


Article

Feasibility of United Arab Emirates Native Seaweed *Ulva intestinalis* as a Food Source: Study of Nutritional and Mineral Compositions

Rashed Farzanah ¹, Mathias Porsmose Clausen ¹, Eva Christensen Arnspang ¹, Jens Ejbye Schmidt ² and Juan-Rodrigo Bastidas-Oyanedel ^{1,*} 

¹ SDU-IGT, Biotechnology Section, Department of Green Technology, University of Southern Denmark, Campusvej 55, M DK-5230 Odense, Denmark; rhf@igt.sdu.dk (R.F.); mpc@igt.sdu.dk (M.P.C.); arnspang@igt.sdu.dk (E.C.A.)

² SDU-IGT, Department of Green Technology, University of Southern Denmark, Campusvej 55, M DK-5230 Odense, Denmark; jesc@igt.sdu.dk

* Correspondence: jrbo@igt.sdu.dk; Tel.: +45-65-50-45-80

Abstract: Food resources are limited in arid countries such as the United Arab Emirates (UAE); the salinity of the groundwater, together with a lack of natural fresh water sources and arable land, force the country to import most of its food. However, seaweed could play an important role in providing a locally available food resource, as it does not require fresh water and arable land to grow. The traditional use of several seaweed species as food sources has been documented in Asia and the Americas, where their nutritional composition has been well reported. Although the UAE's aquatic environment is quite harsh due to high water salinity (over 40 g/L) and high surface water temperatures (over 35 °C), its native seaweed species could play a role as a food source in this arid region, thereby bolstering the country's level of food security. To evaluate its potential in this context, fresh samples of the native *Ulva intestinalis* seaweed were collected in the shallow waters of Abu Dhabi Emirate, UAE. These samples were calculated to contain 34.38 ± 0.24 kcal, with a biomass composition of $5.185 \pm 0.04\%$ carbohydrate, $3.32 \pm 0.14\%$ protein, and $0.04 \pm 0.01\%$ fat (by dry matter). Of all the minerals present in the biomass, potassium had the highest concentration (7947 ± 319.5 ppm), followed by magnesium (3075.9 ± 1357 ppm) and sodium (756.3 ± 478 ppm). The water-soluble vitamins B1, B2, B3, B6, and C were below the detection limit in the samples. The rich concentration of essential minerals such as potassium, magnesium, iron and zinc in *Ulva intestinalis* makes it a promising novel food source. To the best of our knowledge, this is the first experimental study to examine the feasibility of using seaweed that is native to the UAE as a nutritional and sustainable food source in order to address the challenge of food security currently being faced by the country.

Keywords: seaweed; *Ulva intestinalis*; edible algae; nutritional composition; minerals; food security



Citation: Farzanah, R.; Clausen, M.P.; Arnspang, E.C.; Schmidt, J.E.; Bastidas-Oyanedel, J.-R. Feasibility of United Arab Emirates Native Seaweed *Ulva intestinalis* as a Food Source: Study of Nutritional and Mineral Compositions. *Phycology* **2022**, *2*, 120–131. <https://doi.org/10.3390/phycology2010008>

Academic Editor: Leonel Pereira

Received: 16 November 2021

Accepted: 15 February 2022

Published: 17 February 2022

Publisher's Note: MDPI stays neutral with regard to jurisdictional claims in published maps and institutional affiliations.



Copyright: © 2022 by the authors. Licensee MDPI, Basel, Switzerland. This article is an open access article distributed under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

1. Introduction

Food, water, and energy are essential elements for a society's development. Lack of food resources is a growing concern for many nations, where access to food is restricted due to, for example, geo-environmental and geopolitical factors. Moreover, these factors can significantly affect food imports and accessibility, eventually increasing a country's poverty rate [1,2]. Food security is a term used to describe the capability of a country to provide food resources, provide access to food resources, and to utilize food resources [3]. Despite being one of the Middle East's fastest-growing economies, the United Arab Emirates (UAE) is facing food security concerns [4]. The country has a well-established import and export system, in which food is one of its primary import goods, with nearly 90 percent of the nation's food needs being covered by imports [5]. Due to climatic and environmental factors,

the UAE suffers severely from a lack of healthy arable land and access to freshwater, which limits its ability to produce locally grown food crops [6]. The UAE's internal renewable freshwater resources measure at 15.81 m³/inhabitant/year [7], which satisfies the definition of being an arid region. Indeed, values below 500 are considered to represent "absolute water scarcity" [8], and this scarcity constrains the nation's domestic agricultural and food production. Therefore, the coastline of the UAE appears to be an attractive location to produce seawater 'crops' in order to boost the nation's food security. The Emirate of Abu Dhabi, which has the longest coastline of the Emirates, is in the southeastern region of the Arabian Gulf. The coastal seawater salinity and surface seawater temperature can reach 40 g/L and 35 °C, respectively [9–11]. These aquatic conditions are quite harsh compared to those in which seaweed is grown in East Asian aquatic environments—the salinity and temperature of eastern Chinese waters are reported to be around 34.71 g/L and 25.7 °C, respectively. Due to these comparatively harsh conditions exhibited by the waters of the Arabian Gulf, the edibility of UAE native seaweed is still yet to be explored [12]. Seaweeds are used as traditional food sources in East Asian countries because of their rich nutritional value [13–15]; they typically contain high concentrations of micro and macro trace elements such as sodium, potassium, calcium, magnesium, sulphur, chlorine, and phosphorus, and also contain micronutrients such as cobalt, iron, nickel, boron, copper, zinc, manganese, molybdenum, fluoride, selenium, and various vitamins [16]. In fact, the mineral content of some seaweed species exceeds that of spinach [17–20]. Furthermore, seaweed does not need arable land or freshwater to grow, and it has a high growth rate compared to terrestrial plants. Some seaweed species (e.g., *Eucheuma denticulatum*, *Rhodophyta*) have a daily growth rate in the range of 5.2–7.2%; indeed, the growth rates of seaweeds can be 10 times faster than those of terrestrial plants [21,22].

Thus, seaweed can play an important role in food security, especially in arid countries such as the UAE. To the best of our knowledge, this is the first experimental study to examine the feasibility of using marine seaweed native to the UAE as a nutritional and sustainable food source in order to address the challenge of food security. In the present study, the nutritional and mineral compositions of the native green seaweed *Ulva intestinalis*, which grows in the coastal areas of the UAE, were studied and compared with those of dates, due to the prevalence of dates as a local food source in this country.

