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A COMPARATIVE STUDY ON THE MORPHOLOGY, POLYSACCHARIDE CONTENT& FUNCTIONAL PROPERTIES OF GREEN SEAWEED, *Caulerpa lentilifera* GROWN IN DIFFERENT ENVIRONMENTAL CONDITIONS

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Environmental variables in seaweed habitat are known to affect the growth, abundance and distribution of seaweed. Polysaccharides extracted from seaweed have promising possibilities and play a significant role in the development of marine-based bioeconomy. In this study, the morphological characteristics of green seaweed, *Caulerpa lentilifera*was studiedin parallel withother studies such asassessing the effect of different treatments to the crude yield samples and the functional properties of the seaweed. The seaweed was sourced from different environmental conditions; the naturally grown (wild) seaweed, the locally-cultivated seaweedand the commercially-cultivatedseaweed.The employed techniques encompass rinsing, water washing, freeze drying, and grinding.Seaweed specimens were extracted using a rotary vacuum evaporator at 60°C, subjected to 4 different treatments (water ; 50% ; 70% ; 90% ethanol at 1:5 solid-solvent ratio). The results showed that the highest crude polysaccharide yield was recorded by the locallycultivated *C.lentilifera* at 80.95% while the wild seaweed recorded only 50.3%. In terms of treatments given, the highest crude polysaccharide yield was obtained when water was used as the solvent andthe minimum crude polysaccharide yield was obtained by the samples treated with 90% ethanol. In addition to that, the results indicate that the locally cultivated*C. lentillifera* exhibited significant differences in its functional properties compared to the wild species. The water activity and moisture content of the locally cultivated species were found to be 0.62 ± 0.00 and $20.29 \pm 0.90\%$. These values were observed to be higher than those of the wild species, which were measured at 0.47 ± 0.01 and $14.08 \pm 0.14\%$. Whereas the water holding capacity (26.54 ± 0.61 g/g DW), oil-holding capacity (8.39 ± 0.19 g/g DW) and swelling capacity

(17.83 ± 0.29 mL/g DW) of locally cultivated species reported higher than the wild species (17.12 ± 0.60 g/g DW, 6.24 ± 0.19 mL/g DW and 17.83 ± 0.29 mL/g, respectively). Additionally, the emulsion stability of the wild species exhibited a statistically significant increase (93.67 ± 0.38%) compared to the locally cultivated species (88.33 ± 0.72%).This study showed that the crude polysaccharide yield was inversely proportional to the high concentration of ethanol and revealed the ability of *C. lentillifera* to enhance the functional characteristics of processed foods thus yielding benefits and contribute to the socioeconomic advancement of Malaysian cultivators.

Keywords: seaweed biodiversity; polysachharide content; environment; taxonomy; functional property

INTRODUCTION

Seaweed, also known as marine macroalgae are autotrophic, eukaryotic, and multicellular organismswhich could grow up to 65 meters in length (Carreira-Casais et al., 2021).There are three major groups of seaweed based on their pigmentation which are brown seaweed (Phaeophyta), green seaweed (Chlorophyta), and red seaweed (Rhodophyta).This study is focusing on the green algae Chlorophyta. Sea grapes (*Caulerpa lentillifera* J. Agardh; Caulerpaceae, Bryopsidales) are green, siphonous macroalgae with a unique thallus structure and texture (Stuthmann *et al*., 2020). The colors of algae cells are the result of the composition of numerous photosynthetic pigments found in the cells. Thcolae pigment is similar to that of vascular plants, which contains chlorophylls a, b, and carotenoids as the primary photosynthetic pigments.

Taxonomically, the green algae are the most diverse group of photoautotrophic found in the biosphere with vast variation in form, size, and behavior. There are over 22,000 different types of green algae. Figure 1 shows the major division of marine macroalgae categorized as green, red, and brown macroalgae which belong to the Phyla Chlorophyta, Rhodophyta, and Phaeophyta respectively (Enamala et al., 2018).

