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Anticancer Activity of Three Jamaican Macroalgae against Prostate, Pancreatic and Skin Cancers

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Authors' contributions

This work was carried out in collaboration between all authors. Authors HICL, JB, CW and NJT designed the study. Authors DD, SAP and KNNA carried out the study, wrote the protocol and wrote the first draft of the manuscript. Authors DD, SAP, NJT and ASL managed the literature searches and with data analysis. All authors read and approved the final manuscript.

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Short Research Article

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ABSTRACT

Aims: Cancer is one of the leading chronic diseases that may lead to death. The search for new therapeutic, medicinal and nutraceutical compounds from folkloric plants including the marine flora are globally important objectives. Therefore the biological assessment of macroalgae is critical.
Methodology: Three macroalgae, *Galaxaura oblongata, Dictyota cervicornis* and *Halimeda incrassata* were collected from the southern coast of Jamaica and assessed for their anticancer activity against prostate, pancreatic and skin (melanoma) cancers using PC-3, MiaPaca-2 and A375 cell lines respectively. The crude hexane, ethyl acetate and methanol extracts were prepared and bio-assayed using the WST-1 cell proliferation assay.
Results: The results indicated that the crude ethyl acetate extract for three of the macroalgae;

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Galaxaura oblongata, Dictyota cervicornis and Halimeda incrassata; had significant activity against A375 cell line with IC_{50} values of 8.432, 7.48, 6.691 µg/ml respectively. No significant effect was observed against melanoma cells for neither the crude hexane nor the methanol extracts, as well as there were no significant effect on the prostate or pancreatic cell lines for all crude extracts.
Conclusion: These results indicate the potency and product potential of the edible marine *macroalgae* as a functional food and nutraceutical. This report represents the first scientific bioassay of the Jamaican species of these algae.

Keywords: Galaxaura oblongata; Dictyota cervicornis; Halimeda incrassate; Jamaica; cancer; cell proliferation assay; macroalgae.

1. INTRODUCTION

In recent years, aquatic plants have been a source of novel compounds and bioactive extracts that have led the development of pharmaceutical compounds, nutraceuticals and functional foods. Marine algae have been shown to posses many compounds with therapeutic value. Approximately 15,000 bioactive compounds have been isolated and identified from marine algae [1,2]. It is because of this potential for new drug discovery that this paper aims to assess the anticancer activity of three macroalgae which are common seaweeds growing along the Jamaican marine coastline. To date there has been no biological assay of these Jamaican species.

Macroalgae are categorized as Green algae (Chlorophyta), Red algae (Rhodophyta) and Brown algae (Phaeophyta). These families are characterized based on the major compounds found within their cells which contribute to their usefulness and classification. Some of the compounds found in these seaweeds include chlorophyll a and b, and contain ulvan (polysaccharide component) from the chlorophytes, phycoerythrin and phycocyanin, its major polysaccharides are agar and carrageenans from the red algae and fucoxanthin (carotenoid) with various polysaccharides - fucans, cellulose, laminarins and alginates from the brown algae [3,4].

The tested seaweeds include the *Halimeda incrassata* which is a chlorophyta that contains antioxidant compounds and a known bioactive compound, Caulerpin, which was found to cause an anti-tumour effect against crown gall tumour [5].

Some of the most important or effective biologically active metabolites have been isolated from Rhodophytes compared to the other classes [4]. The red algae, *Galaxaura* have been shown to possess medicinal properties, based on reported antimicrobial, antibacterial, anti-proliferation and cytotoxic effects investigated on *G. filamentosa* and *G. marginata* [6,7]. Galaxamide, isolated from *G. filamentosa* was the active anti-proliferation compound [8], however, for the species of interest, *G. oblongata*, this has not yet been established.

Dictyota cervicornis is a phaeophyte with folkloric uses in Traditional Chinese and Ayurvedic medicines [9]. Scientific validations of the use of this ethno-medicinal aquatic plant has been done for other species showing antibacterial, anti-tumour, immunological and antiviral effects and thus more research is needed to contribute to the wealth of knowledge of the uses of these alternative forms of medicine used.

Natural remedies provide the necessary clues for the creation of new pharmaceutical products. In recent years, the marine algae have been shown to posses many active compounds that may be potential treatment for many ailments.

2. METHODOLOGY

The marine algae were identified by the Port Royal Marine lab, UWI, Mona following collection from the South-coast of Kingston, Jamaica (Table 1). They were washed to remove the excess salt and sediments, and subsequently dried and milled into a powder prior to solvent extraction. Each plant material was then treated sequentially with hexane for 24 hours followed by ethyl acetate and methanol. The crude extracts were dried *in vacuo* to obtain the crude hexane, ethyl acetate and methanol extracts (Table 1). The residues were dissolved in DMSO and stored at -20℃ until bioassay.

