ISETC2025

UNIVERSITI TEKNOLOGI MARA

ISETC2025

2 ND INTERNATIONAL SCIENCE, ENGINEERING AND TECHNOLOGY COLLOQUIUM



THE POWER OF SCIENTIFIC INNOVATION

INTELLIGENT SOLUTIONS FOR A SUSTAINABLE WORLD

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PREFACE

Welcome to the 2nd International Science, Engineering and Technology Colloquium 2025 (ISETC 2025)!

It is with great pleasure that we present this year's colloquium, a distinguished gathering of scholars, researchers, and professionals dedicated to the advancement of applied sciences. Held virtually on 9th July 2025, ISETC 2025 serves as a platform to highlight cutting-edge research, foster meaningful networking, encourage collaborations, and explore innovative solutions to global challenges.

This year's theme, "The Power of Scientific Innovation: Intelligent Solutions for a Sustainable World" highlights our shared goal to solve global challenges through applied science. It celebrates innovation as a key to building a more sustainable and resilient future. We're proud to feature keynote speakers and presenters who bring fresh insights, bold ideas, and breakthroughs shaping tomorrow's world.

We would like to extend our heartfelt appreciation to the Faculty of Applied Sciences, Universiti Teknologi MARA, Perak Branch, Tapah Campus, for their outstanding support and assistance throughout the planning and execution of the event. Their dedication has been instrumental to the success of this colloquium. We would like to sincerely thank all participants and researchers for their valuable contributions. We also appreciate the reviewers for their careful evaluations and helpful feedback. Your hard work and support mean a lot to us.

As editors, we are proud to present this collection of proceedings. It is an honour to bring together the interesting and meaningful work of our speakers and authors. We hope the ideas shared will lead to new discoveries, encourage more research, and help solve global challenges through science and innovation.

Warm regards,

Dr. Emi Norzehan Mohamad Mahbob
Dr. Saiyidah Nafisah Hashim
Ms. Lili Widarti Zainuddin
Ms. Nurul Nazwa Mohammad
Ms. Rozaina Saleh

ISETC 2025 Proceedings Editors

INNOVATIVE SILVER NANOPARTICLE PRODUCTION VIA MICROALGAE EXTRACT

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Abstract: Silver nanoparticles (AgNPs) are highly valuable for their antibacterial, catalytic, and optical features. Yet, traditional production techniques use hazardous chemicals and involve substantial energy consumption that increased environmental concerns. This study determined an environmentally friendly technique that uses microalgae extracts from *Spirulina platensis* and *Chlorella vulgaris* as bio-reducing agents. By optimising important parameters such as incubation period, extract-to-silver nitrate ratio, and pH, the greatest yield of 78.57 wt% Ag was achieved with 48 hours of incubation, a 25:75 volumetric ratio, and pH 10. UV-Visible Spectroscopy (UV-Vis), Particle Size Analysis (PSA), Field Emission Scanning Electron Microscopy (FE-SEM), and Transmission Electron Microscopy (TEM) all verified that nanoparticles were formed successfully. Spirulina-derived AgNPs exhibited a Localised Surface Plasmon Resonance peak at 375-381.7 nm, whereas *Chlorella vulgaris* produced minimal nanoparticles. The synthesised AgNPs had an average particle size of 20-30 nm, a crystalline metallic silver structure, and a uniform distribution. This research indicates microalgae's potential as a sustainable alternative for AgNP green synthesis, to provide an environmentally friendly and scalable approach. Future research will focus on improving efficiency, increasing output, and broadening applications in a variety of areas, including biomedicine and environmental technology.

***Keywords*:** *Bio-reducing agents, Spirulina platensis, Chlorella vulgaris, nanoparticle characterisation, Localised Surface Plasmon Resonance (LSPR), green synthesis, sustainable nanotechnology*

INTRODUCTION

Nanotechnology is a rapidly growing field that focusses on transforming materials at atomic and molecular levels ranging from 1 to 100 nanometres (nm). At this scale, materials show distinct features that differ from bulk materials, such as increased reactivity, strength, and functionality, which makes nanoparticles (NPs) highly significant in a variety of industrial applications (Premarathna, 2024). Silver nanoparticles (AgNPs) are notable for their superior antibacterial, catalytic, and optical features, which makes them valuable in areas like biomedicine, water treatment, and electronics (Dhaka, 2023).