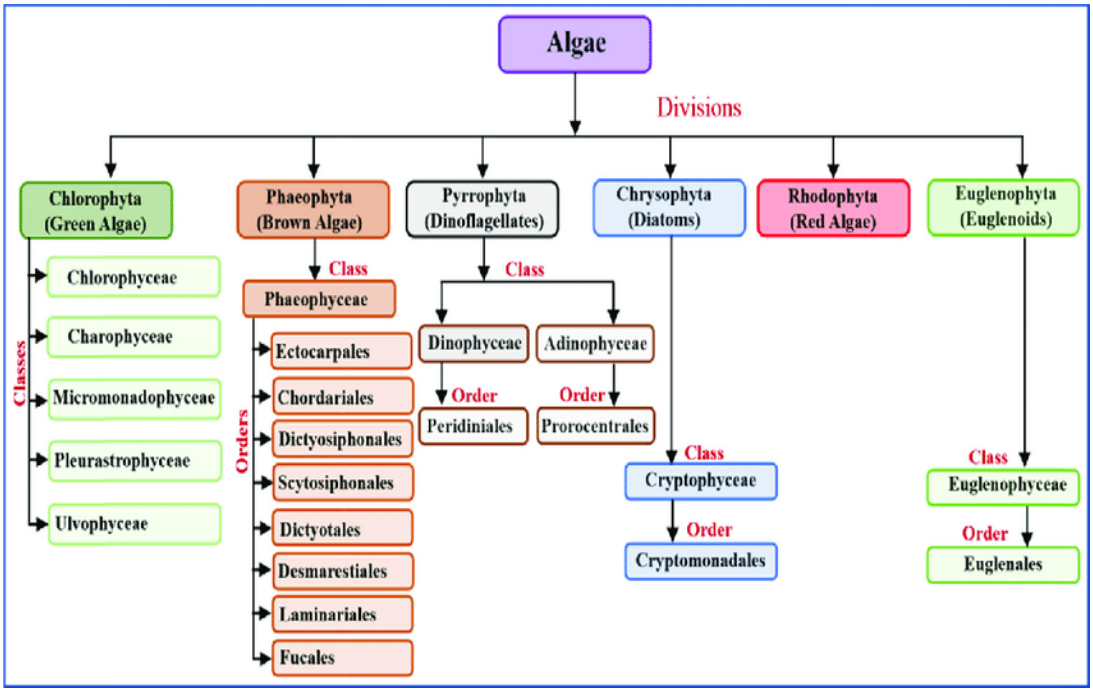


Figure 1: The major division of macroalgae (Enamala et al., 2018)

According to Tiwari & Troy (2015), aquaculture of seaweed is vital to the economy of the Asian region. In Malaysia, the annual revenue from the seaweed industry exceeds USD 14

million, accounting for nearly 50% of the nation's entire aquaculture output in 2020. Seaweeds can be obtained from either naturally growing (wild) or cultivated (farmed) crops. In contrast to cultivated or farmed seaweeds, seaweeds that grow naturally in the wild are sometimes referred to as wild seaweeds (Tiwari & Troy, 2015).*Caulerpa lentillifera* can be cultivated efficiently and sustainably due to its fragmentation-based propagation, low cost and simple needs (de Gaillande *et al*., 2016). Sea grapes are rich in polyunsaturated fatty acids, antioxidant activity, vitamins, minerals, and bioactive substances, making them a nutritious food source and a good alternative for contributing to food security, especially in tropical coastal locations (Stuthmann *et al*., 2020).Environmental conditions including water temperature, salinity, light, and nutrients, can affect the nutritional composition of seaweeds (Sinurat & Fadjriah, 2019).

The fundamental structural components of cell walls are polysaccharides, which are made up of many monosaccharide residues that are joined together by glycoside linkages. Polysaccharides, proteins, peptides, lipids, amino acids, polyphenols, and mineral salts in seaweed is usually high. Polysaccharides are available in numerous types, have a linear or highly branched molecular structure. Sulfated polysaccharides found in marine macroalgae are commonly applied in the cosmetics and pharmaceutical sectors. Blood coagulation, antiviral activity, antioxidant activity, and anticancer activity are all possible applications for seaweed-derived sulfated polysaccharides. Polysaccharides are able to bind water up to 20 times larger than their volume and this ability is closely related to the long and thick structure of the seaweed fiber particles (Sjamsiah *et al*., 2013). In addition to that, polysaccharides that have a high affinity for water (hydrocolloids) show unique functional properties such as gel properties and viscosity that play an important role in improving texture, gel formation and viscosity.Kumari *et al*. (2022) highlighted that the functional and nutritional properties of seaweed biomass and protein make it useful as a food additive or in functional foods. In the food industries, the usefulness of a product is determined by its water and oil holding capacity, foaming capacity, nitrogen solubility, and emulsifying stability. These functional properties are nonetheless contingent on several factors, including temperature, pH, and salinity (Suresh Kumar *et al*., 2014).

