Original Article

Seaweeds from Mauritius as a source of bioactive compounds

Vellen Ramsamy[1], Bhuvaneshwaree Surroop[1], Nadeem Nazurally[1,2]*

[1] Department of Agricultural and Food Science, Faculty of Agriculture, University of Mauritius, Réduit, Mauritius, 80837

[2] Faculty of Fisheries, Hokkaido University, Japan, 060-0817

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* **Corresponding author:**
n.nazurally@uom.ac.mu

Abstract

Mauritius boasts a highly diverse marine ecosystem, with 435 seaweed species. However, limited research has been conducted on their bioactive potential. This study assessed the antioxidant, anti-*Candida albicans*, and anti-*Staphylococcus aureus* activities of four seaweed species: *Caulerpa racemosa*, *Boodlea* sp., *Chondrus crispus* and *Padina gymnospora*. Specimens were collected on the structures of a marine fish farm and macerated with five solvents: methanol, ethanol, acetone, dichloromethane, and deionized water. Antioxidant activity was measured using the 2,2-diphenyl-1-picrylhydrazyl assay, while minimum inhibitory concentrations (MICs) were evaluated using the broth microdilution method. Acetone and methanol yielded the highest extract concentrations (up to 77.7 mg/mL). Antioxidant activity varied significantly by species and solvent, with the strongest activities observed in the acetone extract of *Boodlea* sp. ($\hat{\psi}$ = 1.55 %; p = 0.030) and the methanolic and dichloromethane extracts of *P. gymnospora* ($\hat{\psi}$ =44.70% and 23.94 %). All species, except *C. racemosa*, exhibited antifungal activity, with ethanol and dichloromethane extracts of *P. gymnospora* the most effective (25 mg/mL and 37.5 mg/mL, respectively). *C. crispus* showed the highest antibacterial activity, especially in its acetonic extract (MIC = 20.8 mg/mL). Deionized water extracts showed no antimicrobial activity. These results highlight the pharmaceutical potential of Mauritian seaweeds and the need for further bioactivity research.

Keywords: Seaweeds, Mauritius, Antioxidant, Antimicrobial, *Staphylococcus aureus*, *Candida albicans*

Introduction

Seaweeds or macroalgae are multicellular algae, classified into three major classes: Chlorophyceae (green algae), Rhodophyceae (red algae), and Phaeophyceae (brown algae) (Pereira, 2021). These species are essential components of marine ecosystems with various roles, as habitats for a range of invertebrates, as the base of food chains, in nutrient recycling and coastal protection (Cotas *et al*., 2023). As photosynthetic organisms, they are involved in oxygen generation, carbon dioxide reduction, and carbon storage, assisting in climate change mitigation (Ross *et al*., 2023). While they are well known in the food industry (García-Poza *et al*., 2022), in aquaculture (Chopin and Tacon, 2021) and more recently in agriculture as fertilizers (Dang *et al*., 2023), their pharmaceutical potential is less well known. In fact, some studies have shown that seaweeds do possess a diverse range of pharmaceutical potentials, such as cytotoxicity, antioxidant and anti-inflammatory (El-Sheekh *et al*., 2023; Lomartire and Gonçalves, 2022; Baghel *et al*., 2023). This capacity is the result of chemical constituents such as phenolic compounds, flavonoids, terpenes, pigments, and polysaccharides that they possess and can produce as protection from harsh and changing environments (Cotas *et al*., 2024). Although there are no FDA-approved drugs made from seaweeds yet, their potentials has long been recognized in traditional Chinese medicine for years (Liu *et al*., 2020).

Under normal physiological conditions, the human body generates free radicals, including reactive oxygen species (ROS) and reactive nitrogen species (RNS), which are typically regulated by endogenous

antioxidants (Jîtcă *et al.*, 2022). However, when the production of free radicals exceeds the body's antioxidant capacity, an imbalance occurs, leading to oxidative stress associated with the development of various diseases such as cardiovascular and neurological disorders, as well as cancer (Jomova *et al.*, 2023). This has intensified the search for external sources of antioxidants. Marine organisms, particularly seaweeds, have evolved effective antioxidant defense mechanisms to adapt to the challenging conditions of their environment. Numerous studies have highlighted the antioxidant potential of seaweed which is attributed to their diverse biochemical composition (Kumar *et al.*, 2021; Begum *et al.*, 2021; Hejna *et al.*, 2024).

antimicrobials (Cotas *et al.*, 2024). Seaweeds are one of the marine species that has been shown to possess a range of bioactive compounds with antimicrobial potential against various pathogens, including both microbes mentioned (Richardson, 2022; Ganeshkumar *et al.*, 2020; Gomes *et al.*, 2022).

