteria (gram-positive and gram-negative).

Table: 1 Antibacterial activity of synthesiszed silver nanoparticles using *Sargassum swartzii* extract

Sr. No.	Name of the organisms	Concentrations (µl)	Zone of inhibition (mm)	
			Silver nitrate	AgNPs
1.	***Bacillus subtilis***	50	11±0.57 ^{d}	22.83±0.60^{c}
		75	12.33±0.33^{d}	25.33±0.33^{bc}
		100	12.66±0.33^{d}	27.17±0.73^{b}
		P.C (100 µl)	31.67±1.85^{a}	
		A.E	0	
2.	***Staphylococcus aureus***	50	12.83±0.17^{d}	21.50±0.76^{c}
		75	12.56±0.81^{d}	22±0.57^{bc}
		100	13.83±0.44^{d}	23.53±0.29^{b}
		P.C (100 µl)	25.33±0.66^{a}	
		A.E	0	
3.	***Pseudomonas aeruginosa***	50	13.16±0.16^{e}	18.83±0.60^{c}
		75	14.33±0.33^{de}	21.33±0.67^{b}
		100	15.16±0.44^{d}	22.33±0.33^{b}
		P.C (100 µl)	30.5±1.25^{a}	
		A.E	0	
4.	***Escherichia coli***	50	11.33±0.88^{b}	16.66±0.33^{a}
		75	12.33±0.88^{b}	17±0.57^{a}
		100	13.17±0.60^{b}	18.67±0.33^{a}
		P.C (100 µl)	17.33±1.33^{a}	
		A.E	**0**	

Note: P.C- Positive control, A.E – Aqueous extract

According to Duncan's multiple range test, mean values accompanied by various (in superscript) letters under various treatments are significantly different at P<0.05(Ji *et al.,* 2007).

DISCUSSION

Seaweeds fabricated various secondary metabolites with their large spectrum of biological activities, so algal is known as the biofactories. In the recent scenarios, Marine algae are the center of attention because of their great importance in various filed like agriculture, food, cosmetics, and medicine (Vijayan *et al.,* 2014). The Green Biosynthesis methods provide benefits against the chemical and physical fabrications methods, but it does not require any special chemicals, harmful chemicals, and high energy inputs (Kathiraven *et al.,* 2015; Govindrajan *et al.,* 2016). In general, the green synthesis methods are inexpensive, easily synthesized and conducted for the rapid formation of silver nanoparticles (Azarudeen *et al.,* 2017; Alshehri *et al.,* 2018; Alyahya *et al.,* 2018; Sinha and Manjihi, 2015).

The silver ions were reduced by the *S. swartzii* extract, resulting in stabilized silver nanoparticles at 60°C (Vinoth *et al.,* 2019). This synthesis of AgNPs was suggested by the production of dark brown colouration (Kathiraven *et al.,* 2015). The emergence of light brown colour could be attributed to surface plasmon resonance impact vibration and deduction of $AgNO_3$ (Madhiyazhagan *et al.,* 2015). The UV-Visible spectrophotometer examines the bioreduction of silver ions, with features detected at 439 nm. Suganya *et al.,* (2020) found a similar type of SPR peak value in the *Sargassum wightii*. The absorption in *Sargassum wightii* at 440 nm and in *Sargassum polycystum* at 418 nm (Vinoth *et al.,* 2019).

Our results indicated distinct peaks, which correlate to Bragg's reflection planes and crystalline cubic structures in the X-ray diffractogram of algae-produced AgNPs. Bragg's reflection corresponds to FCC type silver (Vinoth *et al.,* 2019). Furthermore, frequent high peaks were observed in the region of the average peaks, which could be related to rare chemicals and protein stabilizing compounds occurring in the marine algal extract. The Scherer equation calculates the particle size around 15.3 nm. According to these results, Suganya *et al.,* (2020) noted the 10 nm particle size in *Sargassum wightii* with the help of the Debbye Scherer equation.

The FTIR study recognized the probable biomolecules in *S.swartzii* AgNPs and the outcomes showed the presence of the amines of the secondary group, aliphatic amine, alkenes, primary aromatic amines, amides, carboxylate, ester and a hydroxyl group. A similar type of results reported by Ravichandran *et al.,* (2018) in the IR spectra of AgNPs synthesized using the *Spatoglossum asperum* aqueous extract indicated the carboxyl group, aromatic amine, alkenes has utilized in the synthesis (Ghorbanpour *et al.,* 2020). In *Pyropia yezoensis* presence of alkenes, aromatic compounds, and carboxylic derivatives are responsible for stabilizing and reducing agents for the fabrication of AgNPs (Srivastava and Bhargava, 2022).