2. Materials and Methods

2.1. Sample Collection and Preparation

Fresh samples of *Ulva intestinalis* (Chlorophyta) were collected in the shallow waters surrounding the coastline of Abu Dhabi's Mangrove Corniche Bay, 24°27'18.7'' N 54°25'11.6'' E, in February 2021. Pictures of *Ulva intestinalis* samples being collected during the sampling trip are presented in Figure 1. Random sampling was carried out at a single location, and all samples were stored in one sealed storage container. The *Ulva intestinalis* samples were hand-washed using tap water at room temperature (20–25 °C) to remove any foreign materials such as sand or dirt from the surface of the seaweed.

2.2. Chemical Composition Analysis

2.2.1. Total Solid and Ash Content

Using Equations (1) and (2) below, the moisture, volatile matter, and total solid contents of the *Ulva intestinalis* sample were determined by drying the sample at 105 °C for 4 h in an air oven, cooling it at room temperature in a desiccator, and then weighing it. In addition, using Equation (3), the total ash content (as a percentage of the remaining sample) was determined after the complete destruction of the organic compounds by heating the sample in a furnace at a temperature of 550 °C for 4 h, according to the National Renewable Energy Laboratory (NREL) procedure, with some modifications as per in-house lab protocol [23].

$$\text{Moisture (and Volatile Matter) (mass \%)} = (m - m_1) \times 100 \quad (1)$$

$$\text{Total Solids (mass \%)} = 100 - \text{Moisture} \quad (2)$$

$$\text{Total Ash (mass \%)} = \frac{(m1 - m2)}{m - m0} \times 100 \quad (3)$$

where (all in grams) $m0$: mass of empty crucible, m : mass of (empty crucible plus wet sample), $m1$: mass of (empty crucible plus sample after drying at 105 °C), thus, $(m - m0)$: mass of wet sample, and $m2$: sample mass of empty crucible plus sample after furnace at 550 °C.



Figure 1. Native *Ulva intestinalis* was sampled on the shore of the shallow waters surrounding Abu Dhabi Island in February 2021.

2.2.2. Protein, Fat, Fiber, Carbohydrate, and Calorie Contents

The total nitrogen and crude protein contents of the sample were calculated using the Kjeldahl method (see Equations (4) and (5)): acid hydrolysis was used to convert the protein to $(\text{NH}_4)_2 \text{SO}_4$ using a selenium mixture as a catalyst at 420 °C. The $(\text{NH}_4)_2 \text{SO}_4$ was then converted to $\text{NH}_4 \text{OH}$, and the excess boric acid was neutralized via automatic titration [24].

$$\text{Nitrogen (mass \%)} = \frac{14.01 \times M \times (A - B)}{1000} \times 100 \quad (4)$$

where A = titrant (mL), B = blank (mL), M = the molarity of the acid, and 14.01 = the atomic weight of nitrogen.

$$\text{Crude Protein (mass \%)} = \text{Nitrogen} \times 6.25 \quad (5)$$

where 6.25 = the conversion factor for protein.

The crude fat content was determined by performing a petroleum ether extraction (using an ANKOM XT15 extractor), in which the extracted compounds were mainly triacylglycerols. The crude fat content was calculated by the difference in mass before and after extraction and drying the filter bag at 102 ± 2 °C (see Equation (6)) [25].

$$\text{Crude Fat (mass \%)} = \frac{(m2 - m3)}{m - m0} \times 100 \quad (6)$$

where $m - m0$: original mass of sample, $m2$: mass of (filter bag + sample before drying), and $m3$: mass of (filter bag + dried sample after extraction).

The crude fiber content was analyzed by treating the sample with sulfuric acid and potassium hydroxide, resulting in the dissolution of cellulose, hemicellulose, and lignin in the sample material. The undigested portion was dried and incinerated at 550 ± 25 °C

for a minimum of 4 h. The difference between the ash content and the undigested portion gave the crude fiber content (see Equation (7)) [26].

$$\text{Crude Fiber (mass \%)} = \frac{(m3 - m1 - m4 - B4)}{m - m0} \times 100 \quad (7)$$

where (all in grams) $m1$: mass of empty fiber bag, $m - m0$: original mass of sample, $m3$: mass of (incinerating crucible + dried fiber bag after digestion), and $m4$: mass of (incinerating crucible + ash); $B4 = B2 - B1 - B3$ where $B1$: mass of empty fiber bag of the blank, $B2$: mass of (incinerating crucible + dried fiber bag of the blank after digestion), and $B3$: mass of (incinerating crucible + ash of empty fiber bag of the blank).

The carbohydrate content was determined via Equation (8) [27]. The caloric content was calculated using conversion factors as specified in EU Directive 90/496 article 5 (see Equation (9)) [28].

$$\text{Carbohydrate (mass \%)} = 100 - (\text{Moisture} + \text{Ash} + \text{Protein} + \text{Fat}) \quad (8)$$

$$\text{Caloric Value (kcal)} = 9 \times \text{Fat} + 4 \times \text{Protein} + 4 \times \text{Carbohydrate} \quad (9)$$

where 9 kcal/g (or 37 kJ/g) = conversion factor for fat and 4 kcal/g (or 17 kJ/g) = conversion factor for both protein and carbohydrate [28].

2.2.3. Heavy Metals and Minerals

The mineral content (aluminum, arsenic, boron, cadmium, chromium, copper, iron, lead, magnesium, manganese, mercury, nickel, potassium, selenium, sodium, and zinc) of the sample was determined via inductively coupled plasma mass spectrometry (ICP-MS, Perkin-Elmer model Elan 6000 DRC-e, Waltham, MA, USA) according to the United States Food and Drug Administration's procedure for the determination of inorganic elements in food, with some modifications as per in-house lab protocol [24]. First, the fresh samples were homogenized using a grinder equipped with titanium blades free from metal residue. The samples were then pretreated with nitric acid using a microwave wet digestion technique before introducing them into the ICP-MS.

2.2.4. Vitamin B Complex and Vitamin C

The vitamin B complex and vitamin C (ascorbic acid) contents (both water-soluble) of the sample were determined using a HPLC-UV detector (Waters C18 Column, 5 μm , 4.6 mm \times 150 mm, Agilent, Santa Clara, CA, USA) according to methods derived from the literature [25,29,30]. The fresh sample was clarified using Carrez solutions to remove materials which would interfere with the vitamin B complex analysis. Two different Carrez solutions were used: Carrez I, which is based on zinc acetate, and Carrez II, which is based on potassium hexacyanoferrate (II) trihydrate. During the vitamin C analysis, the fresh samples were treated with zinc acetate dihydrate and potassium ferrocyanide trihydrate solution before being introduced into the HPLC-UV.

