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Emission of short-lived halocarbons by three common tropical marine microalgae during batch culture

Yong-Kian Lim[1,2] · **Siew-Moi Phang**[1,3] · **William T. Sturges**[4] · **Gill Malin**[4] · **Noorsaadah Binti Abdul Rahman**[5]

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Abstract Very short-lived halocarbons of marine biogenic origin play an important role in affecting tropospheric and stratospheric chemistry. In recent years, more attention has been paid to tropical regions where the influence of strong convective forces is responsible for rapid uplifting of the volatile organohalogens from the open surface waters into the atmosphere. This laboratory-based study reports on three common tropical marine microalgae capable of emitting a range of short-lived halocarbons, namely, CH_3I, $CHBr_3$, CH_2Br_2, $CHBr_2Cl$, and $CHCl_3$. Chlorophyll *a* and cell density were highly correlated to the quantity of all five compounds emitted ($p < 0.01$). The diatom *Amphora* sp. UMACC 370 had a higher range of CH_3I emission rate (10.55–64.18 pmol mg^{-1} chl *a* day^{-1}, $p < 0.01$) than the cyanobacterium *Synechococcus* sp. UMACC 371 and chlorophyte *Parachlorella* sp. UMACC 245 (1.04–3.86 pmol mg^{-1} chl *a* day^{-1} and 0–2.16 pmol mg^{-1} chl *a* day^{-1}, $p < 0.01$, respectively). Furthermore, iodine was the dominant halogen emitted in terms of total combined halide mass of all three species. Overall, the emissions of short-lived halocarbons were both species- and growth phase-dependent, highlighting the importance of considering cell physiological conditions when determining gas emission rates.

Keywords Halocarbons · Marine microalgae · Tropical · Batch culture · Climate change · Algal biotechnology

Introduction

Biogenic volatile halocarbons are important carriers of halogen radicals to the troposphere and the stratosphere. Very short-lived species (VSLS), such as iodinated (e.g., CH_3I, CH_2BrI, CH_2ClI) and brominated compounds (e.g., $CHBr_3$, CH_2Br_2, $CHBr_2Cl$) of oceanic origin, are released into the atmosphere and may be transported to the stratosphere when intense convection occurs in the troposphere (Kritz et al. 1993; Randel and Jensen 2013). These halogen-containing organic compounds might, therefore, contribute to the reactive halogens that account for the catalytic destruction of the ozone layer (WMO 2014). It is well established that brominated VSLS significantly contribute to stratospheric halogen loading, but the contribution of the shorter-lived iodinated compounds remains controversial (WMO 2014). Both iodinated and brominated VSLS have the potential to affect tropospheric chemistry (Sherwen et al. 2016).

Global emissions of CH_3I are estimated to be 157–260 Gg I $year^{-1}$ (Ziska et al. 2013; Stemmler et al. 2014) where some 240 Gg I $year^{-1}$, including 60 Gg I $year^{-1}$ of CH_3I, originates from open seawater and coastlines (Jones et al. 2010). Emission of short-lived brominated compounds

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✉ Siew-Moi Phang
phang@um.edu.my

[1] Institute of Ocean and Earth Sciences (IOES), University of Malaya, 50603 Kuala Lumpur, Malaysia

[2] Institute of Graduate Studies (IPS), University of Malaya, 50603 Kuala Lumpur, Malaysia

[3] Institute of Biological Sciences, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia

[4] Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, Norwich Research Park, Norwich NR4 7TJ, UK

[5] Department of Chemistry, Faculty of Science, University of Malaya, 50603 Kuala Lumpur, Malaysia