Mauritius is an island located in the Indian Ocean, 855 kilometers east of Madagascar, between longitudes 57°16' and 57°49' east, and latitudes 19°58' and 20°34' south. With an Exclusive Economic Zone (EEZ) of 2.3 million square kilometers and a diverse marine ecosystem, the island is highly dependent on its marine resource, which also includes 435 seaweed species (59

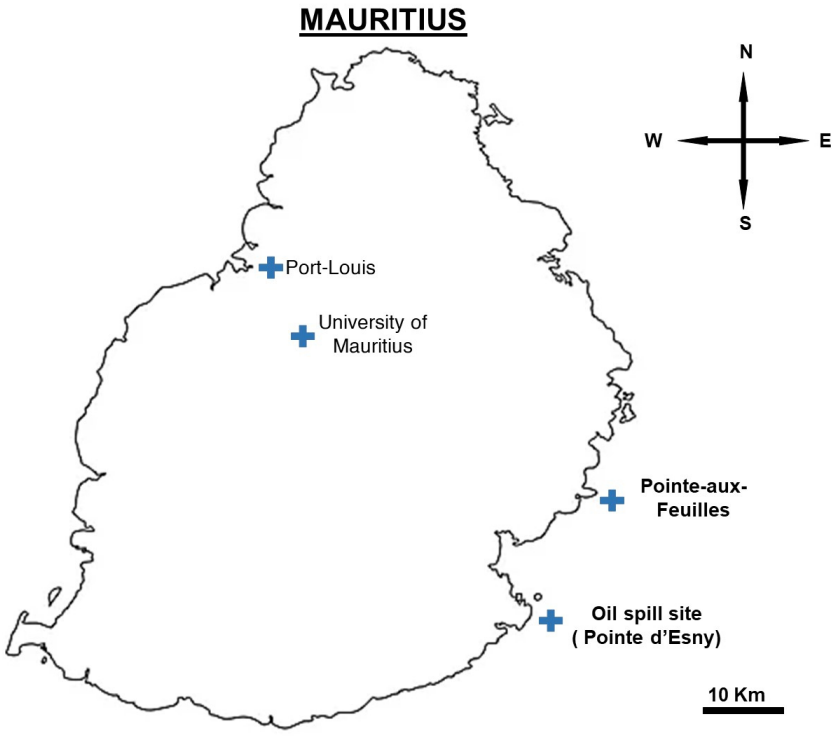


Figure 1. Mauritius in the Indian Ocean and site of sample collection.

Antimicrobial resistance is an issue that continues to pose a threat to humanity, resulting in an estimated 10 million deaths annually by 2050 (Naghavi *et al.*, 2024). In 2019 alone, *Staphylococcus aureus*, responsible for various diseases, including skin infections, osteomyelitis, pulmonary infections, and toxic shock syndrome, was associated with more than 1 million deaths (GBD Antimicrobial Resistance Collaborators, 2022). Similarly, approximately 150 million mucosal infections and 200,000 deaths are caused by the fungus *Candida albicans* (Richardson, 2022). One way to deal with this issue is to tend towards new sources of

brown, 108 green and 268 red algae) (EDB Mauritius, 2022; Nazurally *et al.*, 2022). The potential of seaweeds is mostly being explored commercially as fertilizers and in aquaculture (Msuya *et al.*, 2022; Nazurally *et al.*, 2022; United Nations Mauritius, 2023). While studies on their antioxidant potential are limited and their antimicrobial properties have not yet been explored, other marine species such as parrotfish, seagrasses and marine bacteria have been studied in this area (Nazurally *et al.*, 2023; Surroop *et al.*, 2024; Aullybux *et al.*, 2022). Therefore, this study aimed to investigate the antioxidant, anti-candidal, and anti-staphylococcal

potentials of four selected seaweed species, representing the three major categories of seaweeds. Additionally, it seeks to identify the most effective solvents for extracting these bioactive compounds.

Materials and methods

Site description and seaweed collection

The four seaweeds *Caulerpa racemosa*, *Boodlea* sp. (Chlorophyta), *Chondrus crispus* (Rhodophyta) and *Padina gymnospora* (Ochrophyta) were collected at Pointe aux Feuilles, which is located on the east coast of Mauritius (Fig. 1) from the ropes of an operational fish farm. Pointe aux Feuilles covers an area of 20 km² and is known for the fish aquaculture farm present, coral nurseries, as well as a tourism attraction and a fishing site (IUCN Tech4Nature, 2021). The species were identified using their morphological traits as described in previous literature (Kalasariya, 2019; Jagtap, 1993) and transported to the University of Mauritius with seawater in ziplock bags, under ice-cold conditions of 4 ^{0}C, to prevent sample deterioration. In the laboratory, the samples were immediately and thoroughly washed with distilled water to remove debris and sand, weighed, and then stored at -70 °C.

Solvent extraction

Two hundred grams of pre-weighed seaweed (wet weight) were freeze-dried and ground into fine powder. The powder was allowed to macerate for four hours with five solvents separately (80 % methanol, 80 % ethanol, 80 % acetone, 80 % dichloromethane and deionized water), in a ratio of 1:10, at 200 rpm on an orbital shaker. The mixture was then centrifuged at 1400 rpm for 20 minutes, and the supernatant was decanted and stored in a vial at 4 °C (Ling *et al*., 2015).

Antioxidant activity: DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging assay

For the DPPH assay, the method used by Nazurally *et al.* (2023) and Bhowany *et al.* (2025) was utilized with some modifications, with ascorbic acid as the standard. One mL of freshly prepared 0.3 mM of DPPH solution was added to 2.5 mL of 10 mg/mL seaweed extracts, or ascorbic acid. The mixtures were allowed to react in the dark at room temperature for 30 minutes and then their absorbance was read at 518 nm. The percentage of DPPH radical scavenging activity was then calculated through the following equation:

DPPH scavenging activity % = ((absorbance of the control − absorbance of the sample) / absorbance of the control) × 100

Antibacterial and antifungal activity: Minimum Inhibitory Concentration (MIC) determination

The broth microdilution method, adapted from Palaniyappan *et al*. (2023) and Surroop *et al.* (2024), was used to determine the MIC of the seaweed extracts against *Staphylococcus aureus* and *Candida albicans*. Pure cultures of the microorganisms were obtained from the Botany laboratory of the University of Mauritius. The microbial suspensions were cultured for 24 hours and adjusted to a 0.5 McFarland turbidity standard.