3. Results and Discussion

3.1. Chemical Characterization and Caloric Value

The results for the nutrient analysis of *Ulva intestinalis* collected from the shallow waters surrounding Abu Dhabi Island are summarized in Table 1.

Table 1. *Ulva intestinalis* chemical characterization and caloric value (% dry matter).

Components	Value
Caloric value by calculation	34.38 ± 0.24
Carbohydrates	5.16 ± 0.04
Crude fiber	1.01 ± 0.13
Fat	0.04 ± 0.01
Moisture	85.83 ± 3.28
Protein	3.32 ± 0.14
Total ash	5.62 ± 3.20

Values are expressed as mean ± SD; *n* = 2.

The water content of seaweed can be affected by many factors, including structure, tissue morphology, collection site, size, seasonality, and sample preparation [31]. In this case, the fresh *Ulva intestinalis* samples were found to have a moisture content of 85.83 ± 3.28%. The ash content (5.62 ± 3.20%) was relatively low compared to the results of other studies of similar species to *Ulva intestinalis*, which found ash contents of 27.6% and 31.4% [32,33]. The reason for this relatively low ash content is the washing of the fresh sample several times using tap water at the sampling stage, which minimized the residual seawater salt content in the biomass. The biomass had a crude fiber content of 1.005 ± 0.13%, which is relatively low compared to the crude fiber content of other seaweeds: other studies have found crude fiber contents of 3.68% in *Ulva* sp. and 34.7% in *Ulva lactuca* [32,34]. The nitrogen-based protein content of the sample was calculated as 3.32 ± 0.14%, which is low compared with the protein content of the famous Japanese edible seaweeds known commonly as “nori” and “wakame” [35]. “Nori” and “wakame” seaweeds are served in various Japanese dishes; they have protein contents of 33.2% and 16.8%, respectively [35]. *Ulva rigida* (a green seaweed) has a protein content of 6.4%, while other *Ulva* species exhibit higher protein contents, ranging from 8.7% to 20% depending on the techniques used to extract protein and the extent to which samples were dried [36,37]. The caloric value of the *Ulva intestinalis* sampled in this study was 34.38 ± 0.24 kcal, while the carbohydrate content was measured to be 5.185 ± 0.04% of the dry biomass matter. The low caloric content of the sample can be correlated with the ash content. Some studies have reported higher caloric and carbohydrate contents for different *Ulva* species; for instance, a sample of *Ulva lactuca* was found to have a caloric content of 242.1 kcal [38]. Elsewhere, *Ulva* sp. have been found to have a carbohydrate content of 49.09% of dry matter, while that of *Ulva lactuca* (formerly *Ulva fasciata*) has been found to be 71.1% [32,39]. The low carbohydrate content of the *Ulva intestinalis* sample in the present study could be correlated with the low crude fiber content.

3.2. Minerals and Heavy Metal Contents

Table 2 presents the mineral composition of the *Ulva intestinalis* sample. The potassium content was measured at 7947 ± 319 ppm, which is comparable to that of *Ulva lactuca* (4670 ppm), but lower than that of *Ulva australis* (formerly *Ulva pertusa*) (15,357 ppm) [33,40]. Potassium is an essential dietary element for human health; an adequate daily intake of this mineral is generally considered to be around 4700 mg/day [41]. As a point of reference, bananas are well known for their high potassium content, measuring at around 3750 ppm [42]. After potassium, magnesium was the second most prevalent mineral in the *Ulva intestinalis* sample, measuring at 3076 ± 1357 ppm; this is lower than the content found in both *Ulva pertusa* (33,596 ppm) and *Ulva lactuca* (30,800 ppm) [33,43]. The sodium content was 756 ± 478 ppm, which is lower than that of *Ulva australis*, yet comparable to that of *Ulva intestinalis* sampled in Thailand [33]. In fact, a lower concentration of sodium is in line with dietary health guidance, as high sodium consumption has been linked to the risk of developing cardiovascular diseases and hypertension [44]. The iron content of the *Ulva intestinalis* sample was measured at 10.11 ± 1.26 ppm, which is comparable to the content measured in other common vegetables; for example, crisphead lettuce has an iron content of 4.1 ppm, whilst that of stem lettuce is 20 ppm [45]. A study on the

effects of adding different species of seaweeds to rice meals has shown that seaweed increases the bodily absorption of iron present in the rice meal [46]. The iron contents of several other seaweed species are as follows: *Ulva* sp. (Chlorophyta), 575 ± 311 ppm; *Sargassum* sp. (Phaeophyceae), 1596 ± 324 ppm; *Porphyra* sp. (Rhodophyta), 155 ± 29 ppm; and *Gracilariopsis* sp. (Rhodophyta), 1959 ± 549 ppm [46]. These findings indicate the potentially significant role of seaweed in increasing the nutritional value of meals in underdeveloped countries.

Table 2. Approximate inorganic chemical content of *Ulva intestinalis* sample (% dry matter).

Elements	Value
Potassium	7947 ± 319 ppm
Magnesium	3076 ± 1357 ppm
Sodium	756 ± 478 ppm
Iron	10.11 ± 1.26 ppm
Aluminum	3.57 ± 0.43 ppm
Chromium	2.26 ± 0.30 ppm
Boron	4.18 ± 2.30 ppm
Manganese	7.65 ± 2.91 ppm
Nickel	3.21 ± 0.77 ppm
Copper	2.09 ± 0.46 ppm
Selenium	0.92 ± 0.61 ppm
Arsenic	0.24 ± 0.05 ppm
Zinc	5.01 ± 0.96 ppm
Lead	0.26 ± 0.07 ppm
Mercury	0.03 ± 0.03 ppm
Cadmium	<0.00001 ppm *

Values are expressed as mean \pm SD; $n = 2$. * Below the limit of detection (LOD).

