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DEVELOPMENT OF NANOENCAPSULATED BIOFERTILIZER FROM THE EXTRACT OF THE SEAWEED *Kappaphycus alvarezii*

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INTRODUCTION

The overuse of chemical fertilizers negatively impacts the environment, causing soil and water pollution and contributing to greenhouse gas emissions. Sustainable alternatives, such as biofertilizers from *Kappaphycus alvarezii*, enhance soil quality and crop productivity. Nanotechnology, particularly nanoencapsulation, improves cell membrane permeability, allowing for more efficient nutrient absorption. This study developed a nanoencapsulated biofertilizer from *K. alvarezii* extract, evaluating its physicochemical properties and potential agricultural benefits as a sustainable solution to reduce chemical fertilizer dependence.

MATERIAL AND METHODS

Fresh *K. alvarezii* biomass was harvested from an aquaculture farm in Penha-SC, Brazil, and subjected to a washing and freezing process. The crude extract was obtained through mechanical disruption and aqueous extraction, followed by lyophilization to concentrate bioactive compounds. The nanoencapsulation process was performed using two methodologies: spontaneous emulsification and conventional emulsion. The nanoparticles were characterized using UV-Vis. spectrophotometry, dynamic light scattering (DLS) for particle size distribution, and zeta potential measurements to evaluate stability. Encapsulation efficiency was assessed by quantifying retained carotenoids and chlorophyll.

RESULTS

Spectrophotometric analyses indicated a 17.9% reduction in carotenoid content and a 17.89% decrease in chlorophyll *a* after 15 days of storage, highlighting the susceptibility of the crude extract to oxidation. The spontaneous emulsification method yielded nanoparticles with smaller sizes (85.37 ± 1.41 nm and 92.18 ± 1.36 nm) and higher uniformity compared to conventional emulsion (ranging from 177.13 ± 4.94 nm to 392.93 ± 89.12 nm). Zeta potential measurements confirmed the greater colloidal stability of the spontaneously emulsified nanoparticles (-42.90 ± 4.19 mV). The nanoencapsulation process improved the bioavailability and retention of bioactive compounds.

CONCLUSIONS

The nanoencapsulation of *K. alvarezii* biofertilizer demonstrated promising results, with spontaneous emulsification yielding more stable and uniform nanoparticles. This process preserved bioactive compounds, enhancing agricultural sustainability by reducing chemical fertilizer dependence.