

Nutritional and Medicinal Assessment of Seaweeds from Mozambique

Juliao Monjane
(juliao.monjane@unimoz.ac.mz; +258 86 867 6497)

Faculty of Science, Eduardo Mondlane University – Maputo, Mozambique

ABSTRACT

Seaweeds are marine autotrophic organisms with numerous bioactive compounds of interest. Several seaweed products are available in the form of food or medicine due to their myriad beneficial biomolecules like anti-diabetic, anti-inflammatory, and antioxidant compounds. Seaweeds rich in essential fatty acids and vitamin B12 (cobalamin) can be an alternative food for vegetarians, as vegetables and fruits are poor sources of these elements. Seaweed-based functional food products and supplements have great potential health benefits and can potentially help to improve malnutrition to fulfil SDG 3 (Good health and well-being). The nutritional composition of the dried seaweeds *Cladofora vagabunda* and *Sargassum crassifolium* from the Mozambican coast, including proximate, minerals, and heavy metals, as well as their medicinal properties, were evaluated. The objective of this present study was to know the nutritional composition and medicinal properties of dried seaweeds for utilization in human nutrition in the future.

Results show that carbohydrate content was the major component in the proximate analysis (65,8% e 81,3%, for *C. vagabunda* and *S. crassifolium*). Humidity (8,6% and 6,7%); ash (15,8% and 8,1%); fat acids(1,4% for both species); proteins (6,2% and 0,5%); total chlorophyll (7,2% and 1,3%); and carotenoids (1,3% and 0,9%), respectively. The proximate analysis was determined based on standard methods. The ICP-OES instrument was used for the quantification of mineral content. The calcium content was higher for both species (1828 and 1502 mg/100 g) than other minerals. The heavy metal content examined in this study was lower than the limit of the quality criteria applied to edible seaweeds found in the literature. Based on the disc agar diffusion method the organic fraction of the studied seaweeds showed inhibition zones against *Staphylococcus aureus* (bacteria), *Candida albicans* (fungi), and the parasite *Entamoeba histolytica*. The preliminary phytochemical analysis revealed the presence of a wide range of secondary metabolites, and the free radical scavenging method showed that both species have antioxidant properties.

Based on the results of this study showed that both species have the potential to be developed as an alternative source of healthy food for humans in the future. The information presented herein gives an overview of the current knowledge of seaweed nutritional values and their potential application as nutraceutical supplements for health benefits in terms of mineral content, fatty acids, antioxidants, and dietary fibres.

INTRODUCTION

Seaweeds are one of the important marine living resources in the world. These macroalgae have been a source of food, feed, and medicine in the East as well as in the West, since ancient times. Marine algae are distributed in the Mozambican coastline (2500 km long), especially around the seashore of Ponta D'Ouro and Bazarruto Island lying in the Mozambique Channel in the Indian Ocean. The nutritional properties of Mozambican seaweeds are not completely known yet, and there are few studies regarding their chemical composition. From the literature, most seaweed biomass and diversity that could be found in Mozambique are rich in nutritional values and medicinal properties, they are under-utilized. Worldwide, seaweeds are consumed as marine vegetables. However, most of the people of Mozambique are not aware that seaweeds can be used as human food. Rarely seaweeds are used as animal feeds or fertilizers by the coastal villagers. Compared to land plants, the chemical composition of seaweeds has been poorly investigated.

To grow interest in marine algae, knowledge of biochemical and chemical composition and its nutritive value is essential. Marine macroalgae are good sources of protein, carbohydrates, and fat. Seaweeds in general contain a large amount of carbohydrates. So far, there is no published study on the nutritional composition and medicinal properties of the Mozambican algae. Therefore, the present research analysed the biochemical composition and medicinal properties of two marine macroalgae, *Sargassum crassifolium* (brown), and *Cladofora vagabunda* (green), collected in the southern part of Mozambique, in Bazaruto Island (Inhambane Province) and Ponta D'Ouro (Maputo Province).

