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Phytochemical Content, Antioxidant and Antibacterial Activities of Three Red Macroalgae from Algerian West Coast

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ABSTRACT

Over the last few decades, isolations and chemical characterizations of secondary metabolites with proven biological activities have been of interest for numerous research groups across the world. Reports on phenolic potentials of marine algae are still scarce. The aim of this study deals with the evaluation of the *in vitro* antioxidant and antibacterial properties of methanolic extracts from three red algae species (*Asparagopsis taxiformis, Hypnea musciformis,* and *Corallina elongata)* collected from Algerian west coast (Oran). Moreover, the extracts were investigated for their polyphenol, flavonoid and tannin contents. Extracts were tested *in vitro* for their antibacterial activity against several pathogenic bacteria including seven ATCC reference strains and five clinical multidrug-resistant bacteria. The results showed that the *C. elongata* exhibited highest phenolic content (18.69± 0.016 GAE/g) and higher condensed tannins content (06.56 ± 0.015mg CE/g extract). Total flavonoids content was highest in methanolic extract of *A. taxiformis* (8.86 ± 0.006 mg QE/g) extract. Among three algae tested, the methanol extract of *C. elongata* exhibited the strongest DPPH scavenging capacity with IC_{50} of 0.11 mg/mL. Each extracts displayed different degrees of antibacterial activity against at least four tested antibacterial strains. *Salmonella typhimurium* ATCC 13311, *Escherichia coli* ATCC 25922, *Bacillus cereus* ATCC 11778 and *Staphylococcus aureus* ATCC 25923 were found to be sensitive to the three extracts. Results of present study confirmed the potential usefulness of marine algae in the pharmaceutical and biotechnological industries

Keywords: Marine algae, *Asparagopsis taxiformis, Hypnea musciformis, Corallina elongate*, Antibacterial activity, Antioxidant activity.

Introduction

Recently, there is increased interest in natural products and bioactive compounds as alternatives to synthetic substances. Marine algae are considered as an excellent source of bioactive compounds endowed with ingenious structure and potential biological activities[1], such as antioxidant[2], antimicrobial[3], antifungal[4,5], antiviral[6], antidiabetic[7], anti-inflammatory[8,9] and anticancer activities.[10,11] Moreover, these health benefits have been partly attributed to the phenolic contents.[12] They are rich sources of structurally diverse bioactive phenolic compounds, which are absent in other taxonomic groups. Algae contain 10 times greater diversity of compounds than terrestrial plants.[13] Additionally, they are known to contain reactive antioxidant molecules, such as ascorbic acid and glutathione (GSH) when fresh, as well as other secondary metabolites, including carotenoids, mycosporine-like amino acids (mycosporine-glycine) and catechins, gallate, phlorotannins, eckol, and tocopherols (α-, χ-, δ-tocopherols).[14]

In this background, many studies underlined positive roles that red algae plays in maintaining human health and modulating immune function in order to prevent specific diseases. For instance, some of their bioactive compounds are available in markets as anti-viral foods in assisting body's specific immune regulatory response.[12] In addition, it has been proved that applications of carrageenan gels from *Chondrus crispus* may block the transmission of the human immunodeficiency virus (HIV) as well as other sexually transmitted diseases (STD) viruses such as gonorrhoea, genital warts and the herpes simplex virus (HSV).[15] The red algae *Chondrus crispus* commonly called Irish moss or carrageen moss and *Mastocarpus stellatus* also called *Cluimhin Cait* (cats' puff), carrageen, or false Irish moss are found in the marine environment and traditionally used to cure for colds, sore throats, chest infections including tuberculosis.[16] Algeria is characterized by an extensive coastline and a phenomenal algal biodiversity. However, data on pharmacological potential of their bioactive secondary metabolites are very scarce. Hence, the current study aimed to assess the biological activity including antioxidant and antibacterial capabilities of three (03) red algae (*Asparagopsis taxiformis, Hypnea musciformis* and *Corallina elongata*) collected from Algerian West Coast (Oran).

