Targeted Protein Translation Suppression in the Dinoflagellate, Prorocentrum lima, using Cell-Penetrating Peptides

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Abstract

Dinoflagellates are a major contributor to harmful algal blooms (HABs), which threaten marine ecosystems and human health. Current mitigation strategies are ineffective at the genetic level due to the challenges of intracellular delivery and complex genetic architecture of dinoflagellates. Cell-penetrating peptides (CPPs) facilitate intracellular delivery, while peptide nucleic acids (PNAs) are short yet specific biomolecules applicable in protein translation regulation. This study explores the use of CPP-PNAs to suppress marine toxin production which marks the first application of this approach in dinoflagellates. *Prorocentrum lima* was selected as a model due to its high okadaic acid production and ecological relevance in HABs. Fluorescence-labelled CPPs were tested for cellular uptake using confocal microscopy. Targeted CPP-PNAs were designed to suppress okadaic acid-producing proteins and modulate ABC transporter expression. Okadaic acid levels were quantified using a protein phosphate inhibition assay (PPIA) while cell viability and growth were counted under a standard microscope. Fluorescence-labelled CPPs successfully penetrated the cell wall which demonstrates efficient intracellular delivery despite the presence of thecal plates with observed cell viability indicating minimal cytotoxic effects. Partial suppression of okadaic acid related proteins provided preliminary evidence of successful protein translation regulation using CPP-PNA within *P. lima*. This study presents a simple yet efficient molecular approach for controlling harmful algal toxin production through targeted protein translation suppression. Our findings established CPPs as an effective delivery tool for dinoflagellates and demonstrated CPP-PNA feasibility in regulating HAB-associated toxins. CPP-PNAs hold significant potential for environmental and aquaculture applications as a targeted approach in managing toxin-producing dinoflagellates.

Keywords: dinoflagellates, protein translation regulation, cell, penetrating peptides, Prorocentrum

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