METHODS AND MATERIALS

Sample Collection and Preparation

The seaweed samples of *Sargassum crassifolium*, and *Cladofora vagabunda*, were collected in the southern part of Mozambique, in Bazaruto Island (Inhambane Province) and Ponta D'Ouro (Maputo Province). Immediately after collection, the seaweed samples were cleaned and washed with seawater to remove sand, debris, epiphytes and other extraneous matter attached to the thalli and transported to the laboratory of Natural Products in the Department of Chemistry of Eduardo Mondlane University. In the laboratory, the sample was sorted and then thoroughly cleaned by rinsing with distilled water to remove the surface salty materials. They were air-dried in the shade for five days and later ground in a blender. The powdered samples were subsequently kept in a dark container and stored at room temperature for further analysis.

Proximate Analysis

The moisture content (%) was determined by drying 2 g of each sample. The sample was put into an oven at 105°C and heated for 3 h. The dried sample was put into a desiccator, allowed to cool, and reweighed (AOAC, 1990). Ash content (%) was determined by heating the sample for 4 in a muffle furnace at 550°C until it turned white and free of carbon. The sample was then removed from the furnace, cooled in a desiccator to room temperature, and reweighed immediately. Total fat content (%) was determined by loosely wrapping a 2 g sample with filter paper and put into the thimble which was fitted to a clean round bottom flask, which has been cleaned, dried, and weighed. The flask contained 120 mL of petroleum ether. The sample was heated with a heating mantle and allowed to reflux for 5 h. The heating then stopped and the thimbles with the spent samples were kept and later weighed. Total protein (%) was calculated from the elemental N determination using the nitrogen-protein conversion factor of 6.25 according to the standard AOAC method. The carbohydrate content (%) was estimated by difference: 100 – (moisture + ash + protein + fat) %.

Mineral and Heavy Metal Analysis, Medicinal properties, Antioxidant activity, and Phytochemical screening

The quantification of minerals and heavy metals was done using an ICP-OES instrument. Medicinal properties were assayed by the disc agar diffusion method. The DPPH was determined using a UV-Vis instrument. 2,2-Diphenyl-1-picrylhydrazyl (DPPH) assay is the most commonly used antioxidant assay for plant extract. In this assay, a molecule or antioxidant with weak A-H bonding will react with a stable free radical DPPH• (2,2-diphenyl-1-picrylhydrazyl, λ_{max} =517 nm) causing discoloration of the molecule. The preliminary phytochemical analysis was performed using standard protocols. Preliminary screening of phytochemicals is a valuable step, in the detection of the bioactive principles present in medicinal plants and subsequently may lead to drug discovery and development.