Table 1. The mass, percentage yield and classification of the macroalgae crude extracts

Classification	Macroalgae	Plant material (g)	Crude Extracts: hexane, ethyl acetate and methanol (yield percent respectively)
Chlorophyta	*Halimeda incrassata*	148	0.30, 0.36, 1.02
Rhodophyta	*Galaxaura oblongata*	63	0.74, 1.02, 9.11
Phaeophyta	*Dictyota cervicornis*	32	1.42, 2.29, 7.12

2.1 Cell lines and Culture Medium

The A375, PC-3 and MiaPaca-2 cell lines were obtained from American Type Culture Collection (ATCC) (Manassas, VA, USA). The cells were maintained in minimum essential media supplemented with 10% fetal calf serum, 1% L-glutamine, 2% penicillin–streptomycin, and 0.2% gentamicin.

2.2 Anticancer Cell Proliferation Assay

The WST-1 (4-[3-(4-iodophenyl)-2-(4-nitrophenyl)-2H-5-tetrazolio]-1, 3-benzene disulfonate) (Roche) colorimetric assay was used [10]. The cells were trypsinized and plated into 96 well plates in 50 µl of media and incubated overnight. Approximately 18 hours after plating, 50 µl of media containing the required drug concentration was added per well. Cells were plated at a density to initiate a 72 hours post drug addition and thus the cells will be in log phase (500-2000 cells/well). The crude extracts were solubilized in DMSO. The cells were then allowed to proliferate for 72 hours at 37℃ in humidified atmosphere of 5% CO_2. The experiment was terminated using WST-1 (Roche) 10 µl per well and absorbance read at 450 nm/ 690 nm. The effect of drugs on growth was assessed as percent of cell viability. The IC_{50} values were determined from the extract dose versus control growth curves using Graphpad Prism software. All experiments were carried out in duplicate and the mean results determined.

3. RESULTS AND DISCUSSION

There were no significant anti-proliferation effect of the crude hexane extracts for *G. oblongata, D. cervicornis, H. incrassata* as the IC_{50} values exceeded 100 µg/ml. The anticancer activity of all crude extracts are presented in Table 2 while Figs. 1-3 presents the dose response curves for the ethyl acetate activity of the three algae against the three cell lines.

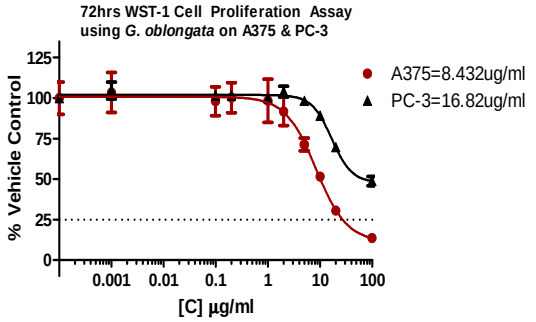

Fig. 1. WST-1 Cell Proliferation Assay using *G. oblongata* on A375 and PC-3

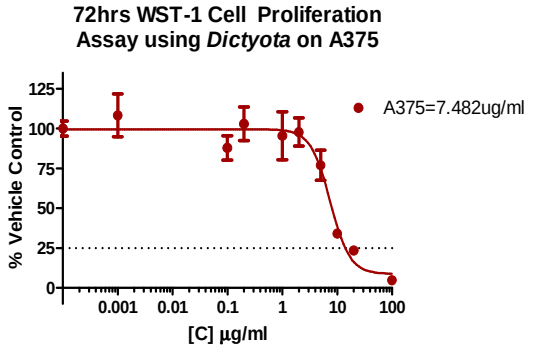

Fig. 2. WST-1 Cell Proliferation Assay using *Dictyota cervicornis* on A375

As previously stated there were no significant anti-proliferation effects of the crude hexane extract for *G. oblongata, D. cervicornis and H. incrassata* as the IC_{50} values exceeded 30 µg/ml. This may be due to the limited non-polar compounds often present in macroalgae extractions as they contain a high concentration of polysaccharide or polysaccharide like compounds which are more polar. The crude methanol extract for *H. incrassata* had an IC_{50} value of 15. 70 µg/ml which showed slight retardation in growth of the melanoma cells; however, the crude ethyl acetate for all the macroalgae assessed produced IC_{50} values (Figs. 1-3) that were significantly lower than 10 µg/ml (8.432, 7.48 and 6.691 µg/ml for

Table 2. Anticancer activity of crude extracts of three Jamaican algae

Sample	Extract	Cell Lines		
		A375	Mia Paca	PC-3
		IC_{50} (µg/ml)		
Galaxaura oblongata	Hexane	NA	NA	NA
	Ethyl acetate	8.432	NA	16.82
	Methanol	NA	NA	NA
Dictyota cervicornis	Hexane	NA	NA	NA
	Ethyl acetate	7.482	NA	58.69
	Methanol	NA	NA	NA
Halimeda incrassata	Hexane	NA	NA	NA
	Ethyl acetate	6.691	NA	13.22
	Methanol	15.70	NA	NA

NA=Not active

G. oblongata, D. cervicornis and *H. incrassata* respectively). As such, these extracts contained the most effective compounds for growth retardation for cancer cells.