Materials and Methods

Algal species collections

Marine red algae were collected from Algerian West Coast (Oran) during March 2019. The algal species were identified by experts in these fields, using standard literature and taxonomic keys. The collected algal samples were cleaned well with seawater to remove impurities matter such as epiphytes, sand particles, The seaweeds were transported to the laboratory in sterile polythene bags and were washed with distilled water several times, spread on plates at room temperature and in the dark for three weeks. Dried samples were cut

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into small pieces and ground with a blender into powder to be analyzed before extraction.

Extraction

Extraction was carried out according to the method described by Senevirathne et *al.* with slightly modification.[17] A quantity of 20 g of dried material was added to 100 mL of methanol and left for 24 h at room temperature with stirring at 200 rpm. The solvent extracts were then filtered and re-extracted three times. We evaporated the filtered solvent under reduced pressure at 40°C, and used the resulting deposits as crude extracts. The resulting extracts were then dissolved in dimethlysulfoxide (DMSO) and kept at - 4°C until further use.

Phytochemical screening

A Powdered sample of each investigated alga was subjected to preliminary phytochemical screening according to standard phytochemical methods as described by Khan et *al.*[18] This analysis determined the presence or absence of different compounds: alkaloids, saponins, flavonoids, tannins, steroids and terpenoids.

Estimation of total phenolic content

The total phenolic contents (TPC) assay was performed in accordance to Rastian *et al.* Briefly, 0.4 mL aliquot of the algal extract was transferred into a test tube containing 0.8 mL of the 10% Folin-Ciocalteau phenol reagent (Sigma). After 3 min, 1.6 mL of the 10% sodium carbonate solution was added.[19] Following 2 hours of incubation in the dark, at room temperature, absorbance was measured at 750 nm using a *SPECORD 200 PLUS*–VIS spectrophotometer. Gallic acid was used as the standard reference. TPC (total phenolic content) was expressed as mg gallic acid equivalents per gram of dried extract (mg GAE/g).

Estimation of total flavonoid content

500 µL of each extract are added to 1500 mL methanol (95%), 100 µl of $AlCl_3$ (10%, m/v), 100 µL of sodium acetate 1M and 2.8 mL of distilled water. The mixture is incubated in the dark at ambient temperature for 30 minutes. The white is done by replacement of the extract by methanol (95%) and the absorbance is measured at 415nm. The results are expressed in milligram quercetin equivalent per gram of dried extract (mg QE/g) in referring to the calibration curve of quercetin.[20]

Estimation of total tannin contents

Total tannin content was determined by the casein precipitation. Briefly, 1 g of powdered casein was added to 6 mL of the extract diluted with 12 mL of distilled water. The resulting solution was agitated for 3 h at room temperature (25°C). After filtration, the filtrate was adjusted to 25 mL final volume. Aliquots of this solution where then tested for residual phenolic compounds using the Folin–Ciocalteau method. The quantity of tannins corresponds to the difference in the absorption of the casein precipitated samples and those obtained in the total phenol analysis.[21]

DPPH Radical scavenging activity assay

The antioxidant activity of different extracts was determined using DPPH free radical scavenging assay as described by Aksoy et *al.* in triplicate and average values were considered. Fifty microlitres of various concentrations of the extracts in methanol were added to 5 mL of a 0.004% methanol solution of DPPH. After a 30 min incubation period at room temperature, the absorbance was read against a blank at 517 nm.[22] The percent radical scavenging capacity (RSC) was calculated by the following equation:

$$RSC\ (\%) = \frac{Absorbance\ of\ control - Absorbance\ of\ sample}{Absorbance\ of\ control}\ x\ 100$$

For comparison purposes, the reciprocal $1/IC_{50}$ values were used. The IC_{50} values corresponded to the % RSC which represents the concentration of extract that caused 50% neutralization, which was calculated by linear regression analysis. All measurements were performed in triplicate. Extract concentration providing 50% inhibition (IC_{50}) was calculated from the graph plotting inhibition percentage against extract concentration.

