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Evaluation of Adsorption and Absorption Factors for Radionuclides and Organic Compounds for Marine Ecosystem in Red sea , Egypt

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Abstract

Aquatic life is impacted by radionuclides and organic substances occurred by oil spills and industrialization. The accumulation of radionuclides such as ^{238}U, ^{232}Th, and ^{40}K and total petroleum hydrocarbon or aliphatic hydrocarbons in the marine ecosystem has a significant ecological and public health concern. Many peoples throughout the globe greatly rely on marine biota as a source of protein. These chemicals impact marine life when adsorbed, absorbed, or directly intake by them and, ultimately, humans. Therefore, the seawater, sediments, and marine algae were analyzed for the absorption and adsorption concentration of radionuclides and organic hydrocarbons. The samples for the study were collected from two regions of the Ras Ghareb Sea coast. The samples were marine algae, water, and sediment. The samples were brought to the laboratory and prepared for further evaluation. The radioactivity and Gas Chromatographic analysis was performed in the Egyptian Nuclear and Radiological Regulatory Authority Laboratory. The concentration of ^{238}U, ^{232}Th, and ^{40}K was higher in coastal sediment than in seawater. The *Chondria seticulosa* show a high concentration of radionuclides, and bioaccumulation of total petroleum hydrocarbon and aliphatic hydrocarbons compared to *Sargassum dentifolium*. Among the TPH high concentration of Decane C10 was 31.6 ng/g DW in the coastal sediment of region 2 while 19.4 ng/g DW in *Chondria seticulosa*. Comparably the Bioconcentration factor of Eosin C20 was 2.607 in the red algae of the region1. Therefore, it is determined that the concentration and bioaccumulation of radionuclide and TAH were high in the coastal sediments and red algae of Ras Ghareb as compared to water and brown algae. *Chondria seticulosa* has a high capacity for absorption of these complex chemicals compounds.

Keywords: Radionuclides, Oil spills; Absorption; Adsorption, Organic compounds

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Introduction

Naturally, radionuclides are unstable when they undergo radioactive decay become stable [1]. Recently, the number of radionuclides such as ^{238}U, ^{232}Th, ^{228}Ra, and ^{40}K in the marine biosphere has drawn much attention as a major ecological and public health concern because radium takes a long time to degrade in the human body[2]. In reality, radium-228 (^{228}Ra) emits beta radiation with low energy and relatively poor ionization capacity, and radium-226 (^{226}Ra) releases alpha particles with very high energy[3]. Several communities of the world take marine biota as a significant source of protein[4]. The three main process uptake mechanisms of radium in marine organisms are adsorption, absorption, and intake through water and feed. The fish take radionuclides through food sediment and mainly water[5]. Several researchers have demonstrated that organisms living in or on polluted sediments can bioaccumulate the pollutants [6]. An elegant experiment carried out by Farrington involving a multiphase experimental exposure design of a demersal fish (*Leiostomus xanthurus*) feeding on a polychaete (*Nereis virens*) with both fish and polychaete exposed to PCB-contaminated [7]. This factor enables the bioaccumulation abilities of two species toward a single radionuclide to be compared. In this case, the term 'bioaccumulation ability' should be understood as the relationship between the bioaccumulation rate during a given time interval and the bioaccumulative capacity. However, more than the simple measurement of radionuclide concentrations is required to distinguish which of these two components is the most influential on the final result.

In knowledge, fishes have many health benefits due to their rich source of vitamins and minerals[8]. In contrast, the intake of accumulated radionuclides fish has many serious health concerns[9]. In studies of the behavior of heavy metals and organic pollutants, radionuclides can be utilized as radiotracers[10]. “Unfortunately, in the current study, the steady state was not achieved during the experiment to calculate radionuclide concentrations in the seawater”. Therefore, it was hypothesized to measure the bioconcentration of radionuclides, total petroleum hydrocarbon, and total aliphatic hydrocarbons in marine algae with water and sediments of habitat. This could be helpful in the determination of targeted chemicals to assess the risk of a hazardous effect on health.

Materials and Methods

Study area

The study area was along the coast of Ras Ghareb, Egypt. The spatial position of station 1 is latitude 28° 21' 13″ and longitude 33°5' 40″ while station 2 is latitude 28°20' 19″ and longitude 33°6' 45″.

