Accepted Manuscript

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PII: S1359-6446(17)30101-0
DOI: https://doi.org/10.1016/j.drudis.2017.10.019
Reference: DRUDIS 2114

To appear in:

Please cite this article as: Gutiérrez-Rodríguez, Anllely G., Juárez-Portilla, Claudia, Olivares-Bañuelos, Tatiana, Zepeda, Rossana C., Anticancer activity of seaweeds.Drug Discovery Today https://doi.org/10.1016/j.drudis.2017.10.019

Anticancer activity of seaweeds

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Highlights

- Anti-cancer activity of seaweeds has been probed in numerous studies.
- Total growth inhibition is a good parameter to evaluate seaweeds' activity.
- We propose the cumulative dose to estimate algae anti-cancer *in vivo* effects.

Teaser: Here, we review seaweed biomolecules as important sources of anticancer drugs.

Cancer is a major health problem worldwide and still lacks fully effective treatments. Therefore, alternative therapies, using natural products, have been proposed. Marine algae are an important component of the marine environment, with high biodiversity, and contain a huge number of functional compounds, including terpenes, polyphenols, phlorotannins, and polysaccharides, among others. These compounds have complex structures that have shown several biological activities, including anticancer activity, in several *in vitro* and *in vivo* models. Moreover, seaweed-derived compounds target important molecules that regulate cancer processes. Here, we review our current understanding of the anticancer activity of seaweeds.

Keywords: marine algae; kelp; anti-proliferative; tumor; cell cycle, apoptosis.

Introduction

Cancer is a collection of related diseases in which cells divide without stopping, spread into surrounding tissues, and form tumors. The etiology of cancer is multifactorial, and involves drug use, infectious organisms, an unhealthy diet, environmental toxins, inherited genetic mutations, hormones, and immune conditions; these factors can act together or in sequence to cause cancer [1]. According to the American Cancer Society, 1 685 210 new cancer cases were expected to be diagnosed worldwide in 2016, with 595 690 patients in the USA expected to die of cancer, which translates to approximately 1630 people per day [2].

The treatment of cancer usually comprises a combination of therapies, in accordance with the characteristics and stage of the tumor, including surgery, chemotherapy, radiation therapy, and immunotherapy [1]. In all cases, the objective of treatment is to destroy the cells that comprise the tumor to achieve tumor reduction without damaging normal cells [3]. Chemotherapy is a commonly used therapeutic modality in cancer and includes a variety of drugs that reach almost all body tissues, and exert their actions on both malignant and healthy cells. Thus, chemotherapy drugs have a range of adverse effects, including anemia, appetite loss, delirium, alopecia, peripheral neuropathy, and irreversible damage to vital organs [1]. In addition to these secondary effects of chemotherapy, drug tolerance is also an issue in cancer treatment [3].

Despite decades of research, an effective treatment for cancer is still lacking; therefore, there is a need for new compounds with anticancer activity that are cell selective with fewer adverse effects, improving the quality of life of patients. Natural products provide a reliable alternative in the search for compounds that can help in the treatment of diseases [4]. Over the past few decades, research attention has turned to natural products from marine organisms, mainly because of their large habitat (covering ~70% of the surface of the Earth), high biodiversity (95% of world biodiversity), and the specific conditions under which some species live (e.g., at extremes