The aluminum content of the *Ulva intestinalis* sample was found to be relatively low (3.57 ± 0.43 ppm); the content of this mineral in other green seaweeds has been reported to be around 34.10 ± 39.63 ppm, whilst that of the famous Japanese dried seaweed *wakame* has been reported to be between 17.7 and 149 ppm [47,48]. The maximum recommended intake of aluminum from natural sources is 10 mg/day for humans, since a high bodily intake of aluminum has been correlated with health issues such as Alzheimer's disease and adverse effects on the nervous system [49]. The aluminum concentration in seaweed can be manipulated through optimal pretreatment in order to comply with the acceptable limit [50,51]. The chromium and boron contents of the sample were measured at 2.26 ± 0.30 ppm and 4.18 ± 2.30 ppm, respectively. This chromium content is higher than that of *Ulva lactuca*, which has been reported to be 1 ppm [52]. The boron content measured is also relatively high: in other green seaweeds, the boron content has been reported as being in the range of 0.56–0.88 ppm [53]. However, the results for the sample in this study are closer to those found for some red seaweed species, such as *Gracilaria edulis*, *Gracilaria canaliculata* (formerly *Gracilaria crassa*), *Gracilaria corticata*, *Sarcodia ceylanica*, and *Centroceros clavulatum* (Rhodophyta), which have boron contents in the range of 2.02–2.73 ppm [53]. As a point of reference, an adequate intake of chromium for humans is only 0.035 mg/day, while the maximum tolerable intake of boron is 20 mg/day [54]. The manganese content of the *Ulva intestinalis* sample was measured at 7.65 ± 2.91 ppm, which is low compared to that reported for other green seaweeds such as *Caulerpa lentillifera* (70.9 ppm) and *Caulerpa racemose* (Chlorophyta) (40.91 ppm) [55]. The nickel content of our sample was measured at 3.21 ± 0.77 ppm, whilst that of other green seaweeds has previously been reported as 0.51 ± 0.33 ppm [47]. No data could be found on the recommended nickel intake for human health; this could be due to the lack of evidence on the importance of nickel as a nutrient [54]. The copper content of our sample was measured at 2.09 ± 0.46 ppm, which is close to the value reported for *Ulva* sp. in other studies (3 ppm). For this nutrient, the

recommended intake ranges from approximately 1.2 to 1.6 mg/day for men and from 1.0 to 1.1 mg/day for women [17,54]. The selenium content of our sample was measured at 0.92 ± 0.61 ppm, which is relatively high; in contrast, *Ulva stenophylla* has been reported to have a selenium content of 0.0017 ppm [56]. As a point of reference, the selenium content of vegetables such as lettuce ranges between 0.001 and 0.015 ppm [45], whilst the recommended daily intake of this nutrient is 0.07 mg/day for men and 0.06 mg/day for women [56]. As many as 180 different seaweed species have been reported to contain arsenic in the range of 0.01–1 ppm [57]; adding to this list, our sample was found to contain 0.24 ± 0.05 ppm. There is currently no evidence for the nutritional value of arsenic in humans, although arsenic deprivation has been linked to impaired growth and abnormal reproduction in some animals [54]. The zinc content of our sample was measured at 5.01 ± 0.96 ppm, which is lower than that of *Ulva* sp. (9 ppm) [17]. As for the remaining minerals examined, the lead and mercury contents were measured at 0.26 ± 0.07 and 0.03 ± 0.03 ppm, respectively, while the cadmium content was below the limit of detection (LOD) of <0.00001 ppm. The LOD is defined as the lowest concentration of analyte that can be detected given the instrumentation and methods used and the quality of the sample preparation. Comparable to that of our sample, the lead content of *Ulva lactuca* has been reported as 0.452 ppm [43], whilst its mercury and cadmium contents are reportedly 0.017 ppm and 0.045 ppm, respectively [43]. Some of these heavy metals, such as cadmium and mercury, are readily available in plant-based foods, and can cause serious health issues related to the kidneys, lungs, liver, and nervous system if consumed in high concentrations [51].

3.3. Water-Soluble Vitamins

As measured in this study, Table 3 presents the water-soluble vitamin contents of the *Ulva intestinalis* sample. The B complex vitamins (including thiamine hydrochloride (B1), riboflavin (B2), nicotinamide (B3), and pyridoxine (B6)) were all found to be below the LOD, as was ascorbic acid (vitamin C). However, water-soluble vitamins have been reported in noticeable concentrations in several other green seaweeds; for example, *Ulva lactuca* has been reported to contain vitamin B1 in the range from <1 to 70 ppm, vitamin B2 in the range from <2 to 40 ppm, and vitamin B3 at a value of approximately 2.1 ppm [55,58]. In most seaweeds, vitamin B6 (pyridoxine) has either not been detected or has been detected only in relatively small quantities, with the exception of a few species that have been found to have concentrations in the range from 3 ppm to over 80 ppm [55,58]. In contrast to our sample, the vitamin C content of some green seaweeds has been reported as ranging from 2 ppm to over 90 ppm [58]. The low vitamin content of *Ulva intestinalis* found in this study could be related to the analytical methods used, seasonal variation, and/or the sample preparation process [59].

Table 3. Water-soluble vitamins in *Ulva intestinalis*.

Components	Value
Ascorbic acid (Vitamin C)	<10.0 ppm *
Nicotinamide (B3)	<3.0 ppm *
Pyridoxine (B6)	<3.0 ppm *
Riboflavin (B2)	<3.0 ppm *
Thiamine hydrochloride (B1)	<3.0 ppm *

* Below the limit of detection (LOD).

3.4. Nutritional Comparison between *Ulva intestinalis* and Palm Dates

The fruit of the date palm, *Phoenix dactylifera*, is a traditional food crop in the Middle East, North Africa, and some parts of Asia [60,61]. Dates have played a significant role in these regional economies; in fact, they have historically been the only export products of some of the countries in these regions [61,62], and the UAE is one of the top producers and exporters of dates and date palm derivatives [62,63]. Moreover, dates are known for

their rich nutritional composition (see Table 4) [64–67]. In order to evaluate *Ulva intestinalis* as a potential food source that is locally available in the UAE, its nutritional content was compared to that of dates. This comparison has not been conducted with the intention of replacing the date palm with seaweed; it merely serves as a benchmark for determining the worth of this seaweed as a local and sustainable source of food. Table 4 provides the chemical composition of *Phoenix dactylifera* fruits as described in the literature [64–67]. From this, we can see that dates have a higher carbohydrate content than *Ulva intestinalis* seaweed (Table 2); this result was expected, since dates are considered to be sweet fruits. The protein content of dates is lower than that of the seaweed sample. However, the protein content in dates varies depending on species, stage of fruit maturity, and the geographical location of the date palm tree [62]. As expected, the ash and moisture contents of the seaweed sample were higher than those of dates, due to the nature of seaweed habitats.

