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Preface

Bioactive substances of various seaweeds and their applications and utilization

DUAN Delin[1, 2, 3, *], CRITCHLEY Alan T.[4], FU Xiaoting[5], PEREIRA Leonel[6]

[1] *Key Lab of Experimental Marine Biology*, *Institute of Oceanology*, *Chinese Academy of Sciences*, *Qingdao 266071*, *China*

[2] *Center for Ocean Mega-Science*, *Chinese Academy of Science*, *Qingdao 266071*, *China*

[3] *State Key Lab of Seaweed Bioactive Substances*, *Qingdao 266400*, *China*

[4] *Verschuren Centre for Sustainability in Energy and the Environment*, *Cape Breton University*, *Sydney*, *Nova Scotia B1P 6L2*, *Canada*

[5] *College of Food Science & Engineering*, *Ocean University of China*, *Qingdao 266000*, *China*

[6] *MARE* (*Marine and Environmental Sciences Centre*), *Department of Life Sciences*, *Faculty of Sciences and Technology*, *University of Coimbra*, *Coimbra 3000-456*, *Portugal*

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Over the past century or more, traditional uses of seaweeds began and initially comprised the simple collection, sorting and drying of seaweeds harvested from the wild, or cast upon the beach, for use as soil "manure/fertilizer/improver". Some macroalgae were used for unprocessed food purposes and subsequently harvested and cultivated biomasses of selected brown and red seaweeds becameindustrially processed to yield alginates, mannitol, iodine, agar, agarose, carrageenan, and more recently biostimulants, etc. Products from various seaweeds are very diverse and are commonly applied in a range that includes textiles and dying, food/feed and supplements and specialized medical applications.

Industrial applications of bioactive compounds from certain seaweeds such as fucoidans (Li et al., 2006), polyphenols, oligosaccharides, and pigments,etc., have found new technological applications. In some instances, these applications have led to demands for increasing volumes of sustainably produced high quality and reliable volumes from highly specific seaweeds, or their selected strains and cultivars, with higher contents of compounds (Yao et al., 2019).

With these perspectives in mind, three special sessions of the symposium entitled "*Seaweeds and Their Bioactive Substances*: *Research and Development in the New Era*" was organized by the Qingdao Bright Moon Seaweeds Group. Over 200 attendees participated in this meeting held on Sep. 21, 2018, Shandong, China, and contributed presentations on diverse topics as applications in cosmetics, bio-fertilizer/biostimulants, anti-oxidant and food additives, drug delivery, etc. Future product developments require concentrated investments in R&D and in particular multidisciplinary collaborations, which specifically integrate new biochemical and microbial technologies into the required industrial scaling of applied seaweed applications. It is the intention of this special issue of *Journal of Oceanography and Limnology* to bring attention to some of these latest developments in both the expectation of the necessary future developments and to draw attention to some of the outstanding areas, which require further attention from the world's phycological community. This would then allow seaweeds attain their true potential in the provision of societal and economic benefits through virtue of their bioactive compounds.

In this special issue, Cornish et al. (2019) provided a mini-review on the microbial continuum, which promotes the judicious consumption of a varied diet of macroalgae and the benefits for human health and

* Corresponding author: dlduan@qdio.ac.cn

nutrition (Gentile and Weir, 2018; Mathieu et al., 2018; Pluvinage et al., 2018). Zhang et al. (2019a) analyzed the structures and anti-complement activity of polysaccharides extracted from *Grateloupia livida*, and provided evidence that the molecular weight and sulfate content were important factors contributing to biological activity. Moreover, Zhang et al. (2019b) studied the agar and its fractions from the red alga *Ahnfeltia plicata*, provided an eco-friendly extraction process, and revealed its potential application for the production of agar, agarose, and agaropectin.

Silva et al. (2019a) used the red seaweed *Osmundea pinnatifida* as a raw material source for the extraction of total phenolic compounds with a higher anti-oxidant capacity, which demonstrated significant potential. Yu et al. (2019b) analyzed the anti-oxidant and anti-inflammatory activities of ultrasonic-assisted, polyphenol-rich compounds extracted from *Sargassum muticum*. They showed that the polyphenol-rich ethanol and ethyl acetate fractions had excellent anti-oxidant and anti-inflammatory properties. Carvalho et al. (2019) report *Bifurcaria bifurcate* from the Portuguese Atlantic has demonstrable anti-fungal activities against human dermatophytic fungi.