Antibacterial activity

Microorganisms and cultural maintenance

Antibacterial activity of algae extract were assessed using (i) seven type cultures (ATCC, American Type Culture Collection) from the laboratory of microbiology of Algerian Pasteur Institute: *Escherichia (E.) coli* ATCC 25922, *Salmonella enteritidis* ATCC 2453, *Salmonella typhimurium* ATCC 13311, *Staphylococcus aureus* ATCC 25923, *Klebseilla pneumoniae* ATCC 70603, *Enterococcus feacalis* ATCC 49452 and *Bacillus cereus* ATCC 11778, (ii) five clinical isolates obtained from laboratory of microbiology of Yessad Khaled Hospital-Mascara-Algeria: multidrug resistance *Enterococcus feacalis* (*MDR*), *Pseudomonas aeruginosa (MDR)* , *Staphylococcus aureus methicillin-resistant* (MRSA), *Staphylococcus epidermidis* (MRSE) and *Klebsiella pneumoniae*, *Vancomycin* Resistant (VRE). All the bacterial strains were grown and maintained on nutrient agar slants (Oxoid, United Kingdom) at 37°C.

Antibacterial assay

Antibacterial activity was evaluated using the agar diffusion technique in Petri dishes.[23] Briefly, all bacterial isolates were suspended in saline to a turbidity equivalent to 0.5 McFarland (1.5×10^8 CFU/mL. Petri dishes containing 20 mL of Mueller Hinton agar (OXOID) were surface inoculate with 0.1 mL standardized inoculum suspension. Sterile filter paper discs, 6 mm in diameters, were loaded with 20 µL of the different extracts and air dried. The crude methanol was dissolved in 10% Dimethyl Sulfoxide (DMSO). Discs impregnated with methanol and with DMSO were used as negative controls. Also, standard discs of the antibiotic Ciprofloxacin (30 µg) served as the positive antibacterial control. All discs were placed on plates of Mueller Hinton, beforehand inoculated. Plates were incubated for 24 h at 35°C. After incubation the clearance zones around the discs were measured and expressed in millimeter.

Statistical analysis

The data were statistically analysed by applying an one-way ANOVA carried out with the Statistical Program for Social Sciences 16.0 (SPSS, USA, ver. 16.0). Pearson's correlation analysis was done to correlate the phytochemicals content and antioxidant potential in the samples.

Results and Discussion

Macroalgae have been extensively investigated for the past 30 years. A Recent report suggests that their extracts possess bioactive compounds of great medicinal value.[10] The present study is aimed to provide data on *in vitro* antioxidant and antibacterial activity of three red algae (*A. taxiformis*, *H. musciformis*, and *C. elongata*) harvested from Algerian west coast (Oran).

Extraction and yield

The total yield values of methanolic extracts under analysis are given in Table 1. Higher extraction yield of *H. musciformis* was 9.8 ± 0.22 %, followed by the crude extract of *C. elongata* (04.76 ± 0.08%) and *A. taxiformis* (4.5 ± 0.13%), respectively. The total yield values of methanolic extracts under analysis are partially in agreement with some earlier studies. The yield of *H. musciformis* methanolic extract was higher compared to that obtained by Chakraborty et *al.*[24] who

Table 1: The extraction yield of methanolic extract from *A. taxiformis*, *H. musciformis* and *C. elongata*

	H. musciformis	***A. taxiformis***	***C. elongata***
Extraction yield (%) ± SD	9.8 ± 0.22	4.5 ± 0.13	04.76 ± 0.08

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obtained 4.8%. For *A. taxiformis*, yield extraction was lower compared with that found by Mellouk et *al.* who worked on the same specie collected on the coast of Oran in northwest Algeria at Bousfer beach (Corrales).[25] Contrastingly, extraction yield in methanolic extract *C. elongata* was higher than that obtained by Oucif et *al*., who obtained 2.53 ± 0.90% for the same specie collected from Algerian West Coast.[26]

Phytochemical screening

The qualitative phytochemical screening of three algae (*H. musciformis*, *A. taxiformis* and *C. elongata)* was carried out in order to assess the presence of bioactive compounds. The qualitative analysis of our extracts were given in Table 02. The obtained results showed that *C. elongata* contains six major groups of chemical compounds: flavonoids, tannins, saponins, terpenoids, anthraquinone as well as coumarins. We note the absence of anthraquinone in *H. musciformis* and theabsence of coumarins in both species of algae *H. musciformis*, *A. taxiformis;* this may be because of using only methanol as an eluent.

