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Study of phenolic compounds and flavonoids in some species of marine algae extracts.

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Abstract

Total phenolic content and total flavonoid content were evaluated among four species of alga: one brown algae (*Cystoseira compressa*), two green algae (*Ulva lactuca* and *Enteromorpha intestinalis*) and one red algae (*Jania rubens*). The seaweeds were collected from submerged rocks between 0 and 50 cm of depth during the month of March 2022 at Kouali – Tipaza in Algeria. The results obtained showed that Decoction method offers better value than maceration for the four algae species. Brown seaweed *Cystoseira compressa* has the highest polyphenol content, with 1,1057 ±0,0192 mg GAE/g and 0.332 ± 0.0074 mg GAE/g respectively for decoction and maceration. The same species offered 0.211 ± 0.0016 mg QAE/g of flavonoids which is the higher value. *Cystoseira compressa* represents a good source of phytochemicals for use as food and feed supplement.

Keywords

Algae, seaweed, polyphenols, flavonoids.

Introduction

Several novel biologically active components which benefit human health have been extracted from marine algae [25]. The beneficial effects of seaweed are mostly due to the presence of minerals, vitamins, phenols, polysaccharides, and sterols, as well as several other bioactive compounds [7] .

Indeed, in recent decades, marine macroalgae have attracted the attention of biotechnologists and pharmacologists as a promising and almost inexhaustible source of polyphenols [2].

Polyphenols comprise a large group of phytochemicals with very diverse chemical structures [19] . Flavanoids, lignans, stilbenes, and phenolic acids are the four main families of polyphenols [22]. Where the predominant bioactivity of all is the anti-oxidative activity [5]. It provides health benefits such as antioxidant, antimicrobian, antidiabetic, immunostimulatory effects [3]. Many studies have shown that people who follow a specific diet (especially polyphenol-rich diets) are at a low risk for a range of chronic diseases, such as obesity, diabetes, cancer, heart disease, etc. [21]. Also, Polyphenols are active substances against various types of viral infections [4].

There is a growing interest in extracting polyphenols from plant sources, in order to produce a safe, natural and low-cost alternative to synthetic compounds, out of which some possess toxic and mutagenic effects [13].

The importance that scientists attach to polyphenols is measured by the large number of studies that have interested about them [9] [15] [18] [20] [2] [4] [27].

Our study aims to identify algae that contain the highest content of total polyphenols and flavonoids for use in health fields,as food and feed supplement especially since Algeria has a great biological diversity spread over 1200 km of coast.

Material and method

Biological materials

Four seaweed samples (Table 1) were collected from submerged rocks between 0 and 50 cm of depth during the month of March 2022 at Kouali – Tipaza : (36°35'27"N 2°30'40"E) 445m. The harvested algae are washed, dried away from light and then crushed and sieved at 200 µm.

Table 1. The four algae studied.

Type of algae	**Algae species**
Brown algae	*Cystoseira compressa* (Figure 1)
Green algae	*Ulva lactuca* (Figure 1)
	Enteromorpha intestinalis (Figure 1)
Red algae	*Jania rubens* (Figure 1)