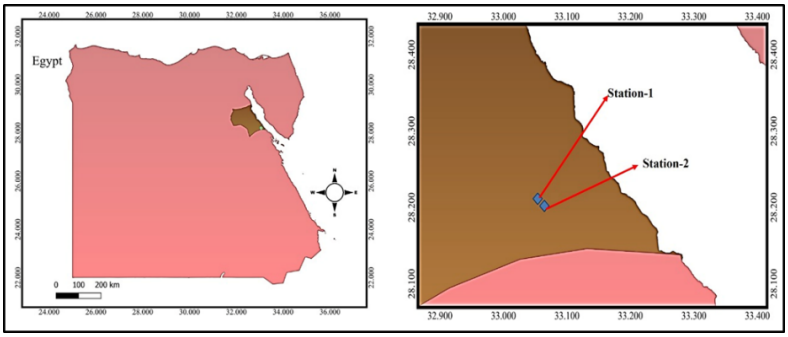

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FIG.1. **The geological position of region 1 and 2 of the sampling area at Ras Gareb**.

Sampling

The samples were taken from superficial shoreline sediment, seawater, marine species of algae, *Sargassum dentifolium* (Brown algae), and *Chondria seticulosa* (Red algae) at Ras Ghareb, Egypt station1, and station2. The samples were properly packed in polythene bags and transported into a laboratory for chemical analysis.

Preparation of experimental samples

The seashore sediment samples were air-dried at room temperature for a week. Further, it was incubated in the oven at 80°C for 48 hours till constant dry weight was obtained while crushed and homogenized. Then the samples were milled, sieved through 0.4 mm mesh filters, and stored for further analysis. The water was collected through a water sampler of 5 liters in each separate polythene bag. Then samples were acidified with Nitric acid that attained a pH of less than 2 to avoid micro-organisms growth. The samples were stored for radioactivity and Polycyclic aromatic hydrocarbon measurements. The samples were taken out of the ice pack, thawed, and rinsed with tap water to eliminate contamination in the lab. Then it was divided into pieces and put in a sample vial after being processed with an aseptic tool and plates. After that, the samples were labeled. The samples of marine organisms *Sargassum dentifolium* and *Chondria seticulosa* were transported to the laboratory in ice boxes and stored at -10^{o}C until further analysis, and about 20 samples of each species were collected from the study area from the same location as water samples. The marine samples were washed and cut into smaller pieces for effective grinding. The cleaned samples were dried in an oven at 70^{o}C for five days to ensure that the sample was completely moisture free and had a constant dry weight gain. The dried samples were ground to fine grain sizes using a stainless-steel cutter blender and sieved to obtain homogeneity. All homogenized samples were divided into two parts. The first part was transferred into a 250 ml sizes Marinelli beaker that was sealed hermetically and left for about four weeks at room temperature to attain secular equilibrium among the ^{238}U-series and ^{232}Th-series precursors with their short-lived progenies[11]**.** The second part was kept in the laboratory at room temperature to be used for the analysis of the organic hydrocarbon samples.

Radioactivity measurements

The concentration of natural radioactive elements ^{238}U, ^{232}Th, and ^{40}K in the samples was determined using a high-resolution HPGe γ-spectrometry system with 30% counting efficiency.

It was performed using 250 cm^3 counting vials filled to a height of 7 cm, corresponding to 170 cm^3. The duration measurement was up to 80,000 sec and was carried out in the Egyptian Nuclear and Radiological Regulatory Authority Laboratory. The obtained spectra were analyzed. The gamma-ray transitions were used to determine the existence of radionuclides and calculate their activities. The ^{226}Ra or ^{238}U activities were estimated from ^{234}Th (92.38keV, 5.6%) for samples assumed to be in radioactive equilibrium. However, γ-energies of ^{214}Pb (351.9 keV, 35.8%) and ^{214}Bi (609.3,45%), (1764.5 keV, 17%), and ^{226}Ra (185.99 KeV, 3.5%) were used to estimate the concentration of ^{226}Ra. The Gamma-ray energies of ^{212}Pb (238.6 keV, 45%), and ^{228}Ac (338.4 keV, 12.3%), (911.07 keV, 29%), (968.90 keV, 17 %) were used to estimate the concentration of ^{232}Th. The activity concentrations of ^{40}K were measured directly by their gamma rays (1460.8 keV, 10.7%). An empty polystyrene container was counted the same way as the samples

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to assess the background distribution caused by naturally occurring radionuclides in the area around the detector. The final activity concentrations were calculated after measurement and subtraction of the background. The activities were determined by measuring their respective decay daughters [12-15].