One hundred µL of Mueller-Hinton broth (for *S. aureus*) or Sabouraud Dextrose broth (for *C. albicans*) was added to each well in sterile 96-well microtiter plates. Seaweed extracts (50 mg/mL) were added to the first row and serially diluted two-fold to obtain final concentrations ranging from 50 to 1.563 mg/mL. Then 100 µL of microbial suspension was added to each well. Three replicates of each plate were carried out.

Negative controls included the solvents and broths only, while positive controls were chloramphenicol (antibacterial) and nystatin (antifungal). Plates were incubated at 37 °C for 24 hours, followed by the addition of 20 µL of 0.2 mg/mL INT (iodonitrotetrazolium chloride) to each well. Plates were further incubated at 37 °C for 30 minutes. A red color indicated microbial growth, while a yellow color signified growth inhibition, indicating the MIC.

Statistical analysis

All experiments were performed in three replicates using a completely randomized factorial design. Results were expressed as means and initially recorded in Microsoft Excel. Statistical analysis was conducted using Jamovi software (Jamovi, 2025). Due to violations of normality and homogeneity of variance, a robust ANOVA was applied to assess differences in antioxidant and antimicrobial activities. Bootstrap post-hoc tests (599 samples) were used to evaluate the main effects of species and solvents, as well as their interaction effects on antioxidant activity. A 5 % significance level ($p < 0.05$) was used for all analyses.

Results

Concentration of extracts

The concentrations of seaweed extracts ranged from 52.3 to 77.7 mg/mL, with the lowest yields obtained using deionized water. Acetone yielded the highest extract concentrations for *Boodlea* sp. (72.2 mg/mL), *P. gymnospora* (76.1 mg/mL), and *C. crispus* (76.6 mg/mL), while methanol was most effective for *C. racemosa*, producing the highest concentration of 77.7 mg/mL (Fig. 2).

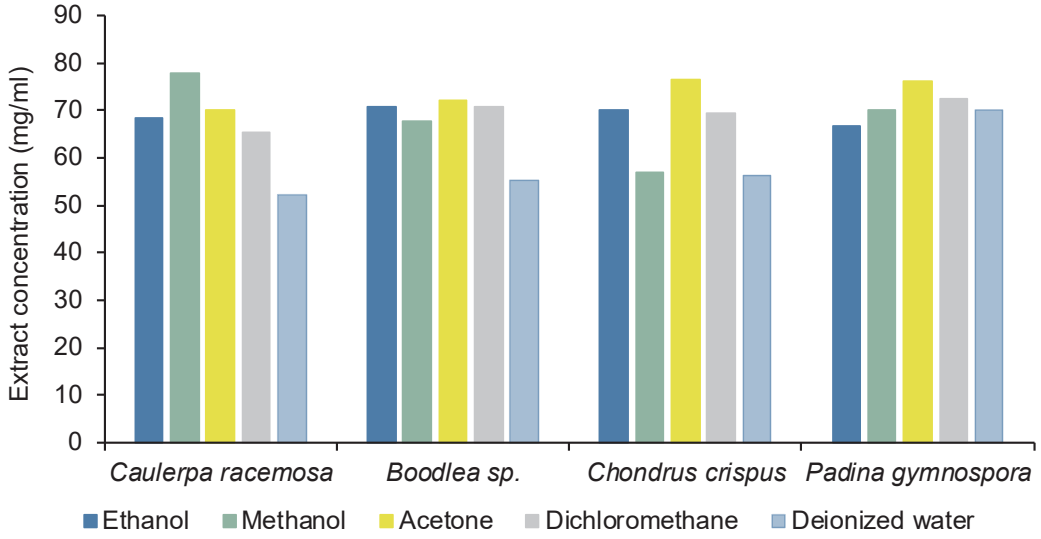


Figure 2. Concentration of seaweed extracts.

Antioxidant activities of seaweed extracts

Figure 3 illustrates the DPPH (2,2-diphenyl-1-picryl-hydrazyl) radical scavenging activities of the seaweed extracts, which varied widely depending on the species and the solvent used. The antioxidant activity ranged from 8.54 ± 2.75 % for *C. crispus* extracted with deionized water to 65.69 ± 2.58 % for *P. gymnospora* extracted with ethanol, indicating substantial variability in extract efficacy. The statistical analysis revealed significant differences in antioxidant activities among the seaweed species. *Boodlea* sp. exhibited the highest antioxidant activity, significantly outperforming *C. racemosa* and *C. crispus*, with robust mean differences of 87.09 % and 69.08 %, respectively. Similarly, *P. gymnospora* demonstrated significantly higher antioxidant activity than *C. racemosa* and *C. crispus*, with robust mean differences of 75.75 % and 57.75 %, respectively. Overall, *Boodlea* sp. and *P. gymnospora* showed the most potent antioxidant activities among the tested seaweeds (Table 1).

