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Within-species and temperature-related variation in the growth and natural products of the red alga *Asparagopsis taxiformis*

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Abstract The red algal genus *Asparagopsis* (Bonnemaisoniaceae) is a significant resource for bioactive natural products. However, prior to domestication for commercial production, we need to understand the potential variation in growth and concentration of natural products between isolates of *Asparagopsis* and, beyond that, how these traits are affected by environmental conditions. Ten isolates of *Asparagopsis taxiformis* were collected from tropical and warm-temperate regions in Queensland, Australia, and identified by molecular barcoding of the mitochondrial intergenic spacer (*cox*2–3 spacer). The isolates were cultured at three temperatures ranging from the minimum of the warm-temperate region to the maximum of the tropical region. Growth rates and the concentration of natural products varied between the region of origin, between isolates within region and between temperatures. Growth differed by up to 50% between isolates, whereas the concentration of natural products differed more than tenfold. Growth rates were highest at the minimum temperature of 20.2°C, irrespective of region of origin, and were lowest at the maximum temperature of 28.1°C. Natural products were threefold higher in tropical isolates, and this variation was not correlated to growth. Consequently, targeting isolates with high concentrations of natural products should be the primary strategy for the domestication of *Asparagopsis* for biotechnology applications.

Keywords Aquaculture · Bromoform · Chemical defence · Genetic variation · Macroalgae · Seaweed · Rhodophyceae

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Introduction

The red algal genus *Asparagopsis* (Bonnemaisoniaceae) is a prolific source of halogenated natural products of which bromoform (tri-bromomethane) is the most abundant of more than 100 brominated, chlorinated and iodinated methanes, acetic and acrylic acids, and cyclic compounds (Burreson et al. 1976; Woolard et al. 1976, 1979; McConnell and Fenical 1977; Greff et al. 2014). These halogenated natural products have strong pharmacological activity as antimicrobials, antivirals, antifungals and in anticancer applications (Paul et al. 2006; El-Baroty et al. 2007; Hutson et al. 2012; Mata et al. 2013; Greff et al. 2014). Furthermore, as the content of the natural products in *Asparagopsis* can be up to 5% of the dry weight (Paul et al. 2006), the biomass also has potential to be used directly as a raw ingredient in biotechnology applications that include cosmetic formulations (Moigne 1998) and feed supplements (Machado et al. 2014). However, the supply of *Asparagopsis* biomass remains one of the major hurdles for companies eager to commercialise the bioactive natural products. Consequently, there is increasing interest for commercial-scale production of *Asparagopsis* that relies on the domestication of isolates from areas with commercial potential, and