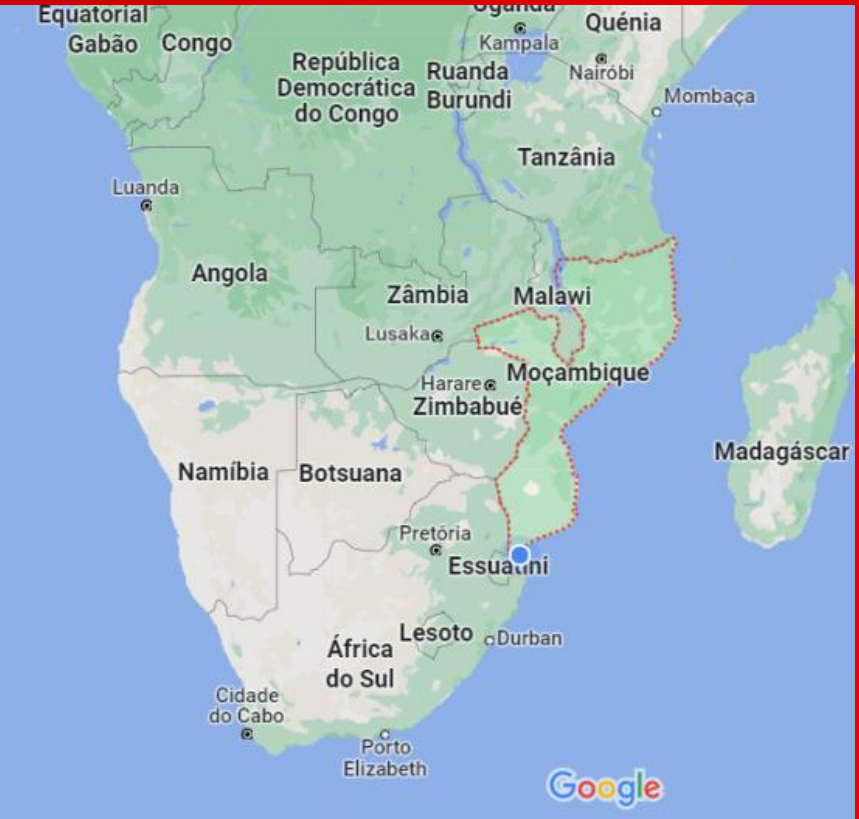


Figure 1. Location of Mozambique in Southern Africa



Figure 2. *C. vagabunda*



Figure 3. *S. crassifolium*