The results of the SEM study reveal the form and size of the AgNPs in prominent detail. A close measurement of the elaboration of the SEM results of the nanoparticles shows that the size of nanoparticles produced is in the 14-50 nm range (Suchomel *et al.,* 2015). According to some reports, mostly the synthesized AgNPs were spherical or cubical (Azarudeen *et al.,* 2017). *Padina sp*. synthesized NPs were spherical, polydispersed, and oval-shaped with some irregular and an average size range of 25 to 61.4 nm (Bhuyar *et al.,* 2020). Similar to our results, SEM images of the marine algae *Sargassum polycystum* AgNPs were predominantly spherical and highly distributed, with an average size from 20-88 nm. The results of the TEM analysis showed the spherical and polydispersed AgNPs synthesized by the algal extract. In agreement with our results, Belattmania *et al.,* (2018) notified spherical nanoparticles ranging between 5 to 50 nm in *Sargassum muticum* (Nguyen *et al.,* 2019). The SAED results on this are similar to the results of Ma *et al.,* (2016) earlier's work.The results indicated that the algal extract of *Sargassum swartzii* is an appropriate reducing agent for constructing well-distributed and crystalline AgNPs.

Silver is the oldest metal with a wide variety of efficient antibacterial properties against various diseases (Kumar and Bharathiraja, 2021). However, the algal synthesized AgNPs indicated effective antibacterial activity against four distinct bacteria. This enormous disparity might be attributable to the sensitivity of the microorganism used in this study. The resulting AgNPs are attached to the cell membrane and penetrate the bacterial organism (Hassan and Hosny, 2018). When AgNPs pass through the membrane of bacteria, they form a reduced

molecular weight patch in the cell's middle, which the bacteria band together to protect the DNA from the Ag ions (Viswanathan *et al.,* 2021). The particles ideally damage the respiratory chain of cell division, resulting in cell death. In bacterial cells, AgNPs released Ag ions, which increases their bactericidal action (Morones *et al.,* 2005; Fouad *et al.,* 2017; Viswanathan *et al.,* 2021). Various studies have revealed that NPS may attach to the cell membrane surface and disrupt the cell's permeability and respiration (Kathiraven *et al.,* 2015; Rikisahedew, 2018). It's also possible that AgNPs don't just interact with the membrane's surface; they might also disrupt the organism from within (Sondi, 2004). Thus the cellular metabolic modification that occurred due to Ag^{+} metals may promote new synthesis due to these marine algae.

CONCLUSION

The present investigation shows the successful extracellular synthesis of algal-based AgNPs using *Sargassum swartzii* as the reducing and stabilizing agents. The use of algal extract is an ideal alternative method for chemical synthesis of AgNPs. This green synthesis is an eco-friendly, novel, reliable, and cost-effective approach, among the other biological methods which have been utilized. The primary characterization was confirmed through the colour change from yellow-brown to dark brown. The absorbance band occurred at 439 nm and rapidly increased with incubation time determine by the UV-visible spectrophotometer. SEM and TEM images revealed the surface morphology and size detail of silver nanoparticles. The particles were polydispersed and spherical shape with an average size of 13.5 nm and diameter range of 14 to 39 nm. FTIR results displayed the capping and reducing agents for silver nanoparticle synthesis. Here the *Sargassum swartzii* recorded as the best biological source for it. The polyphenolic components, amines or alkenes, carboxylates, and OH group of algal extract act as very good stabilizers for particle production. XRD analysis generated the pattern that indicated face centric cubic structure and crystal nature of particles at various diffraction peaks at 27.84, 32.315, 38.17, 44.29, 46.28 and 77.56. Overall, all the characterization techniques strongly proved the synthesis of nanoparticles. Furthermore, the antibacterial activity of algal synthesized silver nanoparticles using agar well diffusion method against the four different types of bacteria indicated a significant impact was observed at 100 µl concentration of silver nanoparticles. The gram positive bacteria such as *Bacillus subtilis* and *Staphylococcus aureus* indicated higher activity compared to gram-negative bacteria. Thus finally it can be concluded that the phytochemicalsof algal extractmayhelp in the rapid production of nanoparticles, and also these metabolites may help in the biological activities. This effective antibacterial properties of nanoparticles can be further explored in the future for pharmaceutical nano-drug generation and other biomedical applications for human health as well as it can be explored in agriculture and industrial applications.

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