The objective of the study was to quantify the crude yield ofwild and cultivated *C. lentilifera*and to evaluate the moisture content, water activity, water holding capacity, oil holding capacity, swelling capacity and emulsion activity in freeze-dried seaweedpowder.

METHODOLOGY

The seaweed specimens,*C. lentilifera*was obtained from different environmental conditions listed below:

i) Thenaturally grown seaweed (wild seaweed) obtained from the coastal area of Port Dickson, located in the west coast of Malaysia.
ii) The locally cultivated seaweedobtained from the seaweed farm in Pulau Langkawi, an island on the north side of Malaysia.
iii) The commercially cultivatedseaweed purchased from a supplier,cultivated in the commercial farm from the neighbouring country.

Morphological observation

For the morphological analyses, around 10 cm stolons from each types of *C. lentillifera* were used for morphological observation. The seaweed samples was observed in terms of physical characteristics such as the number of branches, the size of fronds, the height of fronds, the

size of ramuli (singular : ramulus), the colour of ramuli and stolons and the smell of the thallus.

Extraction of crude polysaccharide extract

The seaweed was harvested on the same day, cleaned from any debris, air-dried, and transported to the laboratory by keeping the specimens in a clean container covered with kitchen towel to absorb any residue from transpiration of the fresh specimens. The specimens were then weighted before being placed (wet weight) in the oven dryerat 60^0Cfor drying process. The drying time iscontinued until constant weight are achieved. The dried specimens wereweighted and calculated to obtain the percentageof dry weight, using the following formula :

$$\text{Dry weight (\%)} = \frac{\text{Weight before (g)} - \text{Weight after (g)}}{\text{Weight before (g)}} \times 100$$

Dried seaweed specimenswereground using a home blender, sealed, and kept in refrigerator for subsequent analyses.In order to examine the efficiency of solvents in the extraction of seaweed specimens, the samples were treated with different types and concentration of solvent (water, 50%, 70 % and 90% ethanol). The mixture of the solvent and sample were prepared by using a 1:5 solid-solvent ratio. 10 g of dried *C. lentilifera* powderweremacerated in 50mL of the solventsfor 5 minutes and filtered using Whatman No 1 filter papers. The filtrates obtained were put in a round flask and further concentrated by rotary vacuum evaporator at 60°C to obtain crude polysaccharides extract. Theweight of round flask before and after extraction process were recorded. The yield of crude polysaccharides was calculated using the mass of crude polysaccharide obtained and the total mass of *C. lentilifera* powder as shown below:

$$\text{Crude polysaccharide yield (\%)} = \frac{\text{Mass of crude polysaccharide (g)}}{\text{Mass of } C.lentilifera \text{ powder (g)}} \times 100$$

Functional Properties

To study the functional properties, seaweed samples were cleaned with distilled water to ensure that the specimens are free of foreign particles and other contaminants. The samples were transferred in an empty bottle and weighed. Afterwards, the seaweed samples were freeze-dried in a Terroni Fauvel (model LH-1500) device for 3 days. The dried seaweeds were powdered using a multifunctional grinder. The powder seaweed was stored in desiccators at a room temperature until further analysis. Protocols to study the functional properties of *C. lentilifera* are described below:

A) Moisture content

The moisture content of the seaweed samples was determined by the following method of Muraguri *et al*. (2016). A dish and its lid were dried in the oven at 105 °C for three hours. It was then placed in a desiccator for cooling. The empty dish and lid were then weighed. Next, approximately 3 g of the freeze-dried *C. lentillifera* samples were weighted into the dish. The dish and sample were placed in the oven and dried at 105°C for three hours. After drying, the dish was moved to a desiccator with its lid partially covered. The weight of the dish and its dried sample were recorded in triplicate. Lastly, with the following formula, the moisture content of the seaweed samples was calculated.

