








Article

In Vitro Enzyme Inhibitory Properties, Secondary Metabolite Profiles and Multivariate Analysis of Five Seaweeds

Mohamad Fawzi Mahomoodally ^{1,2,†}, Nabeelah Bibi Sadeer ^{2,†}, Gokhan Zengin ^{3,†}, Zoltán Cziáky ⁴, József Jekő ⁴, Alina Diuzheva ⁵, Kouadio Ibrahime Sinan ³, Kishneth Palaniveloo ⁶, Doo Hwan Kim ⁷ and Kannan R. R. Rengasamy ^{7,†,*}

¹ Institute of Research and Development, Duy Tan University, Da Nang 550000, Vietnam; mohamadfawzimahomoodally@duytan.edu.vn

² Department of Health Sciences; Faculty of Science, University of Mauritius, Réduit 80837, Mauritius; nabeelah.sadeer1@uom.ac.mu

³ Department of Biology, Science Faculty, Selcuk University, 42250 Konya, Turkey; gokhanzengin@selcuk.edu.tr (G.Z.); sinankouadio@gmail.com (K.I.S.)

⁴ Agricultural and Molecular Research and Service Institute, University of Nyíregyháza, 4400 Nyíregyháza, Hungary; cziaky.zoltan@nye.hu (Z.C.); jjozsi@gmail.com (J.J.)

⁵ Faculty of Forestry and Wood Sciences, Czech University of Life Sciences, 16500 Prague, Czech Republic; adyuzheva@gmail.com

⁶ Institute of Ocean and Earth Sciences, Institute for Advanced Studies Building, University of Malaya, Wilayah Persekutuan Kuala Lumpur 50603, Malaysia; kishneth@um.edu.my

⁷ Department of Bioresources and Food Science, Konkuk University, Seoul 05029, Korea; kimdh@konkuk.ac.kr

* Correspondence: Rengasamy@iceir.net

† These authors contributed equally to this work.

Received: 23 January 2020; Accepted: 5 April 2020; Published: 8 April 2020



Abstract: Seaweeds have been exploited as both food products and therapeutics to manage human ailments for centuries. This study investigated the metabolite profile of five seaweeds (*Halimeda* spp., *Spyridia hypnoides* (Bory de Saint-Vincent) Papenfuss, *Valoniopsis pachynema* (G. Martens) Børgesen, *Gracilaria fergusonii* J. Agardh and *Amphiroa anceps* (Lamarck) Decaisne using ultra-high-performance liquid chromatography coupled with electrospray ionization mass spectrometry (UHPLC-ESI-MS/MS). Furthermore, these seaweeds were assessed for antioxidant and inhibitory effects against α -amylase, α -glucosidase, acetyl-cholinesterase (AChE), butyryl-cholinesterase (BChE) and tyrosinase. *Valoniopsis pachynema* and *A. anceps* yielded the highest flavonoid (4.30 ± 0.29 mg RE/g) and phenolic content (7.83 ± 0.08 mg RE/g), respectively. Additionally, *A. anceps* exhibited significant antioxidant properties with all assays and significantly depressed BChE ($IC_{50} = 6.68 \pm 0.83$ mg/mL) and α -amylase activities ($IC_{50} = 5.34 \pm 0.14$ mg/mL). Interestingly, the five seaweeds revealed potent inhibitory effects against tyrosinase activity. In conclusion, *A. anceps* might be considered as a key source of phytoantioxidants and a potential candidate to develop nutritional supplements. Besides, the five tested seaweeds warrant further study and may be exploited as promising natural sources for managing hyperpigmentation.

Keywords: seaweeds; antioxidants; tyrosinase; bioactive metabolites; biological activities

1. Introduction

Seaweeds are the ‘lungs of the sea’ as well as a potential ‘wild pharmacy’. These plant like organisms produce 70–80% oxygen for the atmosphere and possess scads of metabolites with unique structures of medicinal values [1,2]. In addition to their ecological importance, seaweeds have been