Table 4. Chemical composition of the fruits of the date palm *Phoenix dactylifera* (average values), according to cited studies [64–67].

Components	<i>Phoenix dactylifera</i>
Ash	1.67%
Carbohydrate	80.6%
Dietary fiber	4.8%
Fat	0.38%
Moisture	15.2%
Protein	2.14%

The macro and micronutrient contents of dates are presented in Table 5, where the values are averages of values given by different cited sources. Dates are rich in nutrients and minerals; for example, the average potassium content of dates is reportedly 7130 ppm, which is actually comparable to that of the *Ulva intestinalis* sample used in this study. The magnesium and sodium contents of *Ulva intestinalis* were found to be higher than those of dates, which is to be expected; a study of more than 20 types of fruits and vegetables showed that the magnesium and sodium contents of vegetables are generally higher than those of fruits, and dates are a type of fruit [62]. The concentrations of heavy metals related to health risks (such as arsenic, cadmium and selenium) are substantially lower in *Ulva intestinalis* than in dates.

3.5. Processing Seaweed as a Food Source and Mineral Supplement

Seaweed can be eaten in many forms: fresh, cooked, powdered, and as an additive. The vitamins and minerals in seaweed can also be consumed as extracted nutrients. As mentioned earlier, seaweed is used as fresh food in some Asian countries [35]; for example, Japanese “nori” seaweed is sold in food markets as a dried sheet of seaweed, in toasted cooked form, as instant soup in restaurants, as a jam ingredient, and as a clarification component for making wine [68]. In China, *Saccharina japonica* (formerly *Laminaria japonica*) (Phaeophyceae) is produced in large quantities and is mainly consumed fresh as a sea vegetable, whilst *Grateloupia filicina* and *Gracilaria* (Rhodophyta) are consumed in salads [69]. In Chile, *Durvillaea antarctica* (Phaeophyceae) is traditionally used in stews [70].

The utilization of seaweed in functional food for dietary benefits has been investigated in relation to many different food products, such as beef, chicken, seafood, and baked goods [70,71]. For example, seaweed and seaweed extracts can be mixed with meat products to increase their fiber and protein content and to promote antioxidant activity [71]. In addition, seaweed powder can be used in baked goods for dietary enhancement [72]. Outside of meals, *Ulva intestinalis* has also been studied as an ingredient in soap, tea, and spice mixes [33,73].

Table 5. Inorganic chemical analysis of the fruit of the date palm *Phoenix dactylifera* (average values) [64–67].

Elements	<i>Phoenix dactylifera</i> (According to Cited Data)
Potassium	7130 ppm
Magnesium	642 ppm
Sodium	329 ppm
Iron	8.3 ppm
Aluminum	30 ppm
Chromium	0.686 ppm
Manganese	2.7 ppm
Nickel	0.82 ppm
Copper	2.4 ppm
Selenium	3.1 ppm
Arsenic	0.58 ppm
Zinc	2.7 ppm
Lead	0.18 ppm
Cadmium	0.01 ppm

The cultivation, harvesting, and processing of seaweed is well established in some parts of Asia, Europe, and Africa [74], where its promising benefits as a foodstuff make it attractive to food industries. In Europe, for instance, the demand for food containing seaweed has increased by 147% in just four years [74]. The results of the *Ulva intestinalis* analysis in this study—revealing its high mineral content, including minerals such as potassium, magnesium, and iron—suggest that it is a good source of nutrients for food additives and dietary supplements. Utilizing the minerals contained within *Ulva intestinalis* as food additives will increase the nutritional value of foods consumed in the UAE such as rice and bread, which are primary components of local Emirati dishes.

4. Conclusions

In this study, the nutrient and mineral contents of the seaweed *Ulva intestinalis*, which is native to the UAE, were analyzed in order to explore the feasibility of using it as a food source. This analysis has shown that *Ulva intestinalis* has an interesting mineral composition, which could be exploited to produce food additives. Furthermore, some of the concentrations of nutrients and minerals in *Ulva intestinalis* exceed or are comparable to those found in date palm fruit, one of the UAE's primary locally grown foods.

With its notable nutritional content, seaweed as a food has numerous health benefits. As such, *Ulva intestinalis* is a perfect candidate food source to meet some of the UAE's food security issues related to poor arable land and limited freshwater resources.

Author Contributions: Conceptualization, R.F. and J.-R.B.-O.; methodology, R.F.; validation, R.F. and J.-R.B.-O.; formal analysis, R.F.; investigation, R.F.; resources, R.F.; data curation, R.F.; writing—original draft preparation, R.F.; writing—review and editing, R.F., J.-R.B.-O., M.P.C., E.C.A. and J.E.S.; visualization, R.F.; supervision, J.-R.B.-O.; project administration, J.-R.B.-O., E.C.A. and J.E.S. All authors have read and agreed to the published version of the manuscript.

Funding: This research received no external funding.

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Data is contained within the article.