Traditional methods of producing AgNPs often involve hazardous chemicals and high energy use, that provide environmental concerns. To solve these challenges, green synthesis methods based on natural materials such as plants, fungus, and algae have gained popularity due to their environmental friendliness and cost-effectiveness (Dhaka, 2023). Microalgaes such as *Spirulina platensis* and *Chlorella vulgaris* have showed significant potential due to their capacity to reduce metals into metal ions forming nanoparticles under mild conditions. This makes them excellent candidates for sustainable nanoparticle production (Mukherjee, 2021).

This study investigates the optimisation of AgNP synthesis with commercially available *Spirulina platensis* and *Chlorella vulgaris* extracts. The primary goal is to find the best synthesis conditions by adjusting variables such as incubation time, algal extract-to-silver nitrate ratio, and pH. UV-Visible Spectroscopy (UV-Vis), Particle Size Analyser (PSA), Field Emission Scanning Electron Microscopy (FE-SEM), and Transmission Electron Microscopy

(TEM) were used to characterise the synthesised nanoparticles and assess microalgae's potential as sustainable sources of AgNP production.

MATERIALS & METHODS

Figure 1 illustrates the project flowchart of silver nanoparticles production from microalgae extract.

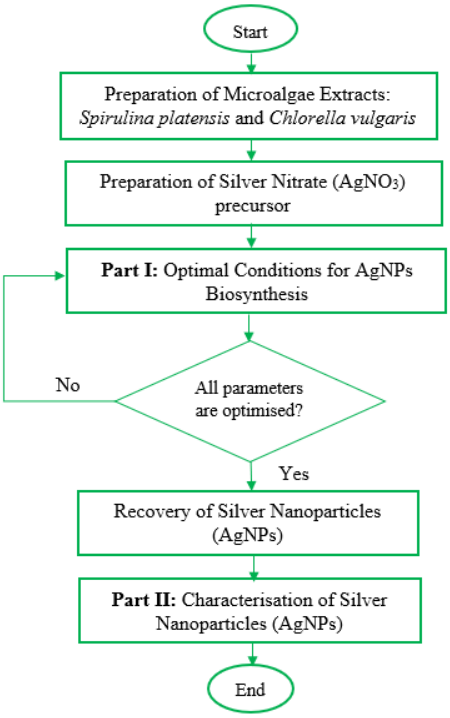


Figure 1. Project experimental flowchart

To prepare microalgae extracts from commercial *Spirulina platensis* and *Chlorella vulgaris* biomass, 5 g of microalgae powder was dissolved in 100 mL of distilled water, stirred for 30 minutes at room temperature (~25°C), and filtered through Whatman Grade 1 filter paper to remove debris. The resulting light green filtrate was used as the reducing agent for AgNP synthesis. To make a silver nitrate ($AgNO_3$) solution, the required amount of solid $AgNO_3$ was dissolved in distilled water. The required mass of solid $AgNO_3$ was calculated based on Eqn (1).

$$Mass\ of\ AgNO_3 = Molarity \times Volume \times Molecular\ Weight\ of\ AgNO_3 \quad (1)$$

The solution was stored in an aluminum-wrapped volumetric flask to prevent light exposure. The synthesis of AgNPs involved varying incubation times (4, 24, 48, 72, and 96 hours), extract-to-$AgNO_3$ ratios (5:95, 10:90, 15:85, 20:80, 25:75), and pH levels (3, 5, 6.3, 8, and 10) using 0.1 M sulphuric acid or sodium hydroxide. The formation of AgNPs was confirmed by the colour change as in Figure 2(a) and UV-Vis spectrophotometry. The synthesised AgNPs were recovered by centrifugation at 13,000 rpm for 15 minutes, then washed with distilled water and dried at 40°C for 48 hours. The dried AgNPs were obtained as in Figure 2(b).