Figure 4. Bazaruto Island



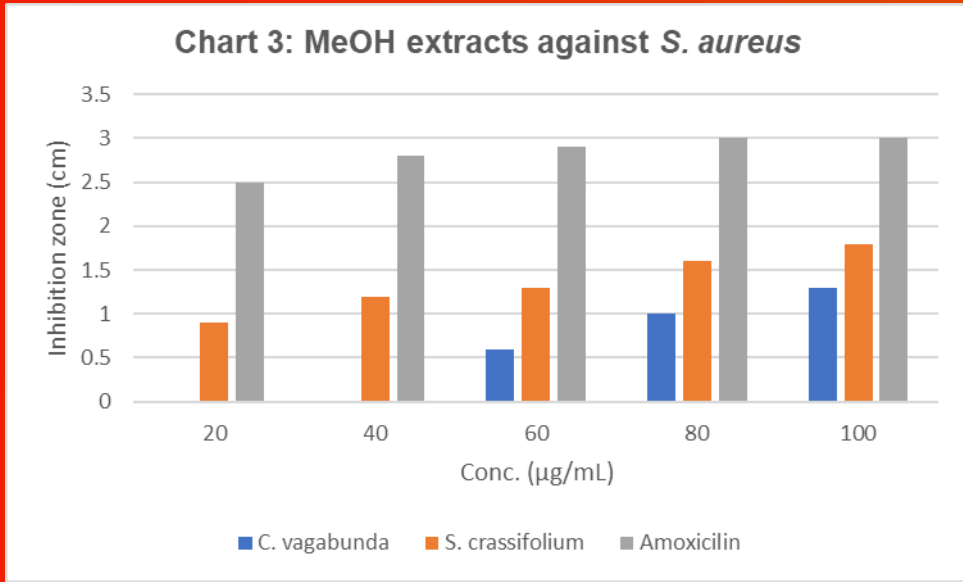
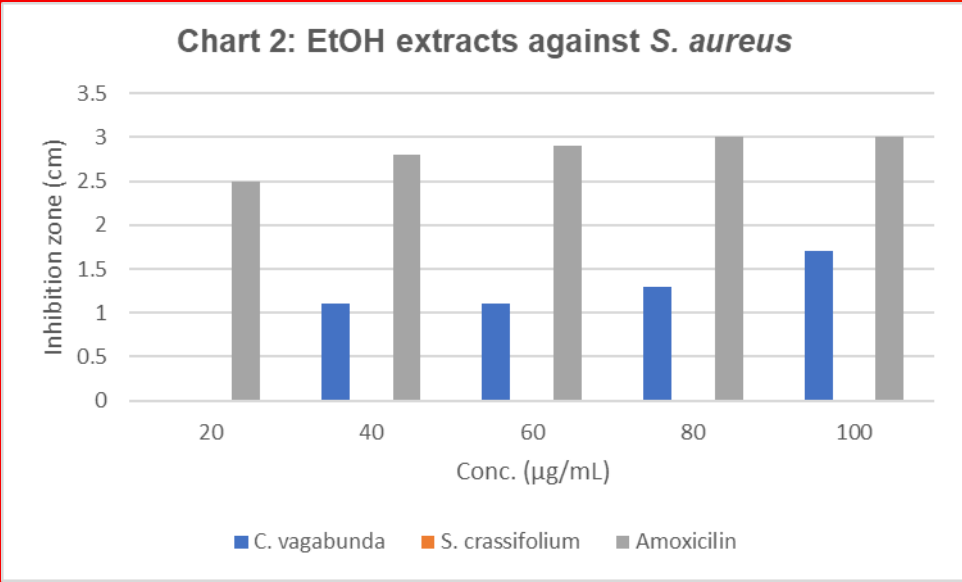
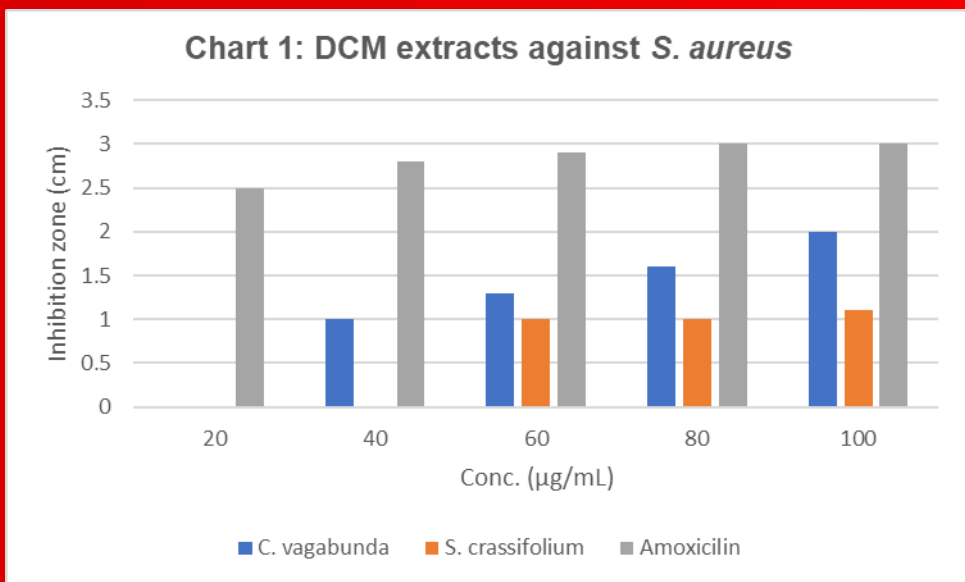
Figure 5. Ponta D'Ouro