In applications for drug delivery and immobilization, Yu et al. (2019a) demonstrated that amphiphilic, sodium alginate-vinyl acetate/CS micro-particles could be developed for the purpose of macro-molecular drug delivery. Hou et al. (2019) applied alginate-chitosan microcapsules as immobilization carriers achieved via emulsification-internal gelation and complexation reactions. These were shown to facilitate the growth and metabolism of yeast cells successfully in bi-phasic, culture media-solvent systems, and concluded that immobilization bio-catalysis was a potential technology, which could improve the activity and stability of bio-catalysts in non-aqueous media for greater efficiencies at an industrial scale.

Din et al. (2019) applied sonication as a pre-treatment with autoclaved red seaweedbiomass, which could produce agar with lowersulfate content, and reported that was an excellent product for applications in gel electrophoresis. Cotas et al. (2019) tested differences in the quantity of seaweed-derived compounds with respect to the influences of environmentally varying salinity on *Fucus ceranoides* and, in addition, demonstrated that variations in post-harvest drying methods also influenced the quality of extracted compounds. In order to reduce raw material costs and improve emulsification stability of pure gum, Wan et al. (2019) used trehalose and octenyl succinic acid for the preparation of octenylsuccinate starch ester with great potential for future applications in the food industry. Chia et al. (2019) investigated the recovery of protein from wet, raw material of the green microalga, *Chlorella sorokiniana CY-1* through a liquid, bi-phasic flotation method, assisted with sonication. These authors concluded that glucose was the most suitable sugar for use in forming the phases with acetonitrile in order to enhance the recovery of protein.

For the purposes of cosmetic applications, Oh et al. (2019) demonstrated applications of *Ecklonia cava* extract as an additive to human hair dyes containing ρ-phenylenediamine, and was found to reduce the cytotoxicity and oxidative stresses induced by hair dyes. Silva et al. (2019b) reported on the benefits of extracts from the brown seaweeds *Ascophyllum nodosum* and *Sargassum muticum* as good bio-fertilizers with positive effects on seed germination, plant development, and crop production. Kawee-ai et al. (2019) with an eye on human food supplements verified that dietary fucoxanthin could be useful for a significant reduction of human obesity and associated diabetes by inhibiting carbohydrate-hydrolyzing enzymes and lipid accumulation. They recommended the use of fucoxanthin as a functional food ingredient ora healthy dietary supplement.

For this special issue Duan D L, Critchley A T, Fu X T, and Pereira L acted as guest editors and they are acknowledged for their efforts, especially in the early stages of manuscript preparation, prior to review and assistance with the comments and suggestions.

Much appreciation is also given to Editor in Chief, Prof. Xiang J H and Executive Editors Dr. Yu Roger, Dr. Chen Y, and many other staff of the editorial office at the journal in helping the editorial process and providing technical support.

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It is sincerely anticipated that this special issue will promote greater and more effective cooperation and multidisciplinary collaborations between many of the leading, applied phycologists and their laboratories in various institutions and enterprises globally. In particular, it is also intended to inspire and encourage the younger generations of applied phycologists to engage in leading-edge research and to enhance

further collaborations both regionally and internationally.

Various seaweeds and their extracts still have much to offer the world and provide beneficial goods and services to society as a whole. According to the FAO (Zhou, 2018), the world annual production of seaweeds is about 30 million tonnes with the value of US$11.7 billion. It is indeed a challenge as to how to derive the maximum benefits for humankind and fully make use of the sustainable, globally available seaweed raw materials and the potential for even larger volumes of cultivated biomass of selected seaweeds. What are the best possible use of the goods and services provided by seaweeds and their various, industrially obtained extracts and bioactives for the fast-changing needs of global society? These are key questions for all of us to ponder and present solutions before our peers. We are convinced that some new drugs and biomedical materials being developed from selected seaweeds are near to being registered and available for use (Paiva et al., 2017; Circuncisão et al., 2018). In addition, we remain confident there will be further, interesting and valuable compounds and products derived from seaweed origins in the very near future.

We believe that future of seaweeds and their bioactive substances in this new era is very bright, yet requires our concerted efforts to bring these ideals and goals to fruition for the benefit of all. The new era has begun!

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