Total Petroleum Hydrocarbons (TPH extraction

The cute parts of algae were crushed in a mortar with a pestle. The extraction was performed using ten grams of samples from each specie, weight through analytical balance. The sample was put into a 100 mL beaker and 60mL of acetone and dichloromethane (1:1 v/v) were used as an extraction solvent. The total petroleum hydrocarbon contents of *Sargassum dentifolium and Chondria seticulosa* were extracted by shaking. The beaker with the content was placed on a magnetic stirrer/ heater and shaken for about 10 minutes at 70°C. The extract was poured into a clean round-bottom flask. Then 30 mL of fresh solvent was added, and the process was repeated. The extracts were combined, and 5 grams of anhydrous sodium sulfate was added to remove water. The extract was concentrated to 3 mL with a rotary evaporator maintained at 20°C. Then 1.5 mL of the concentrated extract was loaded on a silica gel column. The silica gel column was prepared by loading a 2 g glass wool, followed by 30 g silica gel, onto a chromatographic column that was 2 cm internal diameter and 10 cm long. Each bed was prepared with 40 ml HPLC-hexane to remove any organic contaminant.

Furthermore, 1.5 mL concentrated extract was loaded and eluted with 30 mL HPLC hexane into a labeled100 mL beaker to get the aliphatic hydrocarbon components in the sample. After the hexane had almost eluted through the column, but before completely letting the column dry, 30 mL of dichloromethane was added to elute the aromatic hydrocarbon contents into another labeled 100 mL beaker. Then 2 g of anhydrous sodium sulfate was added to remove any traces of water left in the extract. The fractions were concentrated using a rotary evaporator of about 2 ml. Then 1ml of the extract was transferred into a well-labeled vial ready for gas chromatographic analysis. The samples were stored at 4°C until GC analysis.

Gas chromatographic analysis

Each extract was transferred to a 1.5 mL vial and was loaded into a gas chromatography system Agilent 6890 series model G1530 A, with Flame Ionization Detector (FID) and cold on-column injection. Then 1µL sample was injected and analyzed for TPH (C9–C36). An HP-5 (crosslinked PH ME siloxane) column with dimensions 30 m x 0.25 mm with a stationary phase thickness of 0.25 µm was used for analytical separation. The carrier gas was purified nitrogen held at a flow rate of 5 mL per minute. The operating temperature program was started at 60°C for 2 mins and then increased at a rate of 10°C per minute to 300°C for 10 minutes. The injector and detector temperature were maintained at 250°C(**FIG. 1**).

Results and Discussion

Radionuclides in seawater and sediments

The absorption of ^{238}U, ^{232}Th, and ^{40}K in seawater and coastal sediments of two regions in Ras Ghareb, Egypt.

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nucleoid concentration was found higher in sediments than in seawater of both regions (**FIG. 2**). Thorium was found with low concentration in sediments than water only in the region1. While the amount of 40K in both water and sediments varies significantly (**TABLE 1**).

A study was done along the coast of the Oman Sea on the concentration of ^{238}U, ^{232}Th, and ^{40}K, showing that sediments have agreater variety of radionuclides than water samples. Though, it was acceptable in terms of environmental andradioisotope risks when compared to reference values fromIran and other regions of the world. Regarding the turkey, the radio nucleotide value was found higher than permitted by global guidelines[16].

$$SiO_2{}^{238}U \longrightarrow SiO_2 + {}^{238}U$$

$$H_2O^{238}U \longrightarrow H_2O + {}^{238}U$$

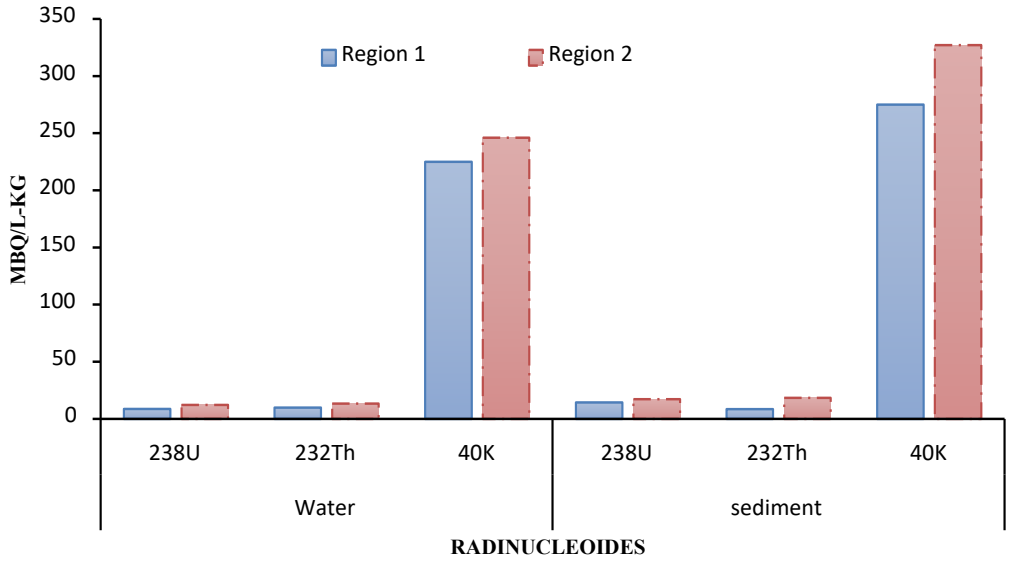
$$SiO_2{}^{32}Th \longrightarrow SiO_2 + {}^{32}Th$$