Significant differences in the main effects of solvents were observed (Table 2). Ethanol was the most effective solvent, producing significantly higher DPPH activity compared to all other solvents. It was followed by acetone, methanol, and dichloromethane, while deionized water consistently resulted in the lowest antioxidant activities. Specifically, ethanol showed significantly greater activity than acetone and dichloromethane, with robust mean differences of 50.60 % and 118.31 %, respectively. Acetone also outperformed

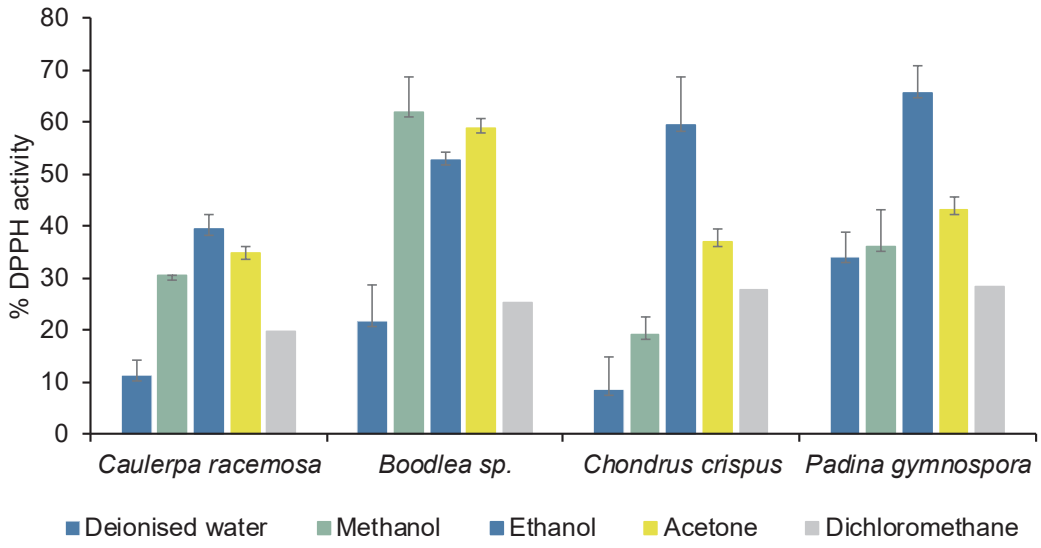


Figure 3. DPPH activities of seaweed extracts.

Table 1. Post Hoc Tests: Main effect of seaweed species on DPPH activity.

				95 % Confidence interval	
		psi-hat	p	Lower	Upper
Boodlea sp.	*Caulerpa racemose*	87.09	<.001	43.83	129.48
	Chondrus crispus	69.08	<.001	27.39	110.27
	Padina gymnospora	11.33	0.212	-20.34	43.95
Caulerpa racemose	*Chondrus crispus*	-18.00	0.177	-64.05	25.10
	Padina gymnospora	-75.75	<.001	-106.95	-40.98
Chondrus crispus	*Padina gymnospora*	-57.75	<.001	-92.20	-27.87

dichloromethane (by 67.71 %), and methanol was more effective than dichloromethane (by 46.57 %).

Significant effects of species–solvent interaction on DPPH activities were observed (Table 3). Notably, the use of deionized water with *Boodlea* sp. and *C. crispus* resulted in markedly lower antioxidant activities, with robust mean reductions of 23.76 % and 29.56 %, respectively. Interestingly, *P. gymnospora* extracted with ethanol also exhibited reduced antioxidant activity (–28.63 %), despite ethanol's overall superior performance. In contrast, several seaweed-solvent combinations yielded significantly higher antioxidant activity compared to other combinations. These included *C. crispus* with dichloromethane (+49.39 %), *P. gymnospora* with methanol (+44.70 %), *C. racemosa* with methanol (+25.31 %), *P. gymnospora* with dichloromethane (+23.94 %), *C. crispus* with acetone (+15.14 %), and *Boodlea* sp. with acetone (+1.55 %).

In summary, optimal solvent-seaweed combinations for antioxidant extraction were species-specific. Acetone was the most effective solvent for *Boodlea* sp., methanol was best suited for *C. racemosa* and *P. gymnospora*, while dichloromethane yielded the highest antioxidant activity for *C. crispus*.

Antibacterial activity

The minimum inhibitory concentration (MIC) was significantly influenced by both the seaweed species and the solvent used for extraction, as determined by a robust ANOVA ($p < 0.01$). MIC refers to the lowest concentration of an extract required to inhibit microbial growth, with lower MIC values indicating stronger antibacterial activity. All seaweed extracts, except those extracted using deionized water, demonstrated significant antibacterial activity against *S. aureus*. Among the seaweeds tested, *C. racemosa* exhibited the weakest antibacterial activity, with MIC values of 50 mg/mL across all solvent extractions except for deionized water, where no activity was observed.

The most potent antibacterial activity was observed in *C. crispus* extracts, particularly when acetone was used as the solvent (MIC = 20.8 mg/mL). Ethanol and methanol extracts of this species also exhibited strong antibacterial effects, with MIC values of 25 mg/mL. In contrast, the dichloromethane extract showed the lowest activity among the *C. crispus* extracts. For *Boodlea* sp., the strongest antibacterial activity was found in the ethanol and methanol extracts (MIC = 25 mg/mL), followed by dichloromethane (MIC = 37.5 mg/mL), with acetone yielding the weakest effect (MIC = 50 mg/mL).