(a)  (b) 

Figure 2. (a) Liquid AgNPs colloidal suspension produced from *Spirulina* (b) Production of Dried AgNPs

RESULTS AND DISCUSSION

Synthesis of AgNPs from Microalgae Extracts

In this study, the biosynthesis of AgNPs was carried out using *Spirulina platensis* and *Chlorella vulgaris* as the source of bioactive compounds, with varies key parameters such as incubation time, microalgae extract to $AgNO_3$ solution ratio, and pH value affecting the synthesis. The UV-Vis spectrophotometry analysis revealed that the best incubation time for AgNP production using *Spirulina platensis* was 48 hours, with a peak absorption of 1.831 a.u. at 374.3 nm as shown in Figure 3(a). The most optimal extract-to-$AgNO_3$ ratio for *Spirulina* was found to be 25:75, which led to the maximum nanoparticle formation with a peak absorbance at 381.7 nm in Figure 3(c). In contrast, *Chlorella vulgaris* produced minimal or no nanoparticles when varying with both of these parameters as in Figure 3(b) & (d). At pH 10, *Spirulina* showed the most substantial nanoparticle formation, with a peak absorption of 1.834 a.u. at 375 nm as in Figure 3(c), This led to a drastic colour shift from light yellow to reddish-brown. Meanwhile, *Chlorella* at alkaline condition, do shown some colours change from pale yellow to brownish yellow which indicates the formation of AgNPs, but with lower absorption levels.

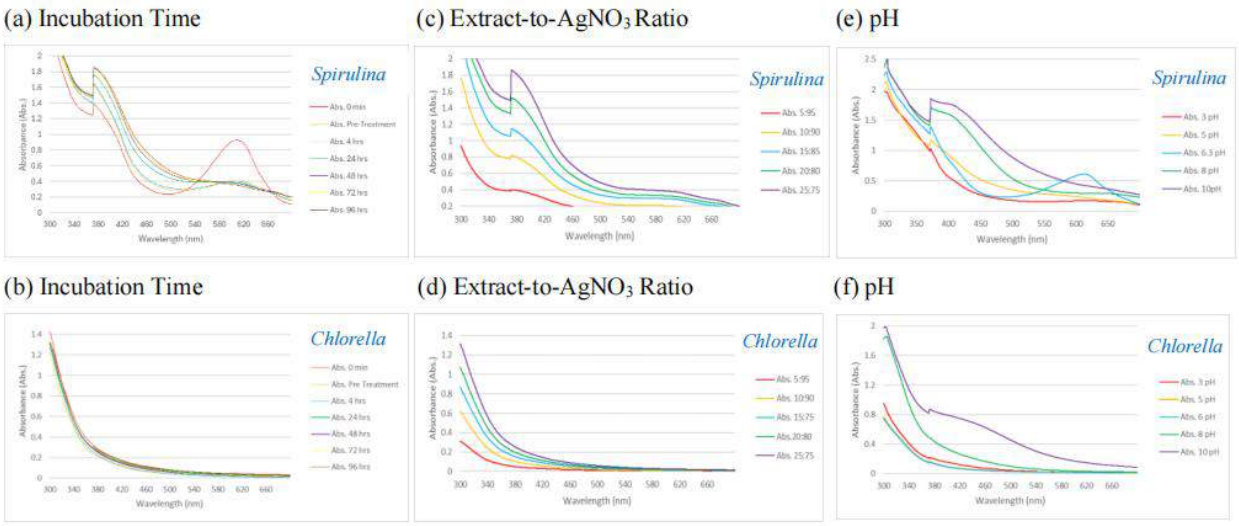


Figure 3. UV–Visible spectroscopic graphs of optimised parameters for AgNPs synthesis (a,b) incubation time, (c,d) extract-to-$AgNO_3$ ratio, (e,f) pH.

Recovery and Yield of AgNPs

The optimal conditions for AgNP production (48-hour incubation, 25:75 extract-to-$AgNO_3$ ratio, and pH 10) yielded a high recovery rate of 78.57 wt% for *Spirulina platensis*. This yield exceeded the 74.85 wt% recorded for *Microcystis aeruginosa* (He, 2022) and was much greater than that of *Chlorella vulgaris*, which indicates *Spirulina* as a highly efficient biosynthetic agent. The AgNP yield was determined using Eqn(2):

$$\%\ Yield = \frac{Dried\ weight\ of\ AgNPs}{Actual\ weight\ of\ Ag\ in\ 5\ mM\ of\ AgNO_3} \times 100\% \qquad (2)$$

Given its higher efficiency, *Spirulina*-derived AgNPs were selected for further characterisation.