Acknowledgments: The authors wish to acknowledge the lab facilities and working space provided by Abu Dhabi Quality and Conformity Council Laboratory (ADQCC). Ahmed Jaber and Abdullah Sidiqqi from ADQCC are also gratefully acknowledged for their tremendous support during the experimental analysis at the QCC facility, in addition to Hind Al Amri from Abu Dhabi Environmental Agency for her kind support.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Deaton, B.J.; Lipka, B. Political Instability and Food Security. *J. Food Secur.* **2015**, *3*, 29–33. [CrossRef]
2. Stringer, L.; Akhtar-Schuster, M.; Marques, M.J.; Amiraslani, F.; Quatrini, S.; Abraham, E. Combating Land Degradation and Desertification and Enhancing Food Security: Towards Integrated Solutions. *Ann. Arid Zone* **2011**, *50*, 1–23.
3. Hassen, T.B.; El Bilali, H. Food Security in the Gulf Cooperation Council Countries: Challenges and Prospects. *J. Food Secur.* **2019**, *7*, 159–169. [CrossRef]
4. Matabadal, A. Country Report United Arab Emirates—RaboResearch. 2013. Available online: <https://economics.rabobank.com/publications/2013/may/country-report-united-arab-emirates/> (accessed on 14 June 2021).
5. Hamza, M. Grain and Feed Annual-UAE. 2020. Available online: <https://www.fas.usda.gov/data/united-arab-emirates-grain-and-feed-annual-2> (accessed on 1 October 2021).
6. Power, L. Scarcity and Abundance: UAE Food and Water Security. *Glob. Food Water Cris. Res. Program.* 2014. Available online: http://futuredirections.org.au/wp-content/uploads/2014/11/FDI_Strategic_Analysis_Paper_-_UAE_Scarcity_and_Abundance.pdf (accessed on 1 October 2021).
7. FAO, AQUASTAT Database. 2014. Available online: <http://www.fao.org/nr/aquastat> (accessed on 14 June 2021).
8. Bastidas-Oyanedel, J.-R.; Fang, C.; Almardeai, S.; Javid, U.; Yousuf, A.; Schmidt, J. Waste biorefinery in arid/semi-arid regions. *Bioresour. Technol.* **2016**, *215*, 21–28.
9. Elshorbagy, W.; Azam, M.H.; Nakata, N.; Terasawa, T. Temperature-Salinity field of the shallow shelf of southern Arabian Gulf. *Far East J. Ocean Res.* **2008**, *1*, 99–126.
10. Almardeai, S.; Oyanedel, J.-R.B.; Haris, S.; Schmidt, J.E. Avicennia marina biomass characterization towards bioproducts. *Emirates J. Food Agric.* **2017**, *29*, 710–715. [CrossRef]
11. Marine Water Quality 2019 Annual Summary Report—Abu Dhabi. 2020. Available online: <https://www.ead.gov.ae/-/media/Project/EAD/EAD/Documents/Resources/Marine-water-Quality-2019-annual-summary-report.pdf> (accessed on 14 June 2021).
12. Yu, H.; Liu, Z.; Berné, S.; Jia, G.; Xiong, Y.; Dickens, G.R.; Wei, G.; Shi, X.; Liu, J.; Chen, F. Variations in temperature and salinity of the surface water above the middle Okinawa Trough during the past 37 kyr. *Palaeogeogr. Palaeoclimatol. Palaeoecol.* **2009**, *281*, 154–164. [CrossRef]
13. Hwang, E.K.; Yotsukura, N.; Pang, S.; Su, L.; Shan, T. Seaweed breeding programs and progress in eastern Asian countries. *Phycologia* **2019**, *58*, 484–495. [CrossRef]
14. Kim, S.-K. *Marine Medicinal Foods Implications and Applications, Macro and Microalgae*, 1st ed.; Elsevier: Waltham, MS, USA, 2011.
15. Mahadevan, K. Seaweeds: A sustainable food source. In *Seaweed Sustain: Food and Non-Food Applications*; Academic Press: Cambridge, MA, USA, 2015; pp. 347–364. [CrossRef]
16. Ferdouse, F.; Løvstad Holdt, S.; Smith, R.; Murúa, P.; Yang, Z. *The Global Status Of Seaweed Production, Trade and Utilization*; Globefish Research Programme; FAO: Rome, Italy, 2018; Volume 124, 120p.
17. MacArtain, P.; Gill, C.I.; Brooks, M.; Campbell, R.; Rowland, I.R. Nutritional Value of Edible Seaweeds. *Nutr. Rev.* **2008**, *65*, 535–543. [CrossRef]
18. Rasyid, A.; Ardiansyah, A.; Pangestuti, R. Nutrient Composition of Dried Seaweed *Gracilaria gracilis*. *ILMU Kelaut Indones. J. Mar. Sci.* **2019**, *24*, 1–6. [CrossRef]
19. Ratana-Arporn, P.; Chirapart, A. Nutritional Evaluation of Tropical Green Seaweeds *Caulerpa lentillifera* and *Ulva reticulata*. *Kasetsart J. Nat. Sci.* **2006**, *40*, 75–83.
20. Alvino, A.; Barbieri, G. Vegetables of Temperate Climates: Leafy Vegetables. In *Encyclopedia of Food and Health*; Walton Street: Oxford, UK, 2016; pp. 393–400. [CrossRef]
21. Kasim, M.; Mustafa, A.; Munier, T. The growth rate of seaweed (*Eucheuma denticulatum*) cultivated in longline and floating cage. *AACL Bioflux* **2016**, *9*, 291–299.
22. Borines, M.G.; de Leon, R.L.; McHenry, M.P. Bioethanol production from farming non-food macroalgae in Pacific island nations: Chemical constituents, bioethanol yields, and prospective species in the Philippines. *Renew. Sustain. Energy Rev.* **2011**, *15*, 4432–4435. [CrossRef]
23. Sluiter, A.; Hames, B.; Ruiz, R.; Scarlata, C.; Sluiter, J.; Templeton, D. Determination of Ash in Biomass: Laboratory Analytical Procedure (LAP). Issue Date: 7/17/2005; 2008. Available online: www.nrel.gov (accessed on 16 June 2021).
24. FDA. Elemental Analysis Manual for Food Products and Related Products. 2020. Available online: <http://www.fda.gov/Food/FoodScienceResearch/LaboratoryMethods/ucm2006954.htm> (accessed on 1 June 2021).
25. Egan, H.; Kirk, R.S.; Sawyer, R. *Pearson's Composition and Analysis of Foods*, 8th ed.; Churchill Livingstone: Edinburgh, UK, 1981.