Table 2. Post Hoc Tests: Main effects of solvent on DPPH activity.

				95 % Confidence interval	
		psi-hat	p	Lower	Upper
Deionised water	methanol	-69.70	<.001	-105.52	-41.23
	ethanol	-141.44	<.001	-177.06	-99.83
	acetone	-90.84	<.001	-129.43	-65.82
	dichloromethane	-23.13	<.001	-38.96	-14.74
Methanol	ethanol	-71.74	<.001	-114.94	-16.18
	acetone	-21.14	0.095	-69.45	14.49
	dichloromethane	46.57	<.001	17.62	74.21
Ethanol	acetone	50.60	0.013	-6.75	85.67
	dichloromethane	118.31	<.001	73.96	144.16
Acetone	dichloromethane	67.71	<.001	41.66	102.24

Table 3. Post Hoc Tests: Seaweed and solvent interaction effects on DPPH activity.

				95 % Confidence interval	
		psi-hat	p	Lower	Upper
Boodlea sp.	deionized water	-23.76	0.018	-50.44	5.60
	methanol	-5.78	0.389	-23.73	18.37
	ethanol	-21.33	0.115	-35.91	13.97
	acetone	1.55	0.030	-0.24	12.58
	dichloromethane	17.97	0.104	-15.19	52.89
Caulerpa racemose	deionized water	2.42	0.321	-31.98	54.89
	methanol	25.31	<.001	3.69	53.50
	ethanol	-15.55	0.217	-44.75	28.18
	acetone	7.34	0.232	-9.08	26.79
	dichloromethane	22.89	0.072	-4.69	38.17
Chondrus crispus	deionized water	-29.56	<.001	-49.91	-12.52
	methanol	19.83	0.053	-8.45	43.02
	ethanol	-8.81	0.222	-36.62	15.77
	acetone	15.14	<.001	8.75	21.73
	dichloromethane	49.39	<.001	13.60	80.83
Padina gymnospora	deionized water	20.76	0.067	-14.41	55.99
	methanol	44.70	<.001	30.96	61.95
	ethanol	-28.63	0.038	-69.95	9.49
	acetone	-4.69	0.285	-24.59	19.76
	dichloromethane	23.94	<.001	2.76	47.77

P. gymnospora exhibited the greatest antibacterial activity with ethanol and dichloromethane extracts (both with MIC = 25 mg/mL), whereas methanol and acetone extracts showed reduced activity (MIC = 50 mg/mL). As expected, the positive control, chloramphenicol, exhibited the highest antibacterial efficacy, with an MIC value of 1.563 mg/mL. (Fig. 4)

Antifungal activity

All seaweed species, with the exception of *C. racemosa*, exhibited significant antifungal activity against *C. albicans* ($p < 0.01$). *P. gymnospora* demonstrated the strongest antifungal properties, but only when extracted with ethanol and dichloromethane, yielding MIC values of 25 mg/mL and 37.5 mg/mL, respectively. Moderate antifungal activity (MIC = 50 mg/mL) was observed

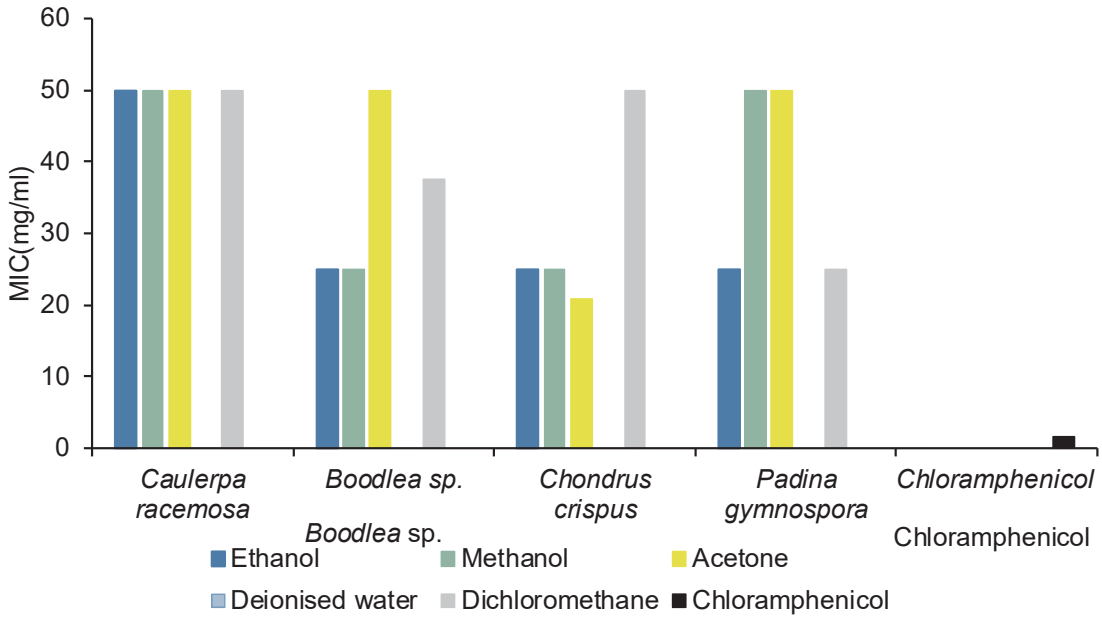


Figure 4. Antibacterial activities (in MIC) of seaweed extracts against *Staphylococcus aureus*.