Preliminary phytochemical analysis revealed a slight variation between the tested species. Our results are partially in agreement with those obtained by Alghazeer et *al*. who demonstrated that metabolic extract of *H. musciformis* collected from the western coast of Libya does not have flavonoids, terpenes, anthraquinones and coumarins.[27] Mellouk et *al*. revealed that extracts from *A. taxiformis* may be a source of antioxidant agents due to the presence of bioactive molecules.[25] Djapic revealed the presence of some chemical compounds in *C. officinalis,* collected at South-eastern Adriatic coast, Montenegro, such as diterpenes, triterpene and alkenes.[28] Seenivasan et *al*. mentioned that red algae (*Acanthophora spicifera*) dosen't contain coumarin, quinone, saponin and tannin.[29] On the other hand, Mansuya et *al*.[30] and Bhuyar et *al*.[31], reported the presence of saponin and tannin in red algae (*Gracilaria corticata , Kappaphycus alvarezii*).

Total of Phenolic contents (TPC), Flavonoids Content (TFC) and Condensed Tannins (TCT)

Based on the absorbance values of the various extract solutions reacted with Folin-Ciocalteu's reagent and compared with the standard solutions of gallic acid equivalent, the total phenolic content was determined by equivalence to the gallic acid (EAG). The results of this assay are shown in figure 1. *C. elongata* exhibited highest phenolic content (18.69 ± 0.016mg GAE/g) as compared to *A. taxiformis* and *H. musciformis* which have a total phenolic contents of 14.11 ± 0.02 mg GAE/g and 13.60 ± 0.16 mg GAE/g extract, respectively. Oucif et *al.*[26.] have reported the total phenolic contents in different seaweeds, collected from Algerian West Coast, ranged from 2.25 ± 0.05 to 10.24 ± 0.09 GAE/g whose *C. elongata* had more weak total phenolic content compared to results found in this study. Contrastingly, this study reveals that total flavonoid content was highest in the methanolic extract of *A.taxiformis* followed by *C. elongata* and *H. musciformis*. Total flavonoid contents ranged from 5.17 ±0.19 to 8.86-±0.006 mg QE/g of extract, which is in agreement with the results obtained by Cox et *al*.[4] who found that red algae (*Palmaria palmata, Chondrus crispus*) have a content ranging from 6.83 and 7.41mg QE/g extract. However, in this same study, the authors have highlighted that brown species (*Laminaria digitata, Laminaria saccharina, Himanthalia elongata*) have a total flavonoid contents higher than red species. In addition, our results showed that methanolic extract of *C. elongata* had high level of tannins compared with *A.taxiformis* and H. *musciformis.* Tannins of the studied algae ranged from 1.48 ± 0.01 to 06.56 ± 0.015 mg CE/g of extract. These values are within the range of values found in the literature. [4-32]

Antioxidant activity

The DPPH radical scavenging activity has been reported in percentage of DPPH inhibition (%). DPPH is a synthetic stable free radical widely used for evaluating natural antioxidants, algae or algal products [22]. The results showed that all extracts exhibited a DPPH scavenging capacity in a concentration-dependent manner, extracts of *C. elongata* had the lowest IC50, and consequently, the highest activity with IC_{50} of 0.11 mg/mL compared to the other two algae extracts (Table 3). However, the standard antioxidant Ascorbic acid exhibited much higher scavenging activity. Moreover, the correlation coefficients (r) between the DPPH scavenging ability ($1/IC_{50}$) and the total phenolic, total flavonoid and total tannins content were determined. A strong correlation between the total phenolic and total flavonoids content of *A. taxiformis* extracts and the free radical scavenging activity was observed ($r^2 = 0.976$, $r^2 = 0.982$, $p < 0.01$) respectively. However, no significant correlation was obtained between *C. elongata* and *H. musciformis* total phenolic, total flavonoid, total tannins contents and DPPH scavenging ability ($1/IC_{50}$).