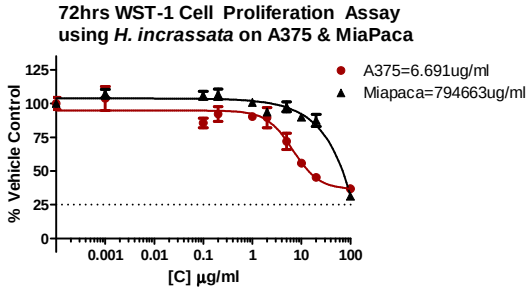

Fig. 3. WST-1 Cell Proliferation Assay using *H. incrassata* on A375 and MiaPaca Dose Response, 72 hours

Although, these results might not stimulate the significant interest as with our other investigations such as with *Tillandsia recurvata* L. (Ball Moss) [11], *Petiveria alliacea* (Guinea Hen Weed) [12] and *Guaiacum officinale* L. (Lignum vitae) [13]; we report this particular finding because of the directly edible nature of this particular species. the combination of the mild antiproliferation activity and the documented palatability of this alga that there will be great interest for the nutraceutical industry. Jamaica is surrounded by fertile marine waters, which already contain this species in seeming large amounts. Thus sustainability of supply is ensured.

4. CONCLUSION

The bioactive ethyl acetate extracts had IC_{50} values below 10 µg/ml which indicates significant anti-proliferation activity. The consumption of *these algae* could become a viable nutritional source for Jamaicans and a potential source of revenue for many households. Additionally, this product could be developed for the export market.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Faulkner D. Marine natural products. Nat Prod Rep. 2002;19(1):1–48.
2. Blunt JW, Copp BR, Hu WP, Munro MH, Nothcote PT, Prinsep MR. Marine natural products. Nat. Prod. Rep. 2008;25:35–94.
3. Garson MJ. Marine natural products. Nat. Prod. Rep. 1989;6:143–147.
4. El Gamal AA. 2010. Biological importance on marine algae. Saudi Pharm. J. 1989;18:1–25.
5. Guven KC, Percot A, Sezik E. Alkaloids in marine algae. Mar Drugs. 2010;8(2):269-284.

6. Reichelt JR, Borowitzka M. Antimicrobial activity from marine algae: Results of a large scale screening programme. Developments in Hydrobiology. 1984;22: 158–168.
7. Rosaz E, Freitas J. Anti-inflammatory activity of the apolar extract from the seaweed *Galaxaura marginata* (Rhodophyta, Nemaliales). J. Venom. Anim. Toxins incl. Trop. Dis. 2007;13(2).
8. Xu W, Liao X, XU S, Diao J, Du B, Zhou X, Pan X. Isolation, structural determination and synthesis of galaxamide. A Rare cylotoxic Cyclic Pentapeptide from a Marine Algae, *Galaxaura filamentosa*. Org. Lett. 2008;10(20):4569–4572.
9. Liu L, Heinrich M, Myers S, Dworjayn S. Towards a better understanding of the brown seaweed, Sargassum in traditional Chinese medicine. Journal of Ethnopharmacology, 2012;142(3):591-619.
10. Ngamwongsatit P, Banada PP, Panbangred W, Bhunia AK. WST-1-based cell cytotoxicity assay as a substitute for MTT-based assay for rapid detection of toxigenic Bacillus species using CHO cell line. Journal of Microbiological Methods. 2008;73,211–215.
11. Lowe HIC, Watson CT, Badal S, Toyang NJ, Bryant J. Cycloartane-3,24,25-triol inhibits MRCKα kinase and demonstrates promising anti prostate cancer activity in vitro. Cancer Cell International. 2012;12: 46-50.
12. Lowe HIC, Toyang NJ, Heredia A, Ayeah KNN, Watson CT, Bryant J. *Petiveria alliacea* L (Guinea Hen Weed) and its major metabolite Dibenzyl Trisulfide demonstrate HIV-1 reverse transcriptase inhibitory activity. European Journal of Medicinal Plants. 2015;5(1):88-94.
13. Lowe HIC, Toyang NJ, Heredia A, Watson CT, Bryant J. Anti HIV-1 activity of the crude extracts of *Guaiacum officinale* L. (Zygophyllaceae). European Journal of Medicinal Plants. 2014;4(4):483-489.

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