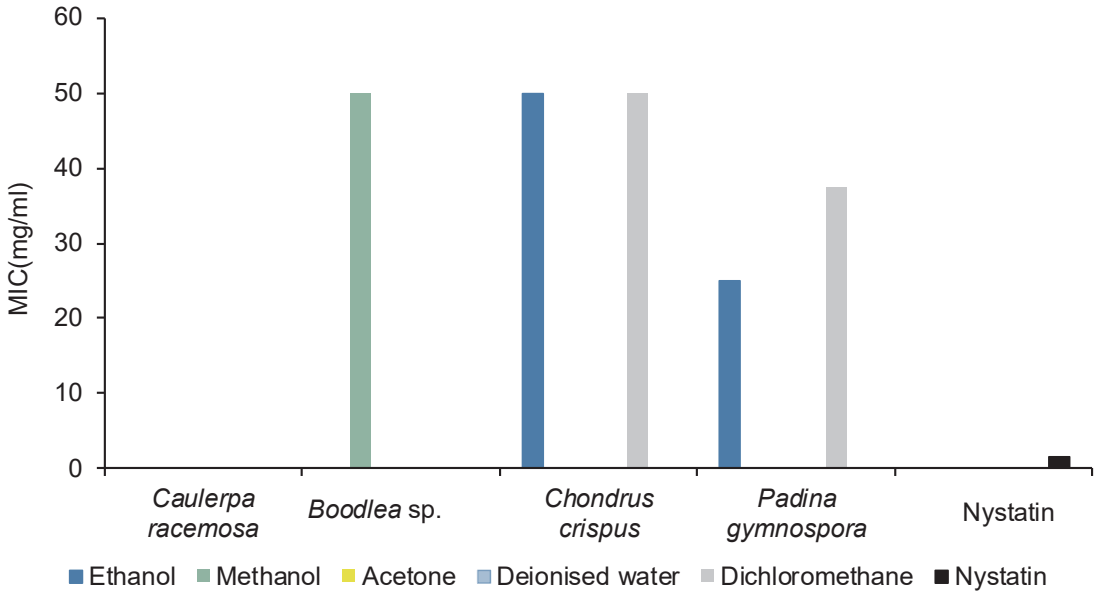


Figure 5. Antifungal activities of the seaweed extracts against *Candida albicans.*

for methanolic extracts of *Boodlea* sp. and for *C. crispus* extracted with ethanol and dichloromethane. No antifungal activity was observed for any extracts obtained using deionized water or acetone. The antifungal control, nystatin, showed the most effective inhibition of *C. albicans*, with an MIC of 1.563 mg/mL, as expected (Fig. 5).

Discussion

Seaweeds are promising marine resources with significant bioactive potential and high cultivation feasibility, making them suitable candidates for drug discovery. One critical step in maximizing their bioactivity is the optimization of extraction conditions, such as the choice of solvent, which significantly influences extract yield and quality (Quitério *et al*., 2022; Savira *et al*., 2021). In the present study, solvent type notably affected the concentration of seaweed extracts. Among the five solvents tested (acetone, methanol, ethanol, dichloromethane, and deionized water), deionized water consistently yielded the lowest extract concentrations, whereas acetone and methanol produced the highest yields depending on the species. These findings partially contrast with those of Sasadara and Wirawan (2021), who reported higher extraction yields for *Gracilaria* spp. using water compared to 100 % acetone and ethanol.

The continuous search for novel antioxidants is essential to combat diseases associated with oxidative stress (Marcucci *et al*., 2023). Seaweeds, which naturally produce antioxidant compounds as part of their defense mechanisms, are excellent candidates for such exploration. In this study, all seaweed species demonstrated antioxidant activity, though the degree varied significantly among species. This variability likely reflects differences in the composition and concentration of bioactive compounds responsible for the observed antioxidant activities. Similar variability in bioactivity among seaweed species is also demonstrated in the study of El-Sheekh *et al*. (2023), among the seaweeds *Ceramium rubrum* (Rhodophyta), *Sargassum vulgare*, *Sargassum fusiforme* and *Padina pavonia* (Phaeophyta), mainly due to differences in composition of polyphenols, pigments, fatty acids, porphyrans, ulvans, and trace elements like zinc.

Among the tested seaweeds, *Boodlea* sp. and *P. gymnospora* exhibited the highest DPPH (2,2-diphenyl-1-picrylhydrazyl) radical scavenging activity, with no statistically significant difference between them. This suggests a similar composition or level of antioxidant compounds in these species. Similar activities of these two species were also reported by Ishakani *et al*. (2016) in India, but with a lower % DPPH (approximately 46 % and 49 % less, respectively). In the study of Nazarudin *et al*. (2022), the DPPH activity of *P. gymnospora* was linked to the secondary compounds alanine, N-phenylacetylphenylalanine, glutamic acid, sarcosine, and ϖ-methylhistidine. Conversely, *C. crispus* exhibited significantly lower DPPH activity as compared to the other seaweeds in this study (19.27 ± 1.48 % in methanol extract), which was the same for *C. crispus* in other studies in Saudi Arabia (Alkhalaf, 2021) and Spain

(López-Hortas *et al*., 2022). Still, *C. crispus* in this study had a greater antioxidant activity than the same species from Spain (1.11 ± 0.01 %).