RESULTS

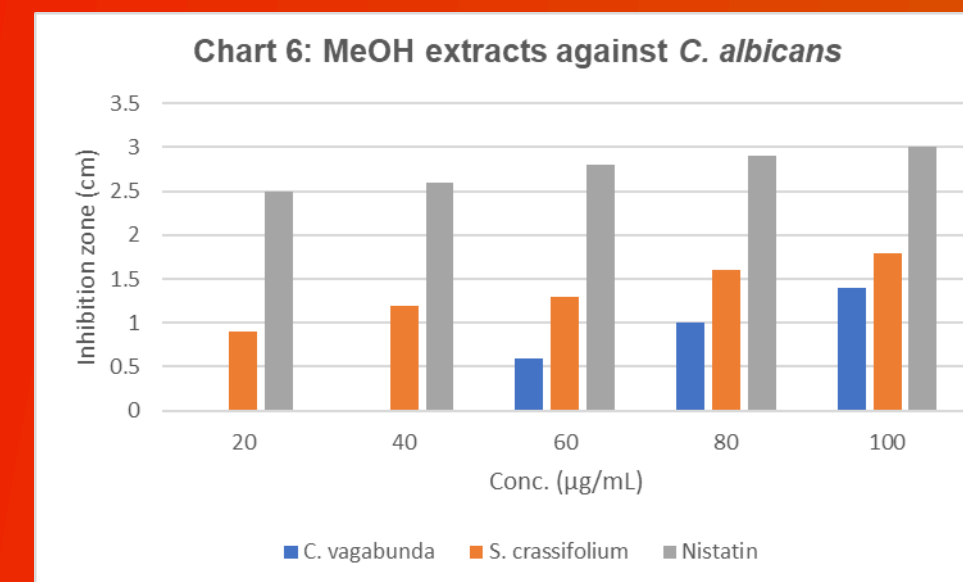
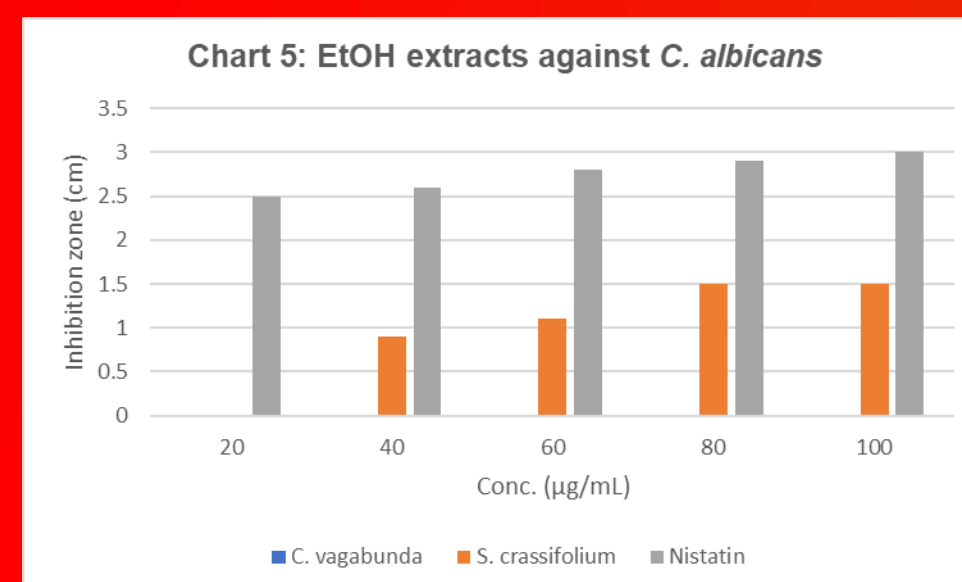
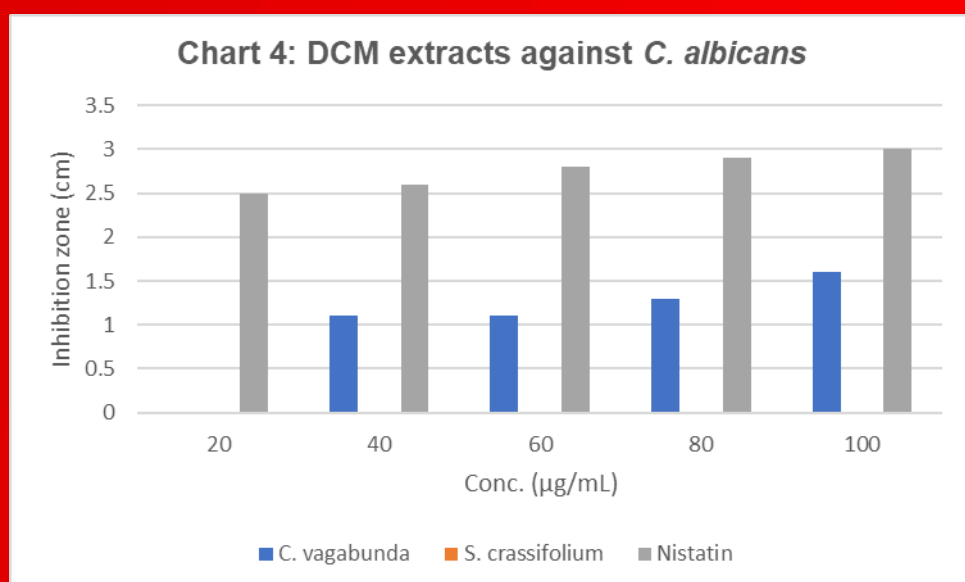
Tabela 1. Nutritional composition