According to the previous reports in literature, marine algae are rich sources of natural antioxidants such as terpenoids, phlorotannins, polyphenols, phenolic acids, anthocyanins, hydroxycinnamic acid derivatives and flavonoids.[2,33] The antioxidant effect of natural phenolic compounds has previously been studied in relation to the prevention of coronary diseases and cancer, as well as for degenerative disorders relative to the age.[34,35,36] One of essays widely used for evaluating natural antioxidants in algae or algal products is DPPH assay. DPPH• is a stable free radical that shows maximum absorbance at 517 nm. When DPPH radicals encounter a proton-donating substrate, such as an antioxidant, the radicals are scavenged and the absorbance is reduced. The decrease in absorbance is taken as a measure of radical-scavenging activity. The higher antioxidant activity is reflected in the lower IC_{50} value. Overall, the three species of red algae showed antioxidant activities with IC_{50} from 0.1 to 0.4 mg/mL. All methanolic extracts showed lower anti-radical activity than ascorbic acid. Our results are within the range of values found in study carried out by Zubia *et al*.[37] who highlighted that 24 species of red macroalgae, collected along the coasts of Brittany, have IC_{50} value ranging from 0.14 mg/mL to 29.72 mg/mL.

The differences in the extracts antioxidant capacity depend on the complexity of their composition, which influences their bioactivities, were synergistic effects among the present compounds, can also occur leading to an increase in antioxidant properties.[38] Collectively, our data indicate a strong positive correlations between DPPH free radical scavenging assay with the total phenolic and total flavonoid content of *A. taxiformis* extracts ($r^2 = 0.962$). These results suggest that phenolic compounds are responsible for the antioxidant activity of these algal species, validating the test used in this study. Our results are consistent with those found by Athukorala *et al*.[39] and Zhang *et al*.[40] who reported that there is a strong relationship between phytochemical contents and DPPH radical scavenging. However, no significant correlation was obtained between total tannins content and DPPH scavenging ability ($1/IC_{50}$). A possible explanation may be related to other types of antioxidant molecules structurally different from phenolic compounds in these algal species (e.g., carotenoids, terpenoids, and ascorbic acid).

The highest antioxidant activity was observed in different algae species belonging to different phyla but this potential is still considered weak in comparison with terrestrial aromatic and medicinal plants.[41]The antiradical activity characterizes the ability of compounds to react with free radical while antioxidant activity represents the ability to inhibit the process of oxidation. Therefore, only one assay cannot determine the total antioxidant potential, the results obtained for the radical scavenging activity must be completed by other methods to determine antioxidant activity of the extracts studied.

Antibacterial assay

The different methanolic extracts of *Asparagopsis taxiformis, Hypnea musciformis* and *Corallina elongata,* were tested for their antibacterial activity against twelve Human pathogenic bacteria including five multidrug-resistant organisms. Overall, *Salmonella typhimurium* ATCC 13311, *Escherichia coli* ATCC 25922, *Bacillus cereus* ATCC 11778 and *Staphylococcus aureus* ATCC 25923 were found to be sensitive to the three extracts.

As shown in table 4, results showed that methanolic extract of *A. taxiformis* elicited remarkable antibacterial activity against majority of Human pathogenic bacteria screened in this study excepted *Salmonella enteritidis* ATCC 2453 and *Enterococcus feacalis* ATCC 49452. Among the Bacterial strains, tested, *Escherichia coli* ATCC 25922 and *Salmonella epidermidis* ATCC 2453 were found most sensitive with inhibition diameter of 14, 25 ± 0.3 mm and 14,02±0,27 respectively. On the other hand, *Hypnea musciformis* extract has been ineffective against most of *antibiotic-resistant bacteria* tested excepted *E. coli* ATCC 25922, *S. typhimurium* ATCC 13311, *B.cereus* ATCC 11778, *K. pneumoniae* (VRE), *E. feacalis* ATCC 49452 and *S. aureus* ATCC 25923. The diameters of inhibition zones of which vary

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between 07.2 ± 2.1 to 13.62 ± 0.1 mm. This study reveals also that *C. elongata* methanolic extract showed a high antibacterial activity. Among the studied bacteria, *S. aureus* ATCC 25923 was found most sensitive with an inhibition diameter of 16.6 ± 0.1 mm.