Solvent polarity plays a crucial role in the extraction efficiency of antioxidant compounds. In this study, solvents ranging from highly polar (deionized water) to non-polar (dichloromethane) significantly influenced DPPH radical scavenging activity ($p < 0.01$). The general trend observed was ethanol > acetone > methanol > dichloromethane > deionized water. However, this trend varied depending on the seaweed species, with a significant interaction observed between solvent and species ($p < 0.01$). This is attributed to the selective solubility of antioxidant compounds in solvents of differing polarities (Nawaz *et al*., 2020; Surroop *et al*., 2024). Polar solvents such as methanol are known to extract higher levels of phenolics, flavonols, and tannins, key compounds with antioxidant properties (Kumari *et al*., 2024).

A similar solvent-dependent effect was reported by Palaniyappan *et al*. (2023) for *C. racemosa* in Tamil Nadu, where methanol showed the highest DPPH activity (54.21 ± 1.39 %), followed by ethanol and acetone. Although lower activities were recorded in the present study, methanol still produced significantly higher antioxidant activity for *C. racemosa* ($p < 0.01$). These differences may result from regional variation in seaweed biochemical profiles. Notably, *Boodlea* sp. exhibited greater DPPH activity when extracted with the less polar solvent acetone ($p = 0.03$), and *C. crispus* showed higher activity with both acetone and dichloromethane ($p < 0.01$), indicating the presence of non-polar or semi-polar bioactive compounds such as lipids, terpenoids, or flavonoids (Rodríguez *et al*., 2020; Romano *et al*., 2025). For *P. gymnospora*, both methanol and dichloromethane extracts exhibited antioxidant activity, with methanol, the polar solvent, being more effective (38.08 ± 1.73 % vs. 28.3 ± 0.49 %). This suggests a predominance of polar antioxidant constituents in this species, consistent with findings by Akbar *et al*. (2021), who reported higher levels of flavonoids, saponins, and phenolics in methanolic extracts of the species.

Marine macroalgae have evolved to synthesize secondary metabolites as chemical defenses against environmental stressors, including microbial threats (Gomes *et al*., 2022; Noorjahan *et al*., 2022; Nazurally *et al*., 2023). In the current study, all four seaweed species demonstrated antibacterial activity against *S. aureus*, although efficacy varied with both species and solvent used. Deionized water was ineffective for all species, likely due to its poor ability to extract some antimicrobial compounds such as pigments as shown in the study of Purnomo *et al*. (2020).

C. crispus exhibited the strongest antibacterial activity, when macerated with acetone, while methanol and ethanol extracts had higher (weaker activity) MICs. López-Hortas *et al*. (2022) also reported antimicrobial activity of *C. crispus* against *S. aureus*, but with even lower MICs (0.25 mg/mL), attributed to high levels of saturated fatty acids, carotenoids, phenolics, and polysaccharides. Conversely, the non-polar dichloromethane extract showed weaker activity, consistent with results from Shobier *et al*. (2023), who observed no antimicrobial activity using non-polar hexane extracts of *Ulva* spp., suggesting the absence of the target bioactive compounds. Although *C. racemosa* showed the lowest activity in this study (MIC = 50 mg/mL), much higher antibacterial efficacy was reported in India (MIC = 0.2 mg/mL), likely reflecting regional differences in chemical composition (Palaniyappan *et al*., 2023).

C. albicans is a commensal yeast that can become pathogenic under favorable conditions. All seaweeds tested exhibited anti-candidal activity, except *C. racemosa*. This contrasts with studies from Indonesia and Sudan, where *C. racemosa* effectively inhibited *C. albicans* (Anggraeni *et al*., 2021; Nursidika *et al*., 2025; Abdalla *et al*., 2016). Among the species studied, *P. gymnospora* displayed the strongest antifungal activity, particularly when extracted with ethanol (25 mg/mL) and dichloromethane (37.5 mg/mL). In contrast, no activity was observed with the ethanolic extracts from Morocco (El Wahidi *et al*., 2015). Although methanolic extracts of *P. gymnospora* have been reported to contain higher polyphenolic and diphenolic content than *Boodlea* sp. (Ishakani *et al*., 2016), only the methanolic extract of *Boodlea* showed anti-candidal activity. This implies that other compounds, such as terpenes and terpenoids, beyond phenolics alone, have contributed to the antifungal activity of *P. gymnospora* (Rao *et al*., 2020). Finally, neither acetone nor deionized water extracts exhibited antifungal activity in any of the four seaweed species studied. This contrasts with findings from India, where acetone was the most effective solvent for 23 seaweed species, followed by methanol (Priyanka and Rajaram, 2022).

Notable regional variations in antioxidant and antimicrobial activities were observed, with certain cases in this study showing higher bioactivity compared to

Table 4. Regional comparison of DPPH activities and antimicrobial activities.