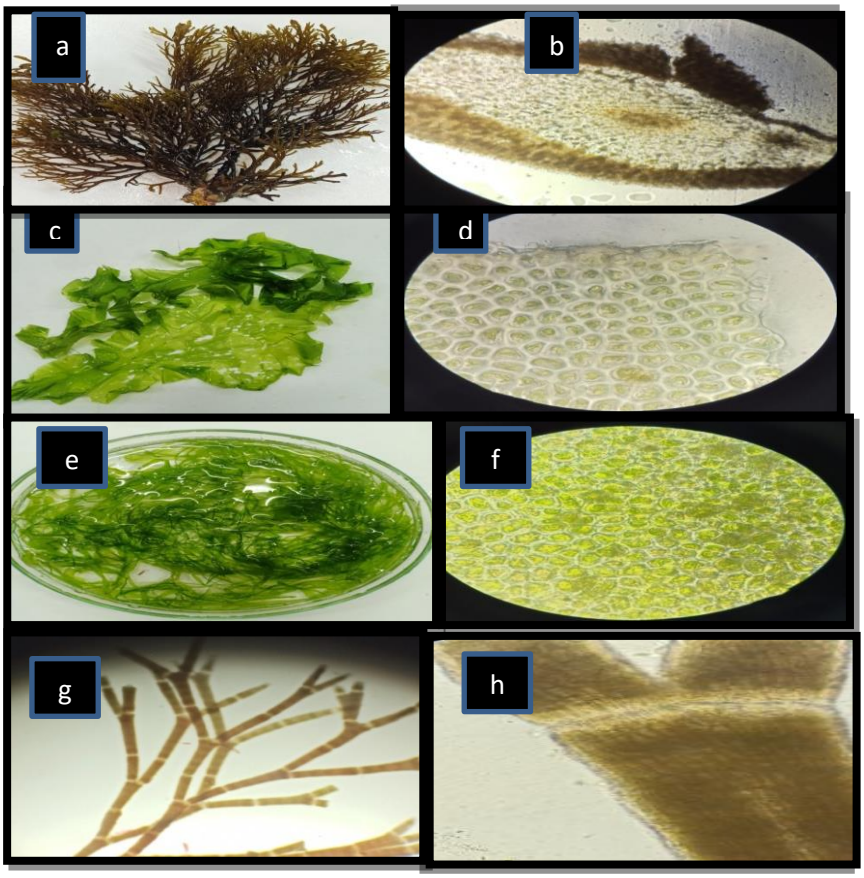
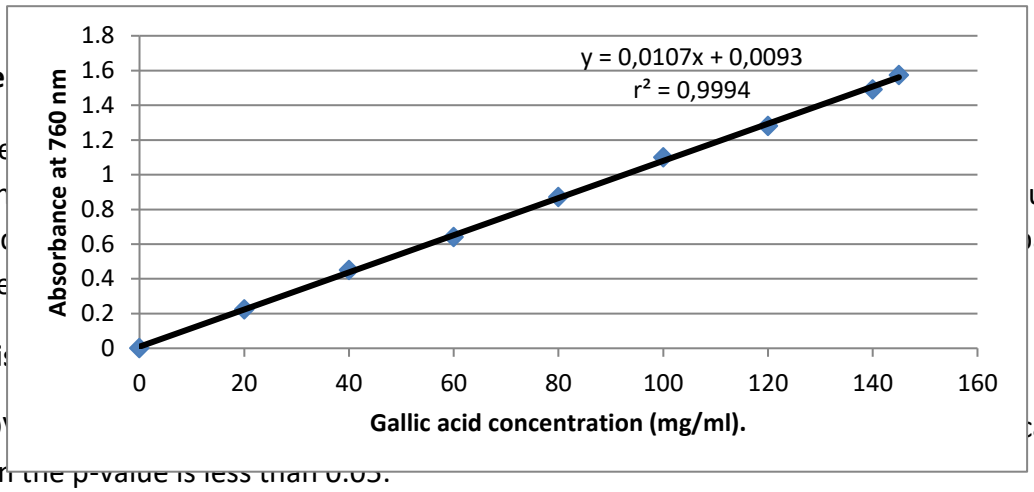


Figure1. Thallus of algae (a and b: *Cystoseira compressa*, c and d: *Ulva lactuca*, e and f: *Enteromorpha intestinalis*, g and h: *Jania rubens*).

Det

The polyphenol content is assessed by two methods of extraction: decoction and maceration. Four solvents were used for extraction by decoction: ethanol, water, methanol and acetone, while only one solvent was used for extraction by maceration which was methanol.