In the present study, each extracts displayed different degrees of antibacterial activity against at least four tested antibacterial strains. Methanolic extract of *A. taxiformis* and *C. elongata* elicited remarkable antibacterial activity against majority of Human pathogenic bacteria screened in this study compared with *H. musciformis* which showed a low antibacterial activity. This result is in agreement with those of González del Val et *al*.[42] who underlined that among the 44 algae species tested, *A. taxiformis* show the broadest spectrum of antimicrobial activity. Manilal et *al*.[43] reported that methanol extract of *A. taxiformis* exhibited highest activity against multidrug resistant clinical human pathogens viz, *B. subtilis, S. aureus, S. epidermidis, M. luteus,* non-haemolytic *Streptococcus , E. faecalis, E. coli, P. mirabilis, P. aeruginosa* and *K. pneumoniae* . Parsaeimehr and Feng Chen reported that *A. taxiformis* is a source of halogenated and aromatic volatile organic compounds with strong antimicrobial activity.[44] Kladi et *al.*[45] acknowledged microbicidal property of *A. taxiformis* was due to volatile metabolites such as halomethanes, haloacetone and acrylates.

Another significant result is that linked to the *C. elongata* methanolic extract which showed a high antibacterial activity against 07 of 12 bacterial strains. Ertürk and Taş, reported that *Corallina officinalis* exhibited antimicrobial activity against six pathogen bacteria (*S. aureus* (ATCC 25923), *B. cereus* (ATCC 10876), *S. typhimurium* (ATCC 14028), *L. monocytogenes* (NCTC 11994), *E. coli* (ATCC 25922) and *P. aeruginosa* (ATCC 27853).[46]

Contrastingly, *H. musciformis* extract exhibited low antibacterial activity. Our results are partially in agreement with Alghazeer et *al*.[27] and Bouhlal et *al*.[47], who concluded in their studies that methanolic extract of *H. musciformis* inhibited simultaneously the growth of gram positive and gram negative such as *E. coli* and *P. aeruginosa*.

Summarizing the results it can be conducted that methanolic extracts of red algae species used in the present investigation showed an interesting activity compared with standard antibiotic (Ciprofloxacin).

At the end, it is imperative to point out that the differences recorded between our results and the results obtained in previous studies may be due to several factors: algal specie, seasonal variation, and solvent type, efficiency of the extraction method and the susceptibilities of the target strains.

Table 2: Phytochemical analysis of methanolic extract from *A. taxiformis, H. musciformis* and *C. elongata*

Phytochemicals tests	***A. taxiformis***	***H. musciformis***	***C. elongata***
Flavonoids	+	+	+
Tannins	+	+	+
Saponins	+	+	+
Anthraquinones	+	-	+
terpénoïds	+	+	+
Coumarins	-	-	+

+ Present - Absent

Table 3: IC_{50} and $1/IC_{50}$ values obtained in DPPH radical scavenging assay

Extracts	**IC_{50} (mg/mL)**	**$1/IC_{50}$ (mg/mL)**
A.taxiformis	0.40	2.5
H .musciformis	0.18	7.69
C. elongata	0.11	9.09
Ascorbic acid	0. 071	14.08

Table 4: Antibacterial activity of methanolic extract *from A. taxiformis, H. musciformis* and *C. elongata* in agar diffusion assay