(% w/w)	<i>C. vagabunda</i>	<i>S. crassifolium</i>
Humidity	8,6±0,21	6,7±0,19
Ash	15,8±2,43	8,1±0,13
Fat acids	1,4±0,02	1,4±0,03
Carbohydrates	65,8±3,91	81,3±0,61
Proteins	6,2±0,11	0,5±0,01
Carotenoids	1,3±0,08	0,9±0,01
Chlorophyll	7,2±0,12	1,3±0,11

Antibacterial activity



Antifungal activity



In vitro Antiparasitic activity

Tabela 3: DCM extract *C. vagabunda* against *E. histolytica*

Incubation time	Conc. (µg/mL)	DCM			Ethanol 96%			Methanol 99.9%		
		Replicates			Replicates			Replicates		
24h	25	+	++	+	++	+++	++	+++	+++	++
	50	0	+	+	++	++	++	+++	+++	++
	75	0	0	0	+	0	0	++	++	++
	100	0	0	0	0	0	0	++	++	++
48h	25	+	++	++	++	++	+	+++	+++	+++
	50	0	0	+	+	++	+	++	++	+++
	75	0	0	0	0	0	0	++	+++	+++
	100	0	0	0	0	0	0	++	++	+++
72h	25	+	+	++	+++	+	+	+++	+++	++++
	50	0	0	0	++	0	+	+++	+++	++
	75	0	0	0	0	0	0	+++	++	+++
	100	0	0	0	0	0	0	+++	++	+++

Tabela 4: DCM extract of *S. crassifolium* against *E. histolytica*

Incubation time	Conc. (µg/mL)	DCM			Ethanol			Methanol		
		Replicates			Replicates			Replicates		
24h	25	+	++	++	+++	+++	+++	+++	+++	++
	50	0	0	+	+++	++	++	++	+	++
	75	0	0	0	+	+	++	+	++	++
	100	0	0	0	+	+	++	0	+	+
48h	25	+	+	+	++	++	++	++	++	++
	50	0	0	0	++	++	+	+	+	+
	75	0	0	0	+	+	+	0	0	0
	100	0	0	0	0	0	+	0	0	0
72h	25	+	+	+	++	+	+	+	++	++
	50	0	0	0	++	+	+	+	+	+
	75	0	0	0	+	+	0	0	0	0
	100	0	0	0	0	0	0	0	0	0

DISCUSSIONS

- Carbohydrate is the most important component of metabolism and it supplies the energy needed for respiration and other metabolic processes. The level of carbohydrates in the two seaweeds was very high. The protein content of brown seaweeds is generally small, whereas higher protein contents are recorded in green and red seaweeds. Algae are not used as a conventional energy source because of their low fat in lipids. The crude lipids content in the studied algae ranged was 1.4%. However, both algae could be used as a source of caloric energy.
- As a result, a significant DPPH scavenging action could be related to the existence of flavonoids as well as other polyphenols throughout extraction, as shown in the current work. Our research found that studied algae have antioxidant properties and might be effective in the treatment of free-radical-induced diseases.
- All organic extracts prepared were active against *S. aureus*, except for the EtOH of *S. crassifolium*. Regarding the antifungal activity, the DCM extract of *C. vagabunda* and the MeOH extract of *S. crassifolium* were the most active at a concentration of 100 µg/mL, while the DCM extracts of both algae showed antiparasitic activity.

CONCLUSIONS

The seaweeds examined in this study have high carbohydrate and low in fat. The result of this study showed that *S. crassifolium* and *C. vagabunda* may be considered to be developed as an alternative source of healthy food for humans in the future to provide good health and well-being.

REFERENCES

- Balboa, E. M., Gallego-fábrega, C., Moure, A., & Domínguez, H. (2016). *Journal of Applied Phycology*, 28, 1943–1953.
- Chen, Y., Michalak, M., & Agellon, L. B. (2018). *Journal of Biology and Medicine*, 91(2), 95–103.
- Coria-monter, E., & Durán-campos, E. (2015). *Hidrobiologica*, 25(2), 249–255.