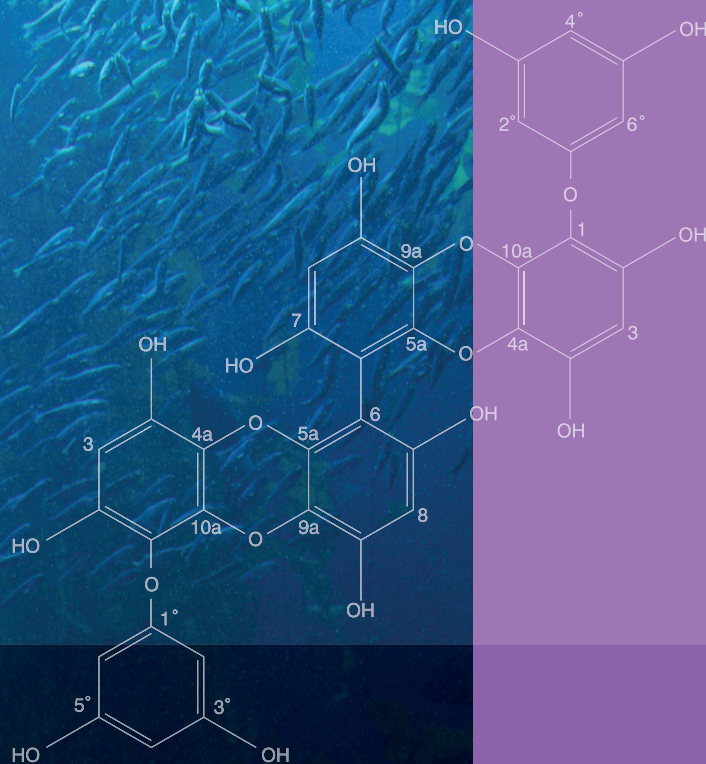


Handbook of Marine Macroalgae

Biotechnology and Applied Phycology

Editor | Se-Kwon Kim



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Se-Kwon Kim

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Preface

Marine environment becoming the most explored habitat because of its chemical and biological diversity. Recently, marine floral and faunal exploration and exploitation becoming a great deal of interest which is the key to combat various diseases. Among the marine sources, algae or seaweeds are the more valuable sources of structurally diverse bioactive compounds. Even though, seaweed salads have been supplied as a regular diet, much information is not available whether the algal food has any significance on human health. For example, the beneficial effects of seaweeds and their bioactive substances like phlorotannins, sulphated polysaccharides, peptides and carotenoid pigments extend their applications from eco-biotechnological to the industrial standpoint. Hence, the utilization of marine macroalgal substances as potential biological and industrial products should be well established worldwide to gain various health and medical benefits. Although Asians consume seaweeds because of the known importance in their daily lives, many of the westerns might not think of the 'seaweed' as a nutritional or a daily supplement in their food. It is because of the term 'weed', which generally represents the unwanted plants in any ecosystem. Hence, I would like to introduce a more appropriate term "sea-vegetables" in this book, which could bring a positive notion in human beings to think 'algae' or 'seaweed' as consumable vegetables from sea.

The present book "*Handbook of Marine Macroalgae: Biotechnology and Applied Phycology*", describes the characteristic feature of marine macroalgal substances, source species, types, production and applications (biological, biotechnological, industrial). There are four discriminating parts present in the present book: **Part-I** deals with an overview of introduction and prospects of marine macroalgal introduction, their eco-physiological and biochemicals importance along with various aspects of macroalgal biodiversity; **Part-II** provides a general and complex aspects of

isolation, extraction and physicochemical properties of various marine macroalgal compounds; **Part-III** discusses various biological and biomedical applications; **Part-IV** deals an over view on the *in vitro* cultivation other biotechnological prospects of marine macroalgae; and **Part-V** provides the information on the industrial utilization of marine macroalgae with their resource management strategies. Each part is a collection of comprehensive information on the past and present research of marine macroalgae, compiled of proficient scientists worldwide. Although significant activities and applications of marine macroalgal derived substances have been shared by various chapters, specific and unique biological, biomedical and industrial applications have been covered individually. Functional foods I personally intended to mention that the present findings and the recent information in this book will be helpful to the upcoming researchers to establish a phenomenal research from wide range of research areas.

