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Synthesis of *Padina tetrastromatica* Seaweed Mediated Silver Nanoparticles and its Toxicological Evaluation against Brine Shrimp *Artemia*

Shin Yi Low[1,a], Jo Sze Lean[1,b], Ke Xin Yu[2,c], Ching Lee Wong[1,d] and Jeck Fei Ng[3,e*]

[1]School of Biosciences, Faculty of Health and Medical Sciences, Taylor's University Lakeside Campus, No. 1, Jalan Taylors, 47500 Subang Jaya, Selangor, Malaysia

[2]Faculty of Health and Life Sciences, Management and Science University, Seksyen 13, 40100 Shah Alam, Selangor, Malaysia

[3]School of Pharmacy, Faculty of Health and Medical Sciences, Taylor's University Lakeside Campus, No. 1, Jalan Taylors, 47500 Subang Jaya, Selangor, Malaysia

[a]shinyi.lsy07@gmail.com, [b]leanjosze@sd.taylors.edu.my, [c]kxyu@msu.edu.my, [d]chingleew@yahoo.com, [e]jeckfei.ng@taylors.edu.my

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Abstract. The present study evaluates the toxicity of AgNPs synthesised from *Padina tetrastromatica* (P-AgNPs) through Brine Shrimp Lethality Assay. The aqueous *Padina* seaweed extract was treated with $AgNO_3$ to synthesise P-AgNPs, and these NPs were then characterised by multiple analytical techniques. The UV-Vis spectra displayed characteristic SPR peaks of AgNPs at about 409.5 nm. The TEM and particle size distribution results verified the formation of polydisperse spherical P-AgNPs with a dominant size of around 48 nm. Zeta potential analysis indicates the moderate stability of P-AgNPs. The FTIR spectrum of P-AgNPs reveals the presence of organic functional groups, suggesting the involvements of seaweed organic matters in capping and stabilising AgNPs. Though the 24-h mortality test showed a dose-dependent increase in *Artemia* death, the results imply a non-toxic property in P-AgNPs (LC_{50} value: 4300 mg/L; >1000 mg/L). These findings conclusively suggest the acute exposure to P-AgNPs has no substantial risk to marine organisms.

Introduction

Silver nanoparticles (AgNPs) are probably one of the most widely exploited NPs considering their exceptional applications in areas ranging from pharmaceutical to medical and electronics [1]. The increased applications signify a distinct increase in human and ecosystem exposures to AgNPs, undeniably raising the need for an eco-friendly synthesis method. Seaweeds have primary and secondary metabolites which are emerging nano-biofactories to offset the non-biodegradable and potentially toxic chemically-synthesised AgNPs. These metabolites could instantaneously engage in silver reduction to nucleate AgNPs and roleplay as capping agents to stabilise AgNPs. Besides, the distinct advantages of seaweeds with high metal uptake potential and their abundance as renewable feedstocks make the rapid seaweed-mediated synthesis of AgNPs feasible [2]. While the biomedical and electrochemical applications of bio-synthesised AgNPs are promising [3], uncertainties still exist regarding the environmental effects of metallic bionanomaterials in general. Evaluating the environmental risks of these manufactured materials is essential to assist relevant risk assessment and ensure safety of such bio-synthesised nanomaterials.

Marine crustaceans are well-suited as partial replacement of toxicity testing involving vertebrates. Primarily, brine shrimp *Artemia* face a higher likelihood of interaction with environmental pollutants through non-selective filter-feeding and their specific role in the food web as a primary consumer in comparison with other marine species. Together with their high fecundity and adaptability to a broad range of salinities (5-300 g/L) and temperatures (6-40 °C), these intrinsic characteristics turn them into a suitable toxicological model [4]. Lethality assay data are available not only for seaweed-derived metallic NPs but also for organic and inorganic engineered nanomaterials [5].