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Effect of salinity on growth and toxin production of *Alexandrium minutum* isolated from a shrimp culture pond in northern Vietnam

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Abstract A clonal culture of a Vietnamese strain of *Alexandrium minutum*, AlexSp17, was subjected to different salinity treatments to determine the growth and toxin production of this strain that produces a novel toxin analogue, deoxy GTX4-12ol. The experiment was carried out in batch cultures without pre-acclimatization at seven salinity treatments from 5 to 35 psu, under constant temperature of 25°C, illumination of 140 μmol photon m^{-2} s^{-1}, and 12:12 light/dark photoperiod. The strain grew in all salinity treatments, with optimum growth at 10–15 psu. However, the specific growth rate (0.2 day^{-1}) was lower than those reported in Malaysian strains and other strains from different geographical areas. The optimum range of salinity for the growth of this species agreed with field observations of the locality of origin. No significant change in toxin profiles was observed at different salinities. The cellular toxin quota, Qt, was not affected by the salinity-dependent growth rate. The toxin GTX4-12ol is presumed to be a transformation product of GTX4 from specific cellular reductase enzymes. Further investigation at the molecular level of toxin biosynthesis and subcellular enzyme activities is needed to provide insight in the production of this unique toxin analogue.

Keywords *Alexandrium minutum* · Salinity · Toxin production · GTX4-12ol · Vietnam

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Introduction

In the tropics, dry–wet seasonal precipitation with freshwater influence results in salinity fluctuations in estuarine waters. This, in turn, affects the growth physiology of organisms living in estuarine environments, particularly the phytoplankton. Many studies have shown that seawater salinity is the important exogenous factor that affects the bloom dynamics of *Alexandrium* species (e.g., Cembella et al. 1988; Cembella and Therriault 1989). For instance, a study of *Alexandrium tamarense* in the Gulf of Maine showed that low-salinity coastal currents promoted the sudden increase in cell density (Anderson 1998). Giacobbe et al. (1996) found that spring blooms of *Alexandrium minutum* in the Mediterranean Sea coincided with the increase in rainfall and freshwater runoff. Our current understanding on the growth physiology and toxin production of *Alexandrium* is mainly derived from studies on the species from temperate estuaries, which may not truly reflect the growth physiology and toxin production of tropical counterparts.

In Southeast Asian countries, the occurrence of *A. minutum* has been frequently reported in estuarine waters (Lim et al. 2004; Lim and Ogata 2005), aquaculture ponds (Matsuoka et al. 1997; Yoshida et al. 2000; Lim et al.