I express my sincere thanks to all the authors, who have contributed in this book and their relentless effort was the result of scientific attitude and immense perseverance descended from their present and past experiences. I am grateful to the experts, who have provided state-of-the-art contributions that are included in this book. I also thank the personnel of Wiley-Blackwell publishers for their continual support, which is essential for the successful completion of the present task.

I hope that the fundamental as well as applied contributions in this book might serve as a potential research and development leads for the benefit of humankind. Altogether, algal biotechnology will be the hottest field in future towards the enrichment of targeted algal species, which further establishes a sustainable oceanic environment. The present book would be a reference book for the emerging students in the academic and industrial research.

Se-Kwon Kim

Editor

Se-Kwon Kim, PhD, is currently working as a professor of marine biochemistry in the Department of Chemistry, Pukyong National University (PKNU), Busan, South Korea.

Dr. Kim received his MSc and PhD degrees from PKNU and joined as a faculty member in the same university. He conducted his postdoctoral research at the Bioprocess laboratory, Department of Food Science and Technology, University of Illinois, Urbana-Champaign, Illinois USA (1988–1989). He became a visiting scientist at the Memorial University of Newfoundland in Canada (1999–2000).

In the year 2004, Dr. Kim became the Director for 'Marine Bioprocess Research Center (MBPRC)' at Pukyong National University. He served as president for the 'Korean Society of Chitin and Chitosan' (1986–1990), and the 'Korean Society of Marine Biotechnology' (2006–2007). Dr. Kim was also the Chairman for 7th Asia-Pacific Chitin and Chitosan Symposium, which was held in South Korea in 2006. He is one of the board members of 'International Society of Marine Biotechnology (IMB)' and 'International Society for Nutraceuticals and Functional Foods (ISNFF)'.

He was the editor-in-chief of the Korean Journal of Life Sciences (1995–1997), the Korean Journal of Fisheries Science and Technology (2006–2007) and the Korean Journal of Marine Bioscience and Biotechnology (2006–till date). To the credit for his research, he won the best paper awards from the American Oil Chemists' Society (AOCS) and the Korean Society of Fisheries Science and Technology (KS-FST) in 2002.

His major research interests are investigation and development of bioactive substances derived from marine organisms and their application in oriental medicine, cosmetics and nutraceuticals via marine bioprocessing and mass-production technologies. Furthermore, he expanded his research fields especially in the field of dietary supplements from sea vegetables for the development of anti-diabetic, anti-arthritis, anti-hypertensive, anti-cancer, anti-aging substances towards the health promotion of senior citizens.

To date, he has authored over 450 research papers and holds 72 patents. In addition, he has written or edited more than 30 books.

PART I

Introduction to Algae and Their Importance

1

Biological Importance of Marine Algae

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1.1 Introduction

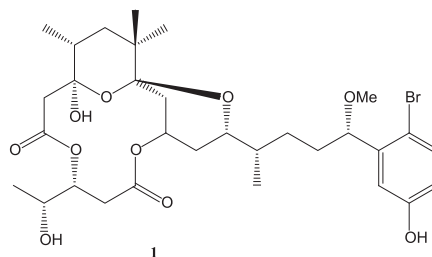
Marine organisms are potentially productive sources of highly bioactive secondary metabolites that might represent useful leads in the development of new pharmaceutical agents (Iwamoto *et al.* 1998, 1999, 2001). During the last four decades, numerous novel compounds have been isolated from marine organisms and many of these substances have been demonstrated to possess interesting biological activities (Faulkner, 1984a,b, 1986, 1987, 1988, 1990, 1991, 1992, 1993, 1994, 1995, 1995, 1996, 1997, 1998, 1999, 2000, 2001, 2002).

