



Potent allelopathy and non-PSTs, non-spirolides toxicity of the dinoflagellate *Alexandrium leei* to phytoplankton, finfish and zooplankton observed from laboratory bioassays

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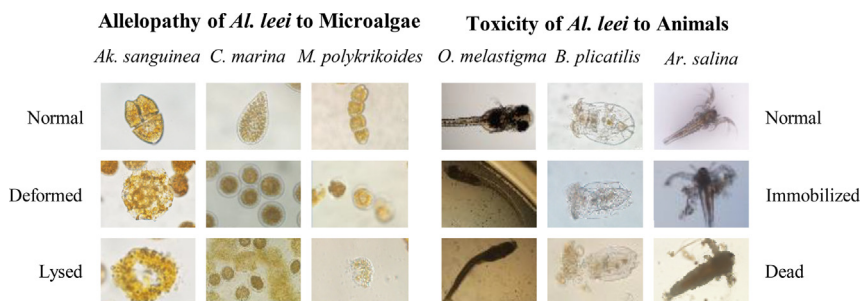
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HIGHLIGHTS

- *A. leei* from Malaysia showed variable allelopathic effects to 13 microalgal species.
- *A. leei* exhibited potent toxicity to finfish, rotifer, and brine shrimp.
- Allelochemicals and toxins of *A. leei* are present both intra- and extra-cellularly.
- Allelopathy and toxicity of *A. leei* are not caused by PSTs and spirolides.
- Allelopathic and toxic *A. leei* blooms may pose threats to fishery and ecosystems.

GRAPHICAL ABSTRACT



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ABSTRACT

The dinoflagellate genus *Alexandrium* has been well known for causing paralytic shellfish poisoning (PSP) worldwide. Several non-PSP toxin-producing species, however, have shown to exhibit fish-killing toxicity. Here, we report the allelopathic activity of *Alexandrium leei* from Malaysia to other algal species, and its toxicity to finfish and zooplankton, via laboratory bioassays. Thirteen microalgal species that co-cultured with *Al. leei* revealed large variability in the allelopathic effects of *Al. leei* on the test algae, with the growth inhibition rates ranging from 0 to 100%. The negative allelopathic effects of *Al. leei* on microalgae included loss of flagella and thus the motility, damages of chain structure, deformation in cell morphology, and eventually cell lysis. The finfish experienced 100% mortality within 24 h exposed to the live culture (2000–6710 cells·mL⁻¹), while the rotifer and brine shrimp exhibited 96–100% and 90–100% mortalities within 48 h when exposed to 500–6000 cells·mL⁻¹ of *Al. leei*. The mortality of the test animals depended on the *Al. leei* cell density exposed, leading to a linear relationship between mortality and cell density for the finfish, and a logarithmic relationship for the two zooplankters. When exposed to the treatments using *Al. leei* whole live culture, cell-free culture medium, extract of algal cells in the f/2-Si medium, extract of methanol, and the re-suspended freeze-and-thaw algal cells, the test organisms (*Ak. sanguinea* and rotifers) all died at the cell density of 8100 cells·mL⁻¹ within 24 h. Toxin analyses by HILIC-ESI-TOF/MS and LC-ESI-MS/MS demonstrated that *Al. leei* did not produce PSP-toxins and 13-desmethyl

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