	A. taxiformis	***H. musciformis***	***C. elongata***	**Ciprofloxacin, 30 µg/disc**	**DMSO**	**Methanol**
E. coli ATCC 25922	14.5 ± 0.3	12.27 ± 2.4	14.5 ± 0.3	21.8	00	00
S. enteritidis ATCC 2453	00	00	12.23 ± 1.9	24.5	00	00
S. typhimurium ATCC 13311	12.4 ± 0.1	09.4 ± 0.1	10.06 ± 1.4	25.00	00	00
. *pneumoniae* ATCC 70603	10.1 ± 1.8	00	00	24.00	00	00
S. aureus ATCC 25923	12.81 ± 2.3	10.26 ± 1.6	16.6 ± 0.1	25.2	00	00
E. feacalis ATCC 49452	00	12.1 ± 1.9	00	00	00	00
B. cereus ATCC 11778	15.42 ± 2.17	13.62 ± 0.1	08.3 ± 0.7	21.00	00	00
K. pneumoniae (VRE)	00	11.2 ± 0.6	00	23.2	00	00
E. feacalis (*MDR*)	12.29 ± 0.7	00	10.42 ± 2.2	00	00	00
P. aerugenosa (MDR)	00	07.2 ± 2.1	12.02 ± 1.7	00	00	00
S. aureus (MRSA)	13.32 ± 9.12	00	08.3 ± 0.1	21.00	00	00
S. epidermidis (MRSE)	14.02 ± 0.27	00	00	20.5	00	00

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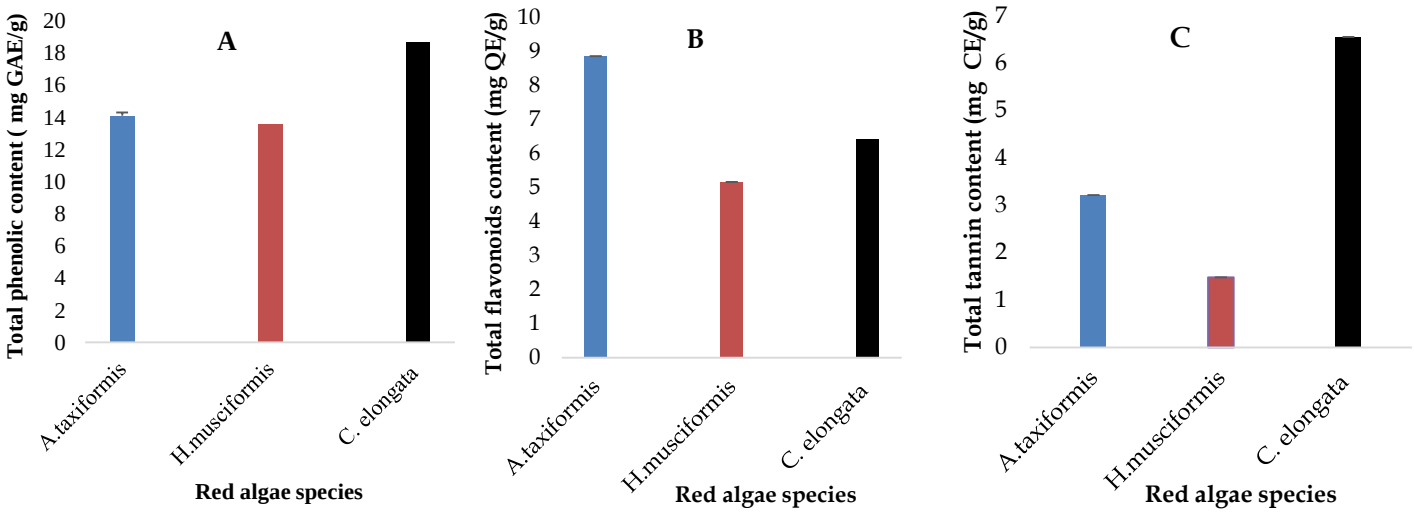

Figure 1: Total phenolic (A), total flavonoids (B) and total condensed tannin contents(C) of *A. taxiformis*, *H. musciformis* and *C. elongata*

Conclusion

From the above study, methanolic extracts of red algae (*A. taxiformis*, *H. musciformis* ,*C. elongata*) harvested from Algerian West Coast (Oran) possess remarkable antioxidant and antibacterial activities. This result could be related to the presence of bioactive metabolites in the selected seaweeds, which are soluble in methanol. Detailed information and data on these activities need to be undertaken with individual species. Therefore, intensive future studies should be performed to characterize the antioxidant and antibacterial components that are behind for this biological property.

Conflict of interest

The authors declare no conflict of interest.

Authors' Declaration

The authors hereby declare that the work presented in this article is original and that any liability for claims relating to the content of this article will be borne by them.

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