$$\text{Moisture (\%)} = \frac{Weight\ of\ sample\ before\ drying\ (g)}{Weight\ of\ sample\ after\ drying\ (g)} \text{x } 100$$

B) Determination of water activity (a_w)

The water activity value of the freeze-dried seaweed samples (a_w) was measured using an AquaLab Water Activity System (Pullman Wash., USA) (Garcia-Vaquero *et al*., 2017). First, a portion of the *C. lentillifera* seaweed samples was transferred to a sample vessel, and the lid was replaced. The temperature of the sample was calibrated with room temperature. The water activity meter was set and operated in accordance with the manufacturer's instructions. The lid was removed from the sample vessel, and the samples were placed in the humidity chamber. Once the a_w meter began measuring (6-20 minutes), final readings were recorded once they stabilized.

C) Determination of emulsion activity (EA) and stability (ES)

The emulsion activity of the seaweed samples was based on the method of Muraguri *etal*. (2016). Approximately 2 g of the freeze-dried *C. lentillifera* samples were dissolved in 20 mL of distilled water, and the resulting suspension was vortexed for 10 minutes using (Vortex mixer model TM- 151 –Japan). At the fifth minute, 20 mL of corn oil was added while stirring continuously. The emulsion was centrifuged at 2100 rpm at 25 °C for 10 minutes with (Beckman CS-6 centrifuge). The volume of the emulsified layer was measured, and the emulsion activity formula shown below:

$$\text{EA}(\%) = \frac{Volume\ of\ emulsified\ layer\ (mL)}{Volume\ of\ the\ suspension\ (mL)} \text{ x } 100$$

To determine the emulsion stability (ES), the previously prepared emulsions were heated at 85°C for 15 minutes, cooled at room temperature for 10 minutes and centrifuged again at 1100 x g for 5 minutes. The ES was expressed as the % of ES remaining after centrifuging as follows:

$$\text{ES}(\%) = \frac{Volume\ of\ eemulsionafterheatingr\ (mL)}{Volume\ of\ originalemulsion\ (mL)} \text{ x } 100$$

D) Determination of water holding capacity

The water-holding capacity of the seaweed samples was measured using a modified centrifugation technique by Kumar *et al*. (2021). In brief, 200 mg of freeze-dried *C. lentillifera* samples were mixed with 20 mL of deionized water in a centrifuge tube. The tubes were kept for 24 hours at 25°C and 37°C in an incubator shaker (New Brunswik Scientific, Eppendorf AG, Germany). The sample were centrifuged (Sigma 3-18KS, Germany) for 30 minutes at 14 000 g and 37°C, and the supernatant was discarded. Both wild and cultivated *C. lentillifera* had their wet weights recorded. The samples were then placed in an oven at 120°C for two hours before their dry weight has been determined. The WHC of samples were calculated by the following formula:

$$\text{WHC} = Wet\ weight\ of\ sample\ (g) - Dry\ weight\ of\ sample\ (g)$$

(WHC was expressed as weight in grams of water held by 1 g of dried sample)

E) Determination of oil holding capacity (OHC)

The Oil Holding Capacity (OHC) of the seaweed samples was determined following the methodology proposed by Kumar et al. (2021). In a centrifuge tube, 3 g of freeze-dried *C. lentillifera* were mixed with 10.5 g of corn oil. The tubes were shaken in a shaker for 30 minutes at room temperature, followed by 30 minutes of centrifugation at 2500 g, and the oil supernatant was collected. OHC was computed using the formula below:

$$\text{OHC} = (Initial\ volume\ of\ oil\ (g) - Volume\ of\ oil\ after\ incubation\ (g)$$

(The OHC was expressed as number of grams of oil held by 1 g of dried seaweed)

F) Determination of swelling capacity

The Bed volume technique was used to evaluate the swelling capacity of the seaweed samples (Kumar *et al*., 2021). In brief, 200 mg of freeze-dried *C. lentillifera* were added into 20 mL of deionized water and vigorously stirred. The temperature effect on SWC was subsequently assessed by subjecting tubes to 25°C and 37°C for 24 hours. The SWC of the seaweeds were determined using the following formula:

$$SWC = Initial\ volume\ of\ water\ (mL) - Volume\ of\ water\ after\ incubation(mL)$$