Algae are very simple, chlorophyll-containing organisms (Bold and Wynne, 1985) composed of one cell or grouped together in colonies or as organisms with many cells, sometimes collaborating together as simple tissues. They vary greatly in size – unicellular of 3–10 μm to giant kelps up to 70 m long and growing at up to 50 cm per day (Hillison, 1977). Algae are found everywhere on Earth: in the sea, rivers and lakes, on soil and walls, in animal and plants (as symbionts-partners collaborating together); in fact just about everywhere where there is a light to carry out photosynthesis.

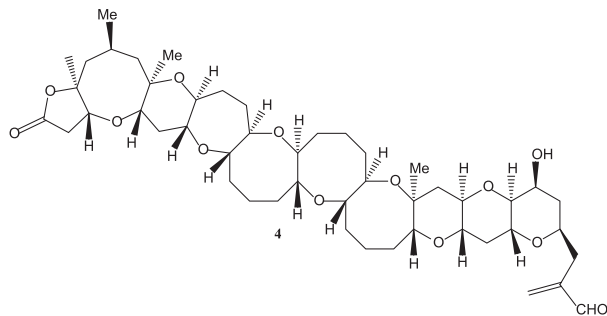
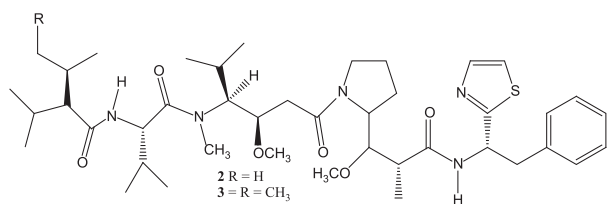
Algae are a heterogeneous group of plants with a long fossil history. Two major types of algae can be identified: the macroalgae (seaweeds) occupy the littoral zone, which included green algae, brown algae, and red algae, and the microalgae are found in both benthic and littoral habitats and also throughout the ocean waters as phytoplankton (Garson, 1989). Phytoplankton comprise organisms

such as diatoms (Bacillariophyta), dinoflagellates (Dinophyta), green and yellow-brown flagellates (Chlorophyta; Prasinophyta; Prymnesiophyta, Cryptophyta, Chrysophyta and Rhaphidophyta) and blue-green algae (Cyanophyta). As photosynthetic organisms, this group plays a key role in the productivity of oceans and constitutes the basis of the marine food chain (Bold and Wynne, 1985; Hillison, 1977).

The true origins of compounds found in marine invertebrates have been a subject of discussion. They may vary from compound to another, but there are strong hints that dietary or symbiotic algae are one of the participants in the production of these metabolites. For example, as early as 1977, the blue-green algae, *Lyngbya majuscula* was recognized as the source of aplysiatoxin 1 found in the sea hares *Aplysia* that feed on this alga (Mynderse *et al.*, 1997). Similarly, a series of highly active antitumor compounds, dolastatin 2 and 3, isolated from sea slugs are considered to be of blue-green algal origin (Shimizu, 2000). Also, eukaryotic algae and various dinoflagellate metabolites are found in shellfish and other invertebrates as toxins (Shimizu, 2000). Brevetoxins 4, ciguatoxins 5, and dinophysistoxins-1&2 and 6 and 7 are well known examples of paralytic shellfish toxins (Hall and Strichartz, 1990).



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1.2 Interesting natural products and their biological activities from macroalgae (seaweeds)

Marine macroalgae or seaweeds have been used as foods especially in China and Japan and crude drugs for treatment of many diseases such as iodine deficiency (goiter, Basedow's disease and hyperthyroidism). Some seaweeds have also been used as a source of additional vitamins, treatment of various intestinal disorders, as vermifuges, and as hypocholesterolemic and hypoglycemic agents. Seaweeds have been employed as dressings, ointments and in gynecology (Trease and Evans, 1996).

Macroalgae can be classified into three classes: green algae (Chlorophyta), brown algae (Phaeophyta) and red algae (Rhodophyta) (Garson, 1989).

