Growth and paralytic shellfish toxin production by the dinoflagellate *Alexandrium catenella* cultured under monochromatic light

Shanshan JIANG, Hiroko IWASHITA, Osamu ARAKAWA and Tomohiro TAKATANI*

**Abstract:** To explore how light wavelength affects the growth of a dinoflagellate species and its production of paralytic shellfish toxin (PST), we examined the growth and PST production of *Alexandrium catenella* (*Ac*) cultured under monochromatic light. The *Ac* strain was cultured for 21 days under blue (470 nm), green (530 nm), or red (660 nm) LED irradiation (Blue, Green, and Red groups respectively). During the culture period, the cell density (*Cd*) increased rapidly in Blue and slowly in Red, while the cell volume (*Cv*) decreased in Blue, but gradually increased in Red. In Green, *Cd* increased slowly, but *Cv* decreased. Interestingly, the increase in the cell biomass per unit medium volume was similar in Blue and Red, suggesting that the cell biomass of *Ac* increases equally by either an increase in the cell number under blue light, or by an increase in the cell volume under red light. HPLC analysis for PST revealed that the amount of toxin produced per cell, cellular toxin concentration, and toxin content per unit medium volume were highest in Red, followed by Green, and then Blue; i.e., *Ac* produced more PST under red light than blue light, despite the equivalent increase in the cell biomass under both conditions.

**Key words:** *Alexandrium catenella*; Paralytic shellfish toxin; Dinoflagellate; LED

1. Introduction

Paralytic shellfish toxins (PSTs), a group of neurotoxins mainly produced by toxic dinoflagellate species of the genera *Alexandrium*, *Gymnodinium*, and *Pyrodinium* (Orr et al. 2013; Asakawa et al. 2015) inhibit nerve and muscle conduction by selectively blocking sodium channels like the pufferfish toxin tetrodotoxin (Cusick and Sayler 2013). To date, more than 50 analogues, including saxitoxin, neosaxitoxin, gonyautoxin (GTX) 1-6, C toxin (C) 1-4, and their decarbamoyl derivatives have been separated from various marine or freshwater organisms (Wiese et al. 2010). Bivalves feeding on highly proliferating PST-producing dinoflagellates become toxic, and their intake could cause lethal human food poisoning. Thus, PSTs pose a serious threat to fishery industries and public health worldwide (Hallegraeff 1993).

Production of PSTs by toxic dinoflagellates differs considerably, even among the same species, depending on the strain, habitat, and season, and even between wild cells and cultured cells (Cembella et al. 1988; Kim et al. 1993; Oshima et al. 1993; Sakamoto et al. 1999; Takatani et al. 1998a, 1998b; Montoya et al. 2010). Various environmental factors, such as water temperature, salinity, nutrient, and light intensity, also influence PST production (White 1978; Ogata et al. 1987; Anderson et al. 1990a, 1990b; Flynn et al. 1994; Siu et al. 1997; Hwang and Lu 2000; Hamaiki et al. 2001; Etheridge and Roesler 2005; Lim and Ogata 2005; Navarro et al. 2006; He et al. 2010; Laabir et al. 2011, 2013), but it is unclear how light quality (irradiation wavelength) affects the