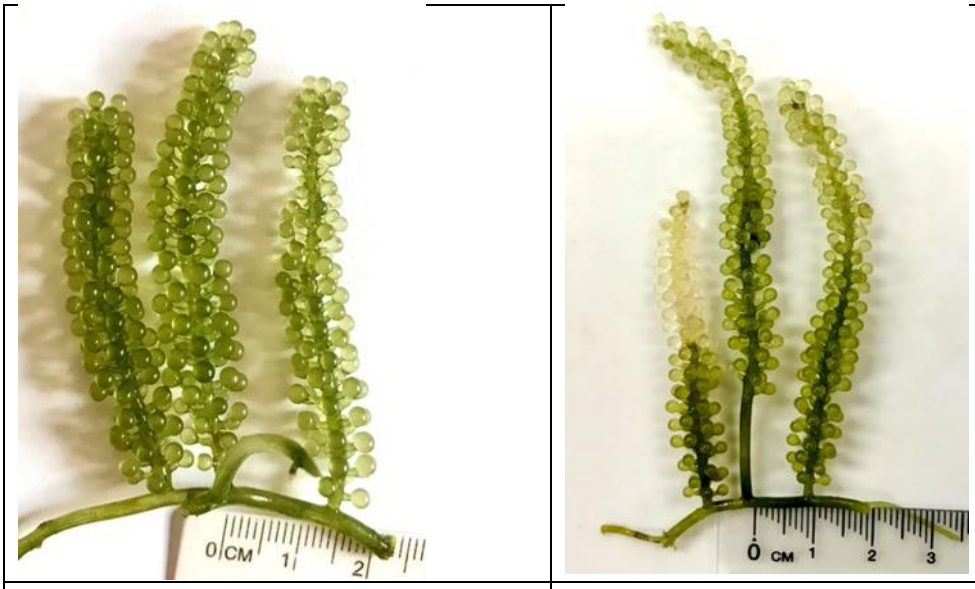
(The SWC was expressed as mL of swollen sample per gram of sample dry weight)

All experiments were conducted in triplicates and the results were reported as mean ± standard deviation of measurements. Paired sample t-test was performed to compare the functional properties between two species of *C. lentillifera*. IBM SPSS Statistic 22 Software and Duncan's test were used to assess significant differences. A positive significant variation between wild and cultivated species was defined at the significance level of $p < 0.05$.

RESULTS AND DISCUSSION

The Morphology of*C. lentilifera*of local and commercial cultivation

The results showed that commercially cultivated *C. lentilifera*showed more branches, larger in size, and higher than locally cultivated *C. lentilifera***(Figure2)**. The height of commercially cultivated *Caulerpa lentilifera* ranges from5 to 12 cm while the height of locally cultivated seaweed ranges from 3 to 11 cm. Both types of local *C. lentilifera* (wild and cultivated) showed smaller ramuli, crushed, and had bright and darkish fronds. On the other hand, thecommercially-cultivated *C. lentilifera*appeared glossy and viscous external appearance and have a natural fishy odour.



(A) (B)

Figure 2: Freshspecimens of green seaweed, *Caulerpa lentilifera*obtained from different environmental conditions : (A) commercially cultivated and (B) locally cultivated

The increases in stolons and branches in local *C. lentilifera*represented the growth of the sea grapes. This type of short and highlybranched thallus development with highlybranched ramets is known as the compact growth formand it represents the growth under greater light

conditionssuch as in an exposed area (Collado-Vides& Robledo, 2002). It is also an adaptable characteristic that can avoid self-shading and allow a wide distributional range for commercially and locally cultivated*C. lentillifera.Caulerpa lentilifera* thrive in the natural environment which in shallow, clean waters with quiet streams. The presence of *Caulerpa lentilifera* in the waters implies acceptable water quality with sufficient light intensity which is the basic prerequisite of environmental parameters for *Caulerpa lentilifera.*

