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Effect of increased temperature on halocarbon emission and bioelectricity generation by *Synechococcus* sp. UMACC 371 in a biophotovoltaics device

Jing-Ye Tee [a,b], Fiona Seh-Lin Keng [a,c,*], Fong-Lee Ng [d], Gill Malin [e], Choon-Weng Lee [a,c], Siew-Moi Phang [a,f,*]

[a] Institute of Ocean and Earth Sciences (IOES), Universiti Malaya, 50603, Kuala Lumpur, Malaysia
[b] Institute for Advanced Studies, Universiti Malaya, 50603, Kuala Lumpur, Malaysia
[c] Institute of Biological Sciences, Faculty of Science, Universiti Malaya, 50603, Kuala Lumpur, Malaysia
[d] School of Biosciences, Taylor's University, Lakeside Campus, 47500, Subang Jaya, Selangor Darul Ehsan, Malaysia
[e] Centre for Ocean and Atmospheric Sciences, School of Environmental Sciences, University of East Anglia, Norwich Research Park, Norwich, NR4 7TJ, United Kingdom
[f] Faculty of Applied Sciences, UCSI University, Jalan Puncak Menara Gading, Taman Connaught, 56000, Kuala Lumpur, Malaysia

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ABSTRACT

As interest in utilizing microalgae for biophotovoltaics (BPV) grows, assessing the environmental impacts, especially under varying temperatures, becomes crucial. This study examines how temperatures from 25 to 37 °C affect halocarbons emissions and bioelectricity generation by *Synechococcus* sp. UMACC 371 in a BPV device. Six halocarbons were investigated, with highest emission rates observed for CH_3I (49.63 pmol mg^{-1} day^{-1}) and $CHBr_3$ (65.39 pmol mg^{-1} day^{-1}). Emissions of iodinated compounds (CH_3I, CH_2I_2) increased at 37 °C and were positively correlated with temperature ($r = 0.703$ to 0.746, $p < 0.01$). Lower F_v/F_m value and negative correlations between emissions and F_v/F_m suggest that cell stress increases emissions. $CHBr_3$ and $CHBr_2Cl$ emissions were higher at lower temperatures and negatively correlated with temperature ($r = -0.627$ to -0.912, $p < 0.01$). Higher F_v/F_m at lower temperatures suggests these emissions were enhanced under optimal conditions rather than temperature stress. The highest specific growth rate and chlorophyll-*a* content at 37 °C, contributed to the highest power density of 3.94 mW m^{-2}. While temperature showed little correlation with normalized power output, a positive correlation between normalized power density and CH_2I_2 emission suggests an indirect link. Further studies are needed to understand the connection between halocarbon emissions and bioelectricity generation in BPV. This study reveals that temperature fluctuations affect halocarbon emissions and bioelectricity generation from *Synechococcus* sp. UMACC 371, addressing the effects of varying temperatures on these processes in tropical microalgae. This is particularly relevant considering the potential widespread deployment of microalgae-based BPV devices in outdoor environments.

1. Introduction

Halocarbon, compounds composed of carbon atoms covalently bonded to one or more halogen atoms, have received less attention compared to other greenhouse gases like CO_2, CH_4 and N_2O for their effect in climate change [1]. Reactive halogen radicals are released from the halocarbons through reactions with hydroxyl radicals or UV photolysis when reaching the upper troposphere or lower stratosphere, which then catalyze the ozone layer degradation [2,3]. While most long-lived halocarbons result from anthropogenic processes, short-lived volatile halocarbons, primarily from natural sources, originate from terrestrial and oceanic environments [4]. According to the World Meteorological Organization (WMO), naturally occurring brominated short-lived halocarbon contribute 5 ± 2 ppt to the stratosphere, accounting for about 27 % of the total stratospheric bromine recorded in 2020 [5]. This highlights the significant role of short-lived halocarbons in stratospheric halogen loading, which can impact ozone abundance and atmospheric chemistry [6].

Halocarbon emission by seaweeds was first documented by Lovelock [7] and has been extensively researched thereafter [8]. Although seaweeds are believed to be the major source of biogenic halocarbons, they are limited to rocky coastal nearshore areas, which account for only 0.3

* Corresponding authors at: Institute of Ocean and Earth Sciences (IOES), Universiti Malaya, 50603, Kuala Lumpur, Malaysia.
E-mail addresses: fionakeng@um.edu.my (F.S.-L. Keng), phangsm@ucsiuniversity.edu.my (S.-M. Phang).

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