The determination of the polyphenol content is ensured by the Folin ciocalteu method [26]. The calibration curve was plotted by determining the absorbance at different concentrations of gallic acid.



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Results and discussion

Evaluation of polyphenol content

Many intervention studies, mechanistic in vitro data and epidemiological studies support a role for polyphenols against the development of chronic diseases. For example, flavanols decrease endothelial dysfunction, lower blood pressure and cholesterol, and modulate energy metabolism [28]. With advancements in technology, phlorotannin could become a promising medication candidate for a variety of diseases and ailments. In vivo investigations for numerous activities are currently absent, which are required for the application of phlorotannin study findings [17].

The calibration curve is shown in figure 2. The regression line equation is $y = 0,0107x + 0,0093$ ($r^2 = 0,9994$).

Decoction method gived better results than maceration for the four algae species (figure 3). Fardjallah [8] also claimed that decoction offers higher polyphenol yields than maceration-based methods. The extraction method plays an important role in the overall effect of natural antimicrobial products [1].

Figure 2. Calibration curve of gallic acid.

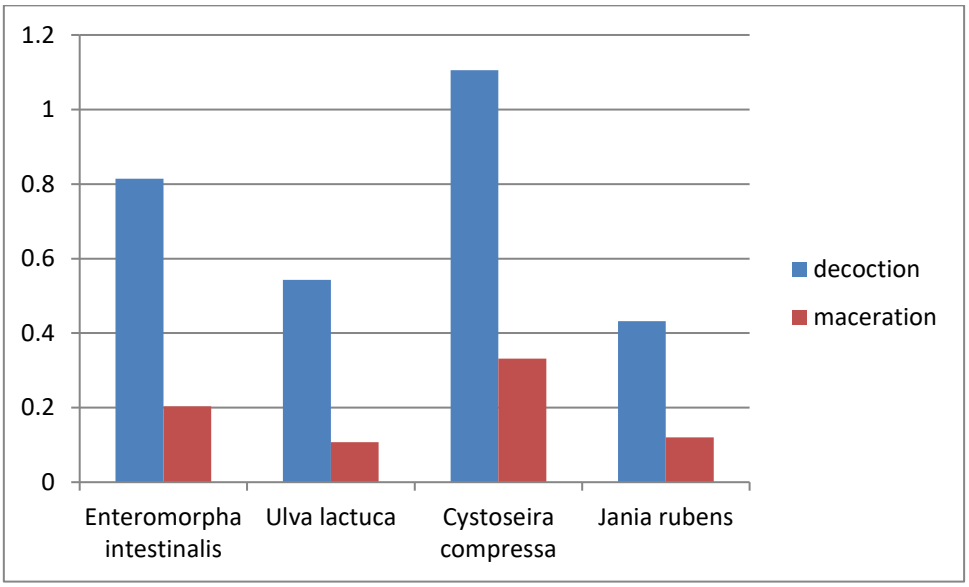


Figure3. Polyphenol content using two extraction methods.

The highest polyphenol content was showed by Brown seaweed *Cystoseira compressa* with respectively value of 1,1057 ±0,0192 mg GAE/g and 0.332 ± 0.0074 mg GAE/g for decoction and maceration (Table 2). These results are in agreement with those obtained by Zhong and al [29] who reported that Brown seaweed showed significantly higher total phenolic content than other seaweed. Also, Imbs and Zvyagintseva [12] reported that phenols extracted from brown alga have great potential as active ingredients for the development of pharmaceutical products.

Table 2: Average of the four algae species in polyphenols using decoction and maceration.

	polyphenols	
	Decoction	Maceration
Enteromorpha intestinalis	0,815±0,00765	0.204 ± 0.014
Ulva lactuca	0,543± 0,00557	0.107 ± 0.021
Cystoseira compressa	1,1057 ±0,0192	0.332 ± 0.0074
Jania rubens	0,432±0,00882	0.120 ± 0.0047

Extraction with methanol gives the best results with an average of 1.117 ± 0.614 mg GAE/g, followed by ethanol and water with averages of 0.934 ± 0.477 mg GAE/g and 0.732 ± 0.076 mg GAE/g

respectively. However, aceton extraction shows the lowest yield with an average of 0.115 ± 0.069 mg GAE/g (table 3).