Yield of crude polysaccharides

A single factor experiment was conducted on the seaweed specimen to obtain the crude polysaccharide yield. This experiment focuses on the effect of the types of solvent to the total yield of crude polysaccharides obtained from the commercially cultivated and locally cultivated*Caulerpa lentilifera*. As shown in Figure 3, the yield of crude polysaccharides from both commercially and locally cultivated *C.lentilifera* dropped as the concentration of ethanol increased. The maximum crude polysaccharide obtained are 80.95% and 50.3% when water was used as the solvent to macerate and precipitate the powder of *C. lentilifera* from commercially cultivated and locally cultivated, respectively. However, the minimum crude polysaccharide yield obtained when using 90% ethanol as the solvent is 61.40% for commercially cultivated *C. lentilifera* and 12.7% for locally cultivated *C. lentilifera*.

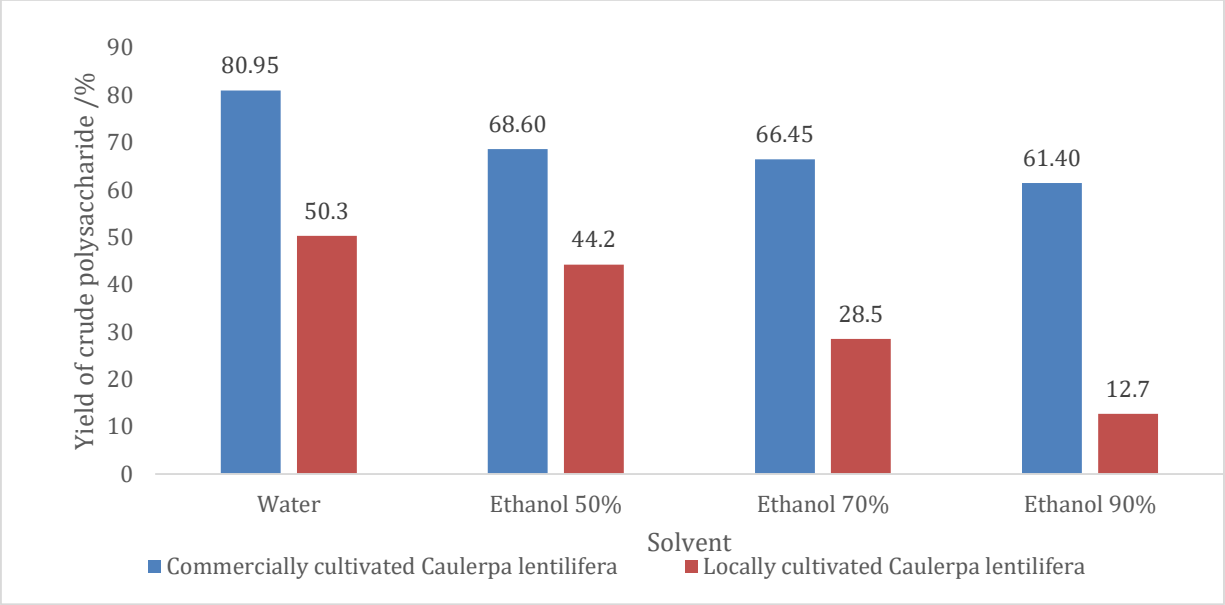


Figure 3 : The effect of different solvents on crude polysaccharide from commercially and locally cultivated *C.lentilifera*

90%ethanol is commonly used toseparate the main polysaccharides and remove the low molecular substances such as lipids from commercially and locally cultivated*C. lentilifera*. The analytical justification seems to be that ethanol has higher volatility, polysaccharides content may be emitted and vaporized into the air before and during the rotary evaporator vacuum process.This study proved that the crude polysaccharide yield was inversely proportional to the high concentration of ethanol. Thus, water as the solvent is the best choice in this experiment to assure maximum crude polysaccharide yield in both commercial and local*C. lentilifera*.

Water Activity And Moisture Content

Based on the result obtained in Table1, both of the *C. lentillifera*recorded a low water activity a_w (below 0.65 for all samples). The wild species recorded a lower value of water activity which is at 0.47 a_w than cultivated species (0.62 a_w). This is expected as there is a linear relationship between moisture content and water activity, where higher moisture content leads to higher water activity.