26. Rapid Determination of Oil/Fat Utilizing High Temperature Solvent Extraction. 2004. Available online: http://www.scco.com.tw/Ankom/PDF_file/CrudeFatMethod.pdf (accessed on 1 July 2021).
27. Kirk, R.S.; Sawyer, R. *Pearson's Composition and Analysis of Foods*, 9th ed.; Longman Group Ltd.: London, UK, 1991.
28. European Communities. Council Directive on nutrition labelling for foodstuff. *Off. J. Eur. Communities* **2000**, *269*, 1–15.
29. Egan, H.; Kirk, R.S.; Sawyer, R.; Pearson, D. *Pearson's Chemical Analysis of Foods*, 8th ed.; Churchill Livingstone: Edinburgh, UK, 1981.
30. Ekinci, R.; Kadakal, C. Determination of seven water-soluble vitamins in tarhana, a traditional Turkish cereal food, by high-performance liquid chromatography. *Acta Chromatogr.* **2005**, *15*, 289–297.
31. Da Silva, V.M.; Silva, L.A.; De Andrade, J.B.; Veloso, M.C.D.C.; Santos, G.V. Determination of moisture content and water activity in algae and fish by thermoanalytical techniques. *Quím. Nova* **2008**, *31*, 901–905. [\[CrossRef\]](#)
32. Jatmiko, T.H.; Prasetyo, D.J.; Poeloengasih, C.D.; Hernawan; Khasanah, Y. Nutritional Evaluation of *Ulva* sp. from Sepanjang Coast, Gunungkidul, Indonesia. *IOP Conf. Ser. Earth Environ. Sci.* **2019**, *251*, 012011. [\[CrossRef\]](#)
33. Benjama, O.; Payap, M. Nutritional composition and physicochemical properties of two green seaweeds (*Ulva pertusa* and *U. intestinalis*) from the Pattani Bay in Southern Thailand, Songklanakarin. *J. Sci. Technol.* **2011**, *33*, 575–583.
34. Yaich, H.; Garna, H.; Besbes, S.; Paquot, M.; Blecker, C.; Attia, H. Chemical composition and functional properties of *Ulva lactuca* seaweed collected in Tunisia. *Food Chem.* **2011**, *128*, 895–901. [\[CrossRef\]](#)
35. Taboada, M.; Lence, R.; Miguez, M. Nutritional value of the marine algae wakame (*Undaria pinnatifida*) and nori (*Porphyra purpurea*) as food supplements. *J. Appl. Phycol.* **2012**, *25*, 1271–1276. [\[CrossRef\]](#)
36. Burtin, P. Nutritional value of seaweeds. *Electron. J. Environ. Agric. Food Chem.* **2003**, *2*, 498–503.
37. Kazir, M.; Abuhassira-Cohen, Y.; Robin, A.; Nahor, O.; Luo, J.; Israel, A.; Golberg, A.; Livney, Y. Extraction of proteins from two marine macroalgae, *Ulva* sp. and *Gracilaria* sp., for food application, and evaluating digestibility, amino acid composition and antioxidant properties of the protein concentrates. *Food Hydrocoll.* **2018**, *87*, 194–203. [\[CrossRef\]](#)
38. Fathy, A. Evaluation of nutritional composition of some attached and drifted marine algae from Alexandria, Egypt. *Egypt. J. Phycol.* **2007**, *8*, 131–141. [\[CrossRef\]](#)
39. Magdugo, R.P.; Terme, N.; Lang, M.; Pliego-Cortés, H.; Marty, C.; Hurtado, A.Q.; Bedoux, G.; Bourgougnon, N. An Analysis of the Nutritional and Health Values of *Caulerpa racemosa* (Forsskål) and *Ulva fasciata* (Delile)—Two Chlorophyta Collected from the Philippines. *Molecules* **2020**, *25*, 2901. [\[CrossRef\]](#)
40. Rasyid, A. Evaluation of Nutritional Composition of The Dried Seaweed *Ulva lactuca* from Pameungpeuk Waters, Indonesia. *Trop. Life Sci. Res.* **2017**, *28*, 119–125. [\[CrossRef\]](#)
41. Stone, M.S.; Martyn, L.; Weaver, C.M. Potassium Intake, Bioavailability, Hypertension, and Glucose Control. *Nutrients* **2016**, *8*, 444. [\[CrossRef\]](#)
42. Hapsari, L.; Lestari, D.A. Fruit characteristic and nutrient values of four Indonesian banana cultivars (*Musa* spp.) at different genomic groups. *Agrivita J. Agric. Sci.* **2016**, *38*, 303–311. [\[CrossRef\]](#)
43. Ramu, A.; Ganesan, K.S. Nutrient and nutraceutical potentials of seaweed biomass *Ulva lactuca* and *Kappaphycus alvarezii*. *J. Agric. Sci. Technol.* **2011**, *5*, 109–115.
44. Grillo, A.; Salvi, L.; Coruzzi, P.; Salvi, P.; Parati, G. Sodium Intake and Hypertension. *Nutrients* **2019**, *11*, 1970. [\[CrossRef\]](#) [\[PubMed\]](#)
45. Mou, B. Nutrient Content of Lettuce and its Improvement. *Curr. Nutr. Food Sci.* **2009**, *5*, 242–248. [\[CrossRef\]](#)
46. García-Casal, M.N.; Pereira, A.C.; Leets, I.; Ramírez, J.; Quiroga, M.F. High iron content and bioavailability in humans from four species of marine algae. *J. Nutr.* **2007**, *137*, 2691–2695. [\[CrossRef\]](#) [\[PubMed\]](#)
47. Filippini, M.; Baldisserotto, A.; Menotta, S.; Fedrizzi, G.; Rubini, S.; Gigliotti, D.; Valpiani, G.; Buzzi, R.; Manfredini, S.; Vertuani, S. Heavy metals and potential risks in edible seaweed on the market in Italy. *Chemosphere* **2021**, *263*, 127983. [\[CrossRef\]](#)
48. Matsushima, F.; Meshitsuka, S.; Nose, T. Aluminum contents in dried and cooked sea vegetables. *Nihon Eiseigaku Zasshi* **1997**, *51*, 763–769. [\[CrossRef\]](#) [\[PubMed\]](#)
49. Krewski, D.; Yokel, R.A.; Nieboer, E.; Borchelt, D.; Cohen, J.; Harry, J.; Kacew, S.; Lindsay, J.; Mahfouz, A.M.; Rondeau, V. Human health risk assessment for aluminium, aluminium oxide, and aluminium hydroxide. *J. Toxicol. Environ. Health B. Crit. Rev.* **2007**, *10* (Suppl. S1), 1–269. [\[CrossRef\]](#)
50. Dastyar, W.; Zhao, M.; Yuan, W.; Li, H.; Ting, Z.J.; Ghaedi, H.; Yuan, H.; Li, X.; Wang, W. Effective Pretreatment of Heavy Metal-Contaminated Biomass Using a Low-Cost Ionic Liquid (Triethylammonium Hydrogen Sulfate): Optimization by Response Surface Methodology–Box Behnken Design. *ACS Sustain. Chem. Eng.* **2019**, *7*, 11571–11581. [\[CrossRef\]](#)
51. Hajeb, P.; Sloth, J.J.; Shakibazadeh, S.; Mahyudin, N.A.; Afsah-Hejri, L. Toxic Elements in Food: Occurrence, Binding, and Reduction Approaches. *Compr. Rev. Food Sci. Food Saf.* **2014**, *13*, 457–472. [\[CrossRef\]](#)
52. Yu-Qing, T.; Mahmood, K.; Shehzadi, R.; Ashraf, M.F. *Ulva Lactuca* and Its Polysaccharides: Food and Biomedical Aspects. *J. Biol. Agric. Healthc.* **2016**, *6*, 140–151.
53. Mageswaran, R.; Balakrishnan, V.; Balasubramaniam, S. Boron content of marine algae from the Mandaitivu and Kirinda coasts and mineral content of nine species of algae from the Kirinda coast. *J. Natl. Sci. Found. Sri Lanka* **1985**, *13*, 131–140. [\[CrossRef\]](#)
54. National Research Council. *Dietary Reference Intakes for Vitamin A, Vitamin K, Arsenic, Boron, Chromium, Copper, Iodine, Iron, Manganese, Molybdenum, Nickel, Silicon, Vanadium, and Zinc*; National Academies Press: Washington, DC, USA, 2001. [\[CrossRef\]](#)

