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EDITED AND REVIEWED BY
Wei Zhang,
Marine Bioproducts Cooperative
Research Centre, Australia

*CORRESPONDENCE
Suresh Veeraperumal
✉ veeraperumalsuresh@gmail.com

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Editorial: Marine algal bioactive molecules for food and pharmaceutical applications

Kit-Leong Cheong¹, Yang Liu² and Suresh Veeraperumal^{2,3*}

¹Guangdong Provincial Key Laboratory of Aquatic Product Processing and Safety, College of Food Science and Technology, Guangdong Ocean University, Zhanjiang, China, ²Department of Biology, College of Science, Shantou University, Guangdong, China, ³Department of Radiation Oncology, State University of New York Upstate Medical University, New York, NY, United States

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Editorial on the Research Topic

[Marine algal bioactive molecules for food and pharmaceutical applications](#)

Marine algae represent a vast and vastly underutilized resource in the ongoing search for bioactive molecules with potential applications spanning food, pharmaceuticals, and biotechnology. With an estimated 300,000 species cataloged, including microalgae and macroalgae, these organisms are integral to aquatic ecosystems and source a diverse array of bioactive compounds (Ahmed et al., 2024). In recent years, marine algae have gained prominence, primarily due to their rich reservoir of bioactive molecules, which could address various challenges in health and sustainability (Selvam et al., 2024). The bioactive compounds derived from marine algae, such as polysaccharides, lipids, phenolics, and carotenoids, are becoming increasingly significant in formulating functional foods, dietary supplements, and therapeutic agents (Alves et al., 2018; Selvam et al., 2024). These compounds exhibit various biological activities, including antioxidants, anti-inflammatory, antimicrobial, and anticancer properties. For instance, fucoxanthin, a carotenoid found in brown algae, has garnered attention for its potential role in weight management and metabolic regulation, presenting exciting opportunities for developing functional foods and promoting health.

Considering global health challenges, encompassing chronic diseases, dietary deficiencies, and the need for sustainable nutritional solutions—integrating algal bioactives into our food systems provides innovative pathways for enhancing public health. Incorporating these natural compounds could enhance the nutritional profiles of food products while also contributing to the prevention of diet-related diseases (Banday et al., 2024). Moreover, the pharmaceutical sector stands to benefit significantly from marine algal metabolites. Algal extracts are currently being investigated for their potential applications in alleviating neurodegenerative diseases, enhancing immune responses, and serving as adjunct therapies in cancer treatment. Empirical studies have demonstrated the neuroprotective effects of algal metabolites. However, further research is necessary to elucidate their mechanisms and deepen our understanding of their therapeutic applications, thus paving the way for novel pharmaceutical developments. Despite these promising avenues, the field faces challenges, particularly concerning the sustainability of

algal cultivation, the efficiency of extraction methods, and the regulatory frameworks governing the usage of marine bioactives (Ahmed et al., 2024). Addressing these challenges will require collaborative efforts among researchers, industry stakeholders, and policymakers to ensure the responsible exploration and utilization of these valuable marine resources.

This Research Topic encapsulates a transformative moment in the exploration of marine algal bioactive molecules. It brings together significant research contributions that illuminate the diverse bioactive compounds derived from these organisms. Each study provides a nuanced understanding of their functional properties and potential applications across various industries, inspiring hope for the future of health and sustainability.

In the review by Cheong et al., the authors comprehensively analyze *Asparagopsis*, underscoring its chemical composition and biological significance (Cheong et al.). Their review delves into the pharmacological properties of *Asparagopsis*, particularly its diverse compounds, including polysaccharides, lipids, and bromoform, which exhibit antioxidative, antimicrobial, and anti-inflammatory effects. Notably, the authors contextualize *Asparagopsis* within pressing environmental discussions, especially regarding its role in reducing methane emissions from livestock and its economic potential in the food and cosmetics industries. This dual emphasis on health and environmental impact positions *Asparagopsis* as a crucial element in the fight against climate change and its associated health challenges.

Complementing this Research Topic, Gong et al. provides an in-depth exploration of the chemical composition of various marine algal species, highlighting their diverse bioactive profiles (Gong et al.). Their review emphasizes polysaccharides, polyunsaturated fatty acids, and antioxidants as key components warranting further investigation. Additionally, the authors delve into fucoxanthin, shedding light on recent advancements in breeding and cultivation techniques that optimize its production. They also evaluate the physiological benefits associated with fucoxanthin, including its anti-obesity and anti-diabetic effects. These findings establish a firm foundation for future studies aimed at harnessing this bioactive compound for functional food applications and therapeutic interventions, underlining the potential of algal extracts to serve as functional ingredients that enhance human health.

Expanding upon these themes, Jin et al. delve into the applications of marine biopolymers in bone tissue engineering, focusing specifically on the pharmacological properties of seaweed polysaccharides (Jin et al.). They examine how these biopolymers can be leveraged to develop innovative scaffolding materials that support tissue regeneration. This exploration underlines the potential of marine-derived substances in addressing significant biomedical challenges and opens new avenues for research that could lead to groundbreaking advancements in regenerative medicine.

Importantly, Naik et al. provide critical insights into the role of marine algal metabolites in neurodegenerative diseases (Naik et al.). Their review systematically examines these compounds' antioxidant, anti-inflammatory, and neuroprotective properties,

providing compelling evidence for their potential therapeutic roles. By advocating for more rigorous clinical trials, they stress the urgency of exploring these natural products as viable alternatives in mitigating the burden of neurodegeneration, a pressing Research Topic in modern medicine. By identifying the mechanisms through which these metabolites exert their protective effects, the research highlights a promising pathway for drug development focusing on natural alternatives.

As the discourse surrounding marine algal bioactive molecules evolves, it is imperative to recognize the multifaceted nature of these compounds. Their encapsulation of biological activities makes them extraordinarily versatile, positioning them as valuable assets in developing functional foods and therapeutic agents that address health concerns and contribute to the sustainability of food systems (Ahmed et al., 2024). Moreover, the potential applications of marine bioactives stretch beyond direct health benefits, as they may influence broader ecological and economic landscapes. Cultivating marine algae can be a sustainable alternative to terrestrial agriculture, potentially alleviating pressures on land-based resources while contributing to carbon sequestration and biodiversity restoration. Furthermore, the commercialization of algal bioactives can create new economic opportunities, from developing novel products to establishing sustainable supply chains. To capitalize on the opportunities presented by marine algal bioactives, sustained investment in research and development is crucial. This includes understanding the ecological impact of algal cultivation, refining extraction methodologies to maximize yield and potency, and navigating the regulatory landscape effectively to ensure safe and beneficial products reach the market.

In summary, exploring marine algal bioactive molecules represents a promising frontier in addressing some of the most pressing challenges in health and sustainability today. Through the collaborative efforts of researchers, industry stakeholders, and policymakers, we can harness the potential of these remarkable resources to forge innovative solutions that promote well-being and environmental stewardship. This Research Topic is vital to this dialogue, illuminating the pathways forward in the responsible exploration and application of marine algal compounds. The potential of marine algal bioactives is vast, and by working together, we can unlock it for the benefit of all.

Author contributions

KL-C: Writing – original draft, Investigation, Data curation. YL: Investigation, Data curation, Writing – review & editing. SV: Writing – review & editing, Conceptualization, Supervision.

Conflict of interest

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