Table 3: average of polyphenols content using the four solvent.

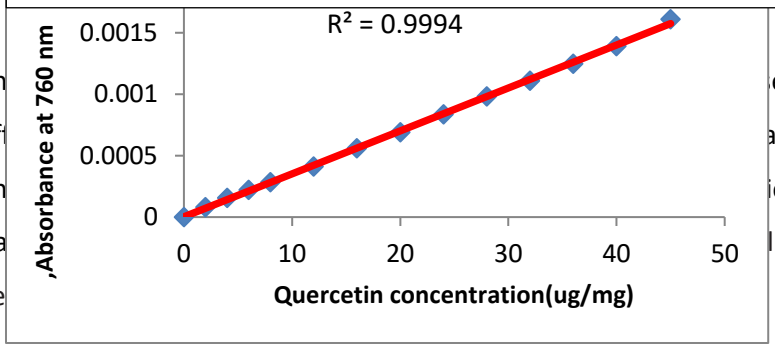
	Mean ± SD	Min	Max	CV	p
Ethanol	**0.934 ± 0.477**	**0.439**	**1.691**	**0.510**	**0.0084***
water	**0.732 ± 0.076**	**0.617**	**0.840**	**0.104**	**< 0.0001*****
methanol	**1.117 ± 0.614**	**0.372**	**1.951**	**0.550**	**0.0696**
aceton	**0.115 ± 0.069**	**0.047**	**0.222**	**0.600**	**< 0.0001*****

Note: SD: standard deviation, Min: minimum, Max: maximum, P : P value.

Evaluation of flavonoid content

The standard calibration curve of quercetin is showed in figure 4, with the regression line equation y=0,0349x + 0,0024 and r^2 = 0,9994

Figure 4. Calibration curve of quercetin.



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The results in table 4 illustrated that *Cystoseira compressa* offered 0.211 ± 0.0016 mg QAE/g of flavonoids which is the higher value in comparison with the others species such as *Enteromorpha intestinalis* and *Ulva lactuca* with repectiveley 0.106 ± 0.0033 mg QAE/g and 0.0512 ± 0.0020 mg

QAE/g. However, *Jania rubens* gived the lowest content (0.039 g QAE/g) (table 2, figure 10). Grina and al [11] have shown that the genus *Cystoseira* provided satisfactory levels of flavonoids. Also, Different content of total flavonoids were obtained varying between 0.53±0.97 CE/100g dried sample and 1.13 CE/100g dried sample [16]. One of the active compounds contained in brown algae that are known to have an analgesic effect is flavonoids [23]. The histopathological examination showed that phlorotannins markedly reduced damage in β cells of pancreases. Phlorotannins from *C. compressa* have efficient antioxidant activity and the antidiabetic effect that may be utilized in human health [10]. flavonoids isolated from brown algae showed antibacterial potentiality against multi-drug resistant Gram positive and negative bacterial isolates including MRSA [1].

Table 4: average of the four algae species in flavonoids.

	Flavonoids
Enteromorpha intestinalis	0.106 ± 0.0033
Ulva lactuca	0.0512 ± 0.0020
Cystoseira compressa	0.211 ± 0.0016
Jania rubens	0.039 ± 0.0012

Conclusion

The phytochemical was assessed in four algae species. The results showed that *Cystoseira compressa* offered the highest content of polyphenolic compounds and flavonoids. So, it can play a major role in improving human and animal health through diets incorporating food supplements based on this brown algae. Also, the highest concentrations of polyphenols were obtained using the decoction method.

Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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