55. Pereira, L. A Review of the Nutrient Composition of Selected Edible Seaweeds. *Seaweed Ecol. Nutr. Compos. Med. Uses* **2011**, *7*, 15–47.
56. Smith, J.; Summers, G.; Wong, R. Nutrient and heavy metal content of edible seaweeds in New Zealand. *N. Z. J. Crop Hortic. Sci.* **2010**, *38*, 19–28. [[CrossRef](#)]
57. Kim, M.-H.; Kim, J.; Noh, C.-H.; Choi, S.; Joo, Y.-S.; Lee, K.-W. Monitoring Arsenic Species Content in Seaweeds Produced off the Southern Coast of Korea and Its Risk Assessment. *Environments* **2020**, *7*, 68. [[CrossRef](#)]
58. Reka, P.; Banu, A.T.; Seethalakshmi, M. Nutrient Content, Phytonutrient Composition and Functional Properties of Selected Seaweeds Collected from Gulf of Mannar, Tamil Nadu, India. *Int. J. Nutr. Diet* **2017**, *4*, 145–159. [[CrossRef](#)]
59. Nielsen, C.; Rustad, T.; Holdt, S. Vitamin C from seaweed: A review assessing seaweed as contributor to daily intake. *Foods* **2021**, *10*, 198. [[CrossRef](#)] [[PubMed](#)]
60. Al-Alawi, R.A.; Al-Mashiqri, J.H.; Al-Nadabi, J.S.M.; Al-Shihi, B.I.; Baqi, Y. Date Palm Tree (*Phoenix dactylifera* L.): Natural Products and Therapeutic Options. *Front. Plant Sci.* **2017**, *8*, 845. [[CrossRef](#)] [[PubMed](#)]
61. Chao, C.T.; Krueger, R.R. The Date Palm (*Phoenix dactylifera* L.): Overview of Biology, Uses, and Cultivation. *HortScience* **2007**, *42*, 1077–1082. [[CrossRef](#)]
62. Dhehibi, B.; Ben Salah, M.; Frija, A. Date Palm Value Chain Analysis and Marketing Opportunities for the Gulf Cooperation Council (GCC) Countries. In *Agricultural Economics*; Kulshreshtha, N., Ed.; Intechopen: London, UK, 2018; pp. 1–17. [[CrossRef](#)]
63. Shahin, S.; Salem, M. Review Future Concerns on Irrigation Requirements of Date Palm Tree in the United Arab Emirates (UAE): Call for Quick Actions. In Proceedings of the 5th International Date Palm Conference, Abu Dhabi, United Arab Emirates, 16–18 March 2014.
64. Ahmed, J.; Aljasass, F.; Siddiq, M. Date Fruit Composition and Nutrition. In *Dates: Postharvest Science, Processing Technology and Health Benefits*; Siddiq, M., Aleid, S.M., Kadel, A.A., Eds.; Wiley: Hoboken, NJ, USA, 2014; pp. 261–284. [[CrossRef](#)]
65. Habib, H.M.; Ibrahim, W.H. Nutritional quality of 18 date fruit varieties. *Int. J. Food Sci. Nutr.* **2011**, *62*, 544–551. [[CrossRef](#)]
66. Al-Farsi, M.A.; Lee, C.Y. Nutritional and Functional Properties of Dates: A Review. *Crit. Rev. Food Sci. Nutr.* **2008**, *48*, 877–887. [[CrossRef](#)]
67. Al-Harrasi, A.; Rehman, N.; Hussain, J.; Khan, A.L.; Al-Rawahi, A.; Gilani, S.A.; Al-Broumi, M.; Ali, L. Nutritional assessment and antioxidant analysis of 22 date palm (*Phoenix dactylifera*) varieties growing in Sultanate of Oman. *Asian Pac. J. Trop. Med.* **2014**, *7*, S591–S598. [[CrossRef](#)]
68. Nisizawa, K. Preparation and marketing of seaweeds as foods. *FAO Fish. Tech. Paper.* **1987**, 273532, 614912.
69. Fleurence, J.; Levine, I. Chapter 5—Seaweeds as Food. In *Seaweed in Health and Disease Prevention*; Academic Press: San Diego, CA, USA, 2016; pp. 149–167. [[CrossRef](#)]
70. Figueroa, V.; Farfan, M.; Aguilera, J.M. Seaweeds as Novel Foods and Source of Culinary Flavors. *Food Rev. Int.* **2021**, 1–26. [[CrossRef](#)]
71. Roohinejad, S.; Koubaa, M.; Barba, F.J.; Saljoughian, S.; Amid, M.; Greiner, R. Application of seaweeds to develop new food products with enhanced shelf-life, quality and health-related beneficial properties. *Food Res. Int.* **2017**, *99*, 1066–1083. [[CrossRef](#)] [[PubMed](#)]
72. Komatsuzaki, N.; Arai, S.; Fujihara, S.; Shima, J.; Wijesekara, R.S.; De Croos, M.D.S.T. Development of Novel Bread by Combining Seaweed *Kappaphycus alvarezii* from Sri Lanka and *Saccharomyces cerevisiae* Isolated from Nectarine. *J. Agric. Sci. Technol. B* **2019**, *9*, 339–346. [[CrossRef](#)]
73. Metin, C.; Baygar, T. Determination of nutritional composition of *Enteromorpha intestinalis* and investigation of its usage as food. *Ege J. Fish. Aquat. Sci.* **2018**, *35*, 7–14. [[CrossRef](#)]
74. Kadam, S.U.; Álvarez, C.; Tiwari, B.K.; O'Donnell, C.P. Chapter 4—Processing of Seaweeds. In *Seaweed Sustainability*; Tiwari, B.K., Troy, D.J., Eds.; Academic Press: San Diego, CA, USA, 2015; pp. 61–78. [[CrossRef](#)]