Seaweed			Chlorophyta		Rhodophyta	Ochrophyta	Citation
			Caulerpa racemosa	*Boodlea sp.*	*Chondrus crispus*	*Padina gymnospora*	
Antioxidant assay: DPPH activity (%)	Present Study	Solvent					
		Ethanol	39.37 ± 6.4	52.7 ± 3.19	59.4 ± 9.32	65.69± 2.58	
		Methanol	30.66 ± 7.07	61.97± 6.68	19.27±1.48	36.08 ±1.73	
		Acetone	34.78 ± 4.8	59	37± 5.32	43.1 ± 2.53	
		Dichloromethane	19.7 ± 0.67	25.4	27.7± 0.67	28.3 ± 0.49	
		Deionized water	11.11 ± 3.02	21.62 ± 0.05	8.54 ± 2.75	33.94 ± 1.19	
	Tamil Nadu, India	Polysaccharides	-	-	-	77.6 % (*Padina* sp.)	(Arunkumar *et al*., 2021)
	Saudi Arabia	Methanol	-	-	25.0 ± 2.6	-	(Alkhalaf, 2021)
	Spain	microwave hydrodiffusion	-	-	1.11 ± 0.01	-	(López-Hortas *et al*., 2022)
	Tamil Nadu, India	Methanol	54.21 ± 1.39 %	-	-	-	(Palaniyappan *et al*., 2023)
		Ethanol	47.59 ± 1.78 %	-	-	-	
		Acetone	46.23 ±0.46 %	-	-	-	
	Gujarat, India (mM Equivalent Ascorbic Acid/ g DW)	Methanol	-	16.42 ± 0.88	-	16.5 ± 0.66	(Ishakani *et al*., 2016)
Antibacterial activity against *Staphylococcus aureus*	Present Study (MIC in mg/mL)	Ethanol	50	25	25	25	
		Methanol	>50	>25	>25	>50	
		Acetone	>50	>50	>20.8	>50	
		Dichloromethane	>50	>37.5	>50	>20	
		Deionized water	NI	NI	NI	NI	
	India	Methanol	>0.2	NI	NI	NI	(Palaniyappan *et al*., 2023)
		Ethanol	>0.2	NI	NI	NI	
		Acetone	>0.2	NI	NI	NI	
	Egypt in mm (disc diffusion in mm)	Methanol	-	-	-	NI	(El Shafay *et al*., 2016)
		Ethanol	-	-	-	11.67 ± 0.57	
	Indonesia in mm (disc diffusion in mm)	Active peptide	-	-	14.4 mm	-	(Habibie *et al*., 2023)
	Spain (MIC in mg/ml)	-	-	-	0.25	-	(López-Hortas *et al*., 2022)
	Indonesia(mic in ppm)	Ethyl-acetate	1000 ppm	-	-	-	(Anggraeni *et al*., 2021)
	Sudan, Africa (mg/Ml)	Methanol	6.25	-	-	-	(Abdalla *et al*., 2016)
	Morocco	Ethanol	-	-	-	NI	(El Wahidi *et al*., 2015)
Antifungal activity against *Candida albicans*	Present Study (MIC in mg/ml)	Ethanol	*NI*	*NI*	>50	>25	
		Methanol	*NI*	>50	*NI*	*NI*	
		Acetone	*NI*	*NI*	*NI*	*NI*	
		Dichloromethane	*NI*	*NI*	50	37.5	
		Deionized water	*NI*	*NI*	*NI*	*NI*	
	Gulf of Mannar, India		-	-	-	>50	(Arumugam *et al*., 2019)
	Indonesia (mic in ppm)	Ethyl-acetate	500	-	-	-	(Anggraeni *et al*., 2021)
	Indonesia (µg/ mL)	96% ethanol, followed by fractionation	64 µg/mL	-	-	-	(Nursidika *et al*., 2025)
	Sudan, Africa	Methanol	6.25 mg/mL	-	-	-	(Abdalla *et al*., 2016)
	Morocco	Ethanol	-	-	-	*NI*	(El Wahidi *et al*., 2015)

NI: No inhibition

previously reported values (Table 4). Interestingly, the collection site for the seaweed species was located on a fish farm in Mauritius, which may have influenced the production of bioactive metabolites. Environmental factors such as nutrient enrichment or exposure to effluents could have induced stress-related metabolic adaptations, potentially enhancing the bioactivity of the seaweeds (Manivannan *et al*., 2011).

Conclusion

All four seaweed species examined demonstrated notable bioactivities, with variations depending on species and extraction solvent. Acetone and methanol yielded higher extract concentrations, while deionized water resulted in the lowest extract yields, weak antioxidant activity, and absence of antimicrobial effect. The strongest antioxidant activities were observed in the acetonic extract of *Boodlea* sp. and the methanolic and dichloromethane extracts of *P. gymnospora*, whereas *C. crispus* showed the weakest activity. Regarding antimicrobial activity, all seaweeds were effective against *S. aureus*, with *C. crispus* (particularly its acetonic extract) showing the greatest antibacterial effect. *C. racemosa* exhibited the lowest antibacterial activity and showed no antifungal activity against *C. albicans*. Acetone and deionized water extracts were ineffective against the fungus, while ethanol and dichloromethane extracts of *P. gymnospora* were the most effective. Moreover, the proximity of the collection site to a fish farm may have influenced the biochemical profiles of some seaweeds. These findings support the pharmaceutical potential of Mauritian seaweeds and highlight the need for further investigation of additional species in the region.

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