$$H_2O^{32}Th \longrightarrow H_2O + {}^{32}Th$$

$$SiO_2{}^{40}K \longrightarrow SiO_2 + {}^{40}K$$

$$H_2O^{40}K \longrightarrow H_2O + {}^{40}K$$

Another study in the Gulf of Thailand of these three natural radionuclides found high concentrations in marine sediment. In Jeddah, Saudi Arabia, a similar study found the normal limit of these radionuclides in the sediment.



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$$C_6H_{15}O_6N^{238}U \longrightarrow C_6H_{15}O_6 + {}^{238}U$$

$$C_6H_{15}O_6N^{32}Th \longrightarrow C_6H_{15}O_6 + {}^{32}Th$$

$$C_6H_{15}O_6N^{40}K \longrightarrow C_6H_{15}O_6 + {}^{40}K$$

FIG. 2. **Variation of nucleoids concentration inred seawater and sediments.**

Radionuclides in marine biota

The comparative analysis of radioactive material in both species revealed varying levels in their respective locations (**FIG. 3)**. The concentration of selected radionuclides was found high in Chondria seticulosa in both regions. While the concentration of these radionuclides was high in region 1 than in region 2 in both algae species (**TABLE 2)**.

A research study was conducted in Nigeria to find out the concentration of radionuclides in fish and fish feed, due to their high consumption rate in the area. The results found that both adults and children received annual committed effective doses that were all below the suggested 1.0 mSv y1 limit for members of the public. This demonstrates that, from a radiological standpoint, the radiation dose derived from ingesting fresh fish samples does not represent any substantial health hazards to the public [17,18]. An investigation was made into the radioactive activity of wild fungi in Iraq, particularly black desert truffles. The measured values were identified as lower than the estimated value for the international mean [19].

The bioconcentration factor algae

The bioconcentration of radionuclides was found with a high concentration in *Chondria seticulosa* in both regions of the samples. The high concretion of ^{238}U **2.016**, was found in *Chondria seticulosa* in Region1. While the BCF of ^{40}K was 1.178 in *Chondria seticulosa*

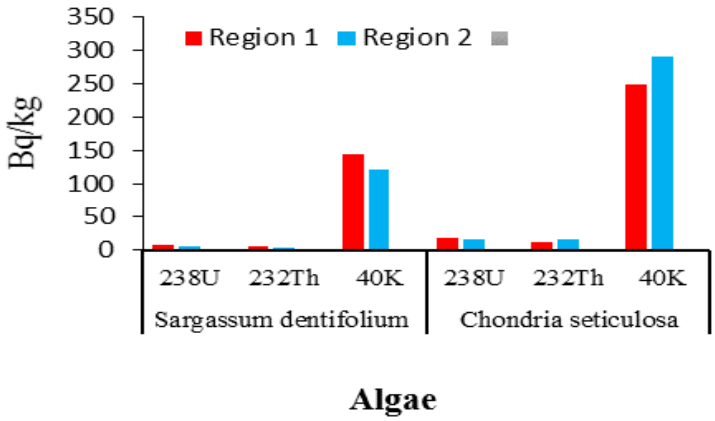

FIG. 3. **Bioconcentration of Radionuclides in algae species of region 2.**

The use of concentration factors as a practical technique to represent the accumulation of radionuclides in biota relative to radionuclide concentrations in seawater was motivated by the necessity to report radionuclide accumulation in biota

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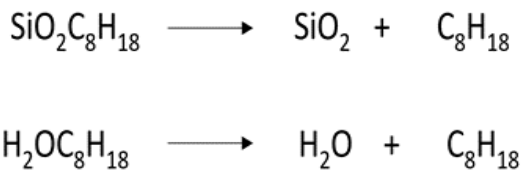
