SILVER NANOPARTICLES PRODUCTION USING MICROALGAE EXTRACTS

Kelly Lai Yan Kei | Bachelor of Chemical Engineering with Honours

Priority Topic Area: **Responsible Production, Innovation and Industry**

1 – Optimizing Green Synthesis of Silver Nanoparticles Using Microalgae Extract

Silver nanoparticles (AgNPs) are valued for their antimicrobial, catalytic, and optical properties. The AgNP market is projected to grow at a CAGR of 17.6%, reaching USD 332 billion by 2032 (Fortune Business Insights, 2024). However, conventional synthesis involves hazardous chemicals and high energy use which poses environmental concerns. This study explores a green synthesis approach using *Spirulina platensis* and *Chlorella vulgaris* extracts as bio-reducing agents. The key parameters like incubation time, extract-to-$AgNO_3$ ratio, and pH were optimised. Characterization was conducted using UV-Vis, PSA, FE-SEM, and TEM, demonstrating the potential of microalgae for sustainable AgNP production.

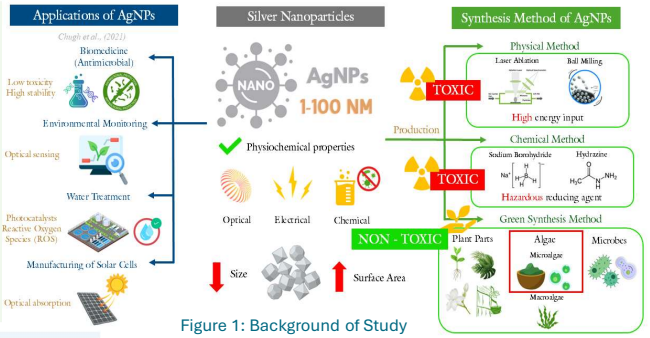

Figure 1: Background of Study (Chugh et.al, 2021)

Figure 2: AgNPs Market Size & Industry Forecast (Allied Market Research, n.d.)

2 – Methodology (Phyco-Nanotechnology Mechanism)

Microalgae extracts from *Spirulina platensis* and *Chlorella vulgaris* were prepared and mixed with $AgNO_3$ solution under controlled conditions. The synthesis process was optimized by adjusting incubation time, extract-to-$AgNO_3$ ratio, and pH levels. The formation of AgNPs was confirmed using UV-Vis spectroscopy, while PSA, FE-SEM, and TEM analyzed particle size and morphology. This method prioritizes eco-friendly synthesis by eliminating toxic chemicals, ensuring a sustainable approach for AgNP production.

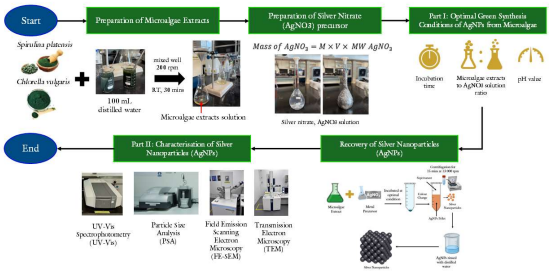

Figure 3: Methodology of AgNPs Synthesisation

3 – Results for Algae-Synthesised Silver Nanoparticles

Through this experiment, the optimum synthesis conditions were identified as 48 hours of incubation, a 25:75 volumetric ratio of microalgae extract to $AgNO_3$, and a pH of 10. The percentage of AgNPs yield obtained after recovery process was 78.57wt % of Ag. Moreover, characterisation of the synthesised AgNPs was conducted using UV-Visible Spectroscopy (UV-Vis), Particle Size Analysis (PSA), Field Emission Scanning Electron Microscopy (FE-SEM), and Transmission Electron Microscopy (TEM). For *Spirulina platensis*, the UV-Vis analysis has validated the successful formation of AgNPs with a Localized Surface Plasmon Resonance (LSPR) peak between 375 – 381.7 nm of absorbance value within 1.805 – 1.834 a.u., whereas *Chlorella vulgaris* exhibited minimal nanoparticle formation. The average particle size measured through PSA analysis fell within 28 nm and these results were then validated by TEM analysis that confirmed the particles measured was between 20 to 30 nm. TEM at high magnification also revealed their crystalline metallic silver structure, while FE-SEM imaging further confirmed the uniform distribution of AgNPs.

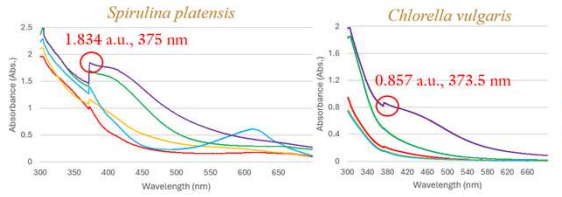

Figure 4: UV-Vis Spectrum at Optimised Parameters

Figure 5: Colour Changes of Reaction after 48 hours

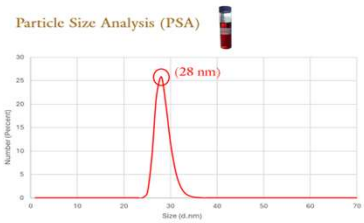

Figure 6: Number Percent Distribution of Optimal Synthesised AgNPs

4 – Benefit Applications

The eco-friendly production of silver nanoparticles (AgNPs) using microalgae benefits society through applications in medicine, water treatment, and environmental monitoring. AgNPs combat infections, detect heavy metals, and degrade pollutants, improving health and sustainability. They also enhance solar cells, supporting renewable energy while reducing harmful chemical use in nanoparticle synthesis.

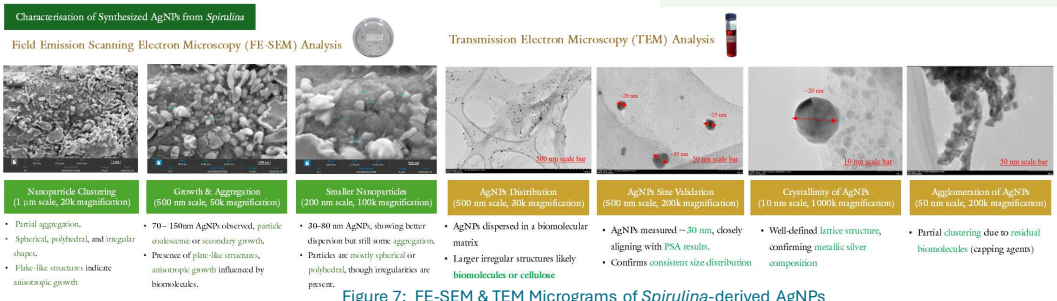

Figure 7: FE-SEM & TEM Micrograms of *Spirulina*-derived AgNPs

5 – Recommendations

Future research should optimise eco-friendly AgNP synthesis using microalgae for large-scale production, that focuses on efficiency, cost, and sustainability. Studies on safety, stability, and environmental impact are essential for medical and environmental applications.

References

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