Characterisation of AgNPs

The Particle Size Analysis (PSA) revealed that the synthesised AgNPs from *Spirulina platensis* had an average size range of 25-35 nm, with a peak distribution at 28 nm as in Figure 4(a). This shows a uniform size distribution of the nanoparticles, which indicates efficient synthesisation under optimised conditions. Moreover, Field Emission Scanning Electron Microscopy (FE-SEM) imaging showed a variety of spherical, polyhedral, and irregularly shaped nanoparticles, some of which had flake-like characteristics, which suggests anisotropic growth Figure 4(b). The analysis also found nanoparticle agglomeration, which was most likely caused by the thermal drying process. Transmission Electron Microscopy (TEM) analysis confirmed the size and morphology of the AgNPs, which had an average size of around 30 nm as in Figure 4(c). The crystalline structure as in Figure 4(d) was confirmed by selected area electron diffraction (SAED) patterns, which verified the metallic nature of the synthesised AgNPs. Some agglomeration was found as in Figure 4(e), which is common for biosynthesised nanoparticles as the remaining biomolecules serve as capping agents.

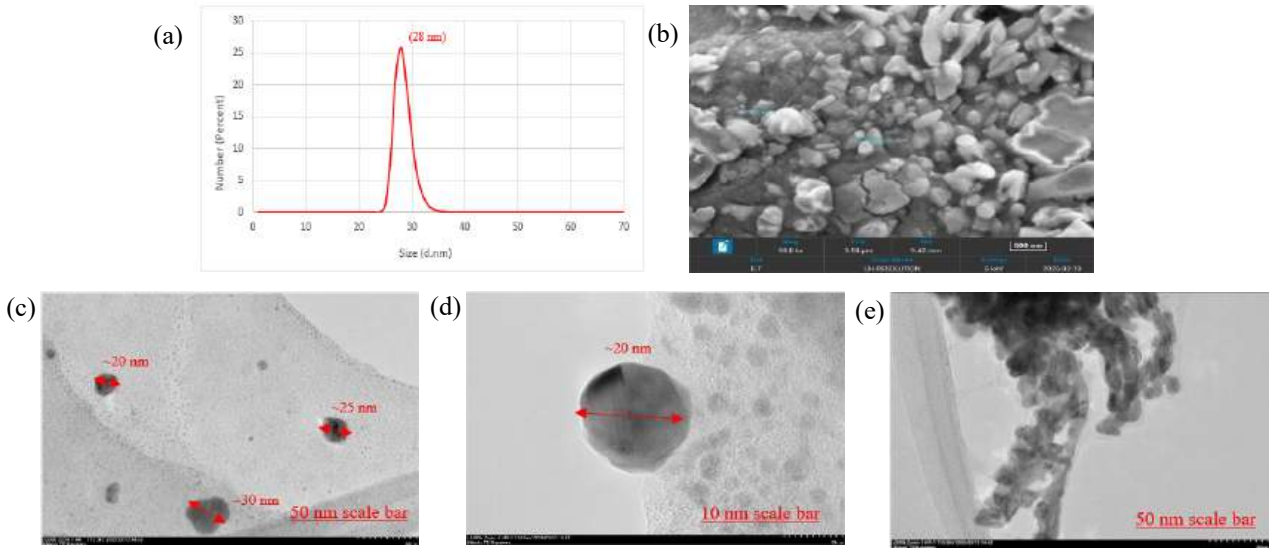


Figure 4. Structural characterization of *Spirulina*-derived AgNPs; (a) Number percent distribution of optimal synthesised AgNPs (b) FE-SEM micrograph of 70 – 150nm AgNPs (50k magnification) (c) TEM micrograph of 20 – 30nm AgNPs (200k magnification), (d) TEM micrograph of AgNPs crystalline structure (1000k magnification), (e) TEM micrograph of agglomerated AgNPs (200k magnification)

CONCLUSION

In conclusion, this study had successfully optimized the biosynthesis of silver nanoparticles (AgNPs) using *Spirulina platensis* and *Chlorella vulgaris* extracts, by identifying optimal synthesis parameters and characterising the physical properties of the AgNPs. The findings showed that *Spirulina platensis* produced AgNPs with an average size of 28

nm, that exhibits uniform distribution and a crystalline structure. Meanwhile, *Chlorella vulgaris* showed limited nanoparticle formation. The biosynthesized AgNPs from *Spirulina platensis* exhibited a yield of 78.57%, which validates its potential as a bio-reducing agent. This study supports sustainable nanomaterial production, that aligns with Sustainable Development Goals (SDGs) 12 and 13 by reducing reliance on hazardous chemicals. Future research should focus on optimising additional parameters and exploring scalability, which could further enhance the efficiency and stability of AgNP synthesis for industrial applications.

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