

Review

# Marine Microalgae with Anti-Cancer Properties

Kevin A. Martínez Andrade, Chiara Lauritano , Giovanna Romano and Adrianna Ianora \*

Department of Integrative Marine Ecology, Stazione Zoologica Anton Dohrn, 80121 Naples, Italy; kevin.martinez@szn.it (K.A.M.A.); chiara.lauritano@szn.it (C.L.); romano@szn.it (G.R.)

\* Correspondence: adrianna.ianora@szn.it; Tel.: +39-081-583-3246

Received: 23 April 2018; Accepted: 12 May 2018; Published: 15 May 2018



**Abstract:** Cancer is the leading cause of death globally and finding new therapeutic agents for cancer treatment remains a major challenge in the pursuit for a cure. This paper presents an overview on microalgae with anti-cancer activities. Microalgae are eukaryotic unicellular plants that contribute up to 40% of global primary productivity. They are excellent sources of pigments, lipids, carotenoids, omega-3 fatty acids, polysaccharides, vitamins and other fine chemicals, and there is an increasing demand for their use as nutraceuticals and food supplements. Some microalgae are also reported as having anti-cancer activity. In this review, we report the microalgal species that have shown anti-cancer properties, the cancer cell lines affected by algae and the concentrations of compounds/extracts tested to induce arrest of cell growth. We also report the mediums used for growing microalgae that showed anti-cancer activity and compare the bioactivity of these microalgae with marine anticancer drugs already on the market and in phase III clinical trials. Finally, we discuss why some microalgae can be promising sources of anti-cancer compounds for future development.

**Keywords:** marine biotechnology; microalgae; anti-cancer

## 1. Introduction

Cancer includes a large group of pathologies related to the unrestrained proliferation of cells in the body [1]. There are more than 200 different types of cancers, and some cancers may eventually spread into other tissues causing metastases that are often lethal. Cancer is the leading cause of death globally, largely due to aging and growth of the world's population. According to the European Cancer Observatory [2], estimates for the four most common types of cancer in the European Union in 2012 were as follows: 342,137 cases of colon cancer, 309,589 cases of lung cancer (including trachea and bronchus cancer), 358,967 cases of breast cancer and 82,075 cases of skin melanoma. Finding more effective methods to treat cancer remains a challenge, and development of new therapeutic agents for cancer treatment is essential for continued progress against the disease. According to Dyshlovoy and Honecker [3] approximately 60% of the drugs used in hematology and oncology have their origin in natural sources, and one third of the most sold are either natural compounds or derivatives thereof. There has also been growing interest in marine bioprospecting, because potent natural compounds (e.g., terpenes, steroids, alkaloids, polyketides, etc.) have already been discovered from marine organisms. Currently there are seven drugs of marine origin on the market, four of which are anticancer drugs. There are also close to 26 marine natural products in clinical trials of which 23 are anti-cancer compounds [4]. Oceans cover nearly 70% of the planet, but remain largely unexplored. To date, more than 28,000 compounds isolated from marine organisms have been reported, and this number is rapidly growing each year [4]. However, despite the number of compounds isolated from marine organisms and the biological activities attributed to many of these, the search for ocean medicines is relatively recent and only in the middle part of the 20th century did scientists begin to systematically probe the oceans for new drugs. Today, the pipeline from the initial demonstration that