Table 1 Water activity and moisture content of wild and cultivated species of *C. lentillifera*

Seaweed	Water Activity (a_w)	Moisture Content (%)
Wild	0.47 ± 0.01^{B}	14.08 ± 0.14^{B}
Cultivated	0.62 ± 0.01^{A}	20.29 ± 0.90^{A}

Note: Values are mean ± standard deviation, n = 3 on dry weight basis. $^{A-B}$ values with different superscripts of capital letter within the same column are significantly different between samples ($p<0.05$)

In accordancewith water activity, the total moisture content of *C. lentillifera* was found to besignificantly higher for wild specimens at14.08 ± 0.14% and higher for cultivated species *C. lentilifera* at 20.29 ± 0.90% for. The obtained results were consistent with the findings of Shanmuga *et al*. (2018), which reported yields ranging from 8% to 29% of moisture content in *Caulerpa*. Findings from Catarino et al., (2023) also reported similar findingsto the current study and that of Shanmuga et al. (2018). It is worth noting that the study from Catarino et al., (2023) are based on the analysis of the moisture content and dry matterof specimens from the wild and cultivated *Sargassum polyschides*. The results indicated that the wild species exhibited a significantly greater dry matter content compared to the cultivated species, with values of 14.7 ± 0.1% and 9.9-10.7% DW, respectively. Therefore, the naturally grown (wild) seaweed showed a lower value for water activity while being within the optimal moisture content range, indicating that it still has the potential to be used as functional food with a longer shelf life.

Water holding capacity (WHC) and oil holding capacity (OHC)

The results presented in Table 2 indicate that the water holding capacity (WHC) of wild *C. lentillifera* was measured to be 17.12 ± 0.60 g/g DW, whereas the cultivated specimens exhibited a significantly higher value at 26.54 ± 0.61 g/g DW. Both of these values exceeded the reported value of 13.75 ml/g DW for brown seaweed, *Sargassum oligocystum*, as stated by Muraguri *et al*. (2016) and *Eucheuma denticulatum* (17.7 ml/g DW), as documented by Senthil *et al*. (2005). Moreover, the seaweed species exhibited a WHC that was marginally greater than the reported range for commercial dietary fibre supplements (6.60-9.00 ml/g DW) as documented by Chan & Matanjun (2017).The high water absorption capacity of proteins plays a crucial role in mitigating moisture loss in viscous food products such as soups, dough and baked goods.This property allows proteins to absorb water without undergoing protein dissolution, resulting in the desired attributes of body, thickening, and viscosity (Suresh Kumar *et al*., 2014). The water holding capacity of food proteins is influenced by intrinsic factors such as the composition of amino acids, the conformation of proteins, and the polarity/hydrophobicity of their surface. The significant water holding capacity exhibited by the cultivated species of *C. lentillifera* indicates its suitability for inclusion in a variety of culinary preparations that necessitate moist ingredients.

Table 2 Results of water holding capacity and oil holding capacity of wild and cultivated *C. lentillifera*

Seaweed	Water Holding Capacity (g/g)	Oil Holding Capacity (g/g)
Wild	17.12 ± 0.60^{B}	6.24 ± 0.19^{B}
Cultivated	26.54 ± 0.61^{A}	8.39 ± 0.19^{A}

Note: Values are mean ± standard deviation, n = 3 on dry weight basis. $^{A-B}$ values with different superscripts of capital letter within the same column are significantly different between samples ($p<0.05$

According to the findings of this study, the oil holding capacity (OHC) of the wild *C. lentillifera* (6.24 ± 0.19 g/g DW) was observed to be lower compared to that of the cultivated *C. lentilifera*(8.39 ± 0.19 g/g DW). However, both values were significantly higher than the reported OHC values for other seaweed species, namely *Sargassum* sp. (3.18 ± 0.16 g/g DW) and *Kappaphycus alvarezi* powder (5.11 ± 0.36 g/g DW) (Nurshahida *et al*., 2018; Kumari *et al*., 2022). In this study, it was observed that the OHC of wild species *C. lentillifera* was slightly greater than that of the protein concentrate of *Himanthalia elongata* (8.1 ± 0.07 g oil / g) as reported by and Kumari *et al*. (2022).

The effective interactions between water, oil, and proteins have indirect implications on the sensory attributes such as flavour and texture of various food products. Nevertheless, it is crucial to acknowledge that the protein conformation and hydrophobicity are significantly influenced by various food processing methods. The capacity of retaining oil is imperative in determining the preservation of flavour, whereas the attributes of additives for stabilising fat emulsions are primarily characterized by the capacity and stability in forming emulsions with fat (Chan & Matanjun, 2017). This study also showed that the freeze-dried *C. lentillifera* exhibited satisfactory water-holding and oil-holding capacities, thus making it a viable option for various food applications, including water retention and texture enhancement. It could also be employed for enhancing the viscoelastic properties of food formulations. Hence, it can be concluded that cultivated species of *C. lentillifera* exhibit greater suitability in comparison to wild species, due to their greater values in terms of both WHC and OHC.

Emulsion stability and swelling capacity

This study showed that stable emulsions were formed for the wild *C. lentilifera*at 93.67% ± 0.38, while the cultivated *C. lentilifera* exhibited a significantly lower value at 88.33% ± 0.72 (Table 3). According to Gbadamosi *et al*. (2012), it has been reported that the emulsifying action of an emulsion is primarily attributed to the hydrophobic lipid components. The protein content of both species was found to be higher compared to the protein content in lupin seed (60%) and soya bean (70%) extracts, which are commonly used as emulsifiers in the food industry (Muraguri *et al*., 2016). Therefore, this study found that *C. lentillifera* exhibited exceptional emulsion stability of with corn oil, as the obtained values surpassed those reported in other studies. This observation holds significant importance in terms of how it can be used as an emulsifier. It further concludes that wild *C. lentillifera* exhibit greater suitability compared to cultivated species, due to higher emulsion stability.

Table 3 Results ofemulsion stability and swelling capacity of wild and cultivated species of *C. lentillifera*

Seaweed	Emulsion Stability (%)	Swelling Capacity (mL/g)
Wild	93.67 ± 0.38^{A}	17.83 ± 0.29^{B}
Cultivated	88.33 ± 0.72^{B}	5.33 ± 0.29^{A}

Note: Values are mean ± standard deviation, n = 3 on dry weight basis. $^{A-B}$ values with different superscripts of capital letter within the same column are significantly different between samples ($p<0.05$

In relation to the swelling capacity (SWC), it was observed in Table 3 that the cultivated *C. lentillifera* exhibited a significantly greater value (17.83 ± 0.29 mL/g DW) compared to the wild *C. lentilifera* (5.33 ± 0.29 mL/g DW).Kumar *et al*. (2021) also observed comparable findings, indicating that the swelling capacity (SWC) of *Sargassum wightii* and *Ulva rigida* was measured at 15.89 ± 0 mL/g DW. In comparison to other research, the wild species of *C. lentillifera* had a mean value of 17.83 ± 0.29 mL/g DW, which suggested good swelling capacity.

Swelling capacityrefers to the capacity of a substance to absorb and retain water, leading to an expansion in its dimensions or overall volume. Notably, the cell wall of *Caulerpa lentillifera*, primarily consists of polysaccharides, one of the components of this study. Honwichit *et al*. (2022) in his recent study, reported that once soaked, the polysaccharides in seaweed would establish interactions with water molecules via hydrogen bonding and electrostatic interactions. This process results in the uptake of water into the cellular matrix of the seaweed, resulting in its expansion. Polysaccharides function as hydrophilic substances, exhibiting a high capacity for water absorption and retention in proportion to their own mass.

CONCLUSION AND RECOMMENDATION

In conclusion, the crude yield of locally cultivated *C. lentilifera*was significantly higher compared to the naturally grown (wild) seaweed. Thehighest crude polysaccharide yield was obtained when the seaweed specimens were treated with water as the extraction solvent. This study also concluded that the cultivated *C. lentillifera* exhibited outstanding functional properties that are comparable to those of other seaweed species studied in other studies over the years. It is evident in the significantly higher values in various functional properties, including water activity,moisture content, water holding capacity, oil holding capacity, emulsion capacity and swelling capacity, all of whichwouldcontribute to the potential application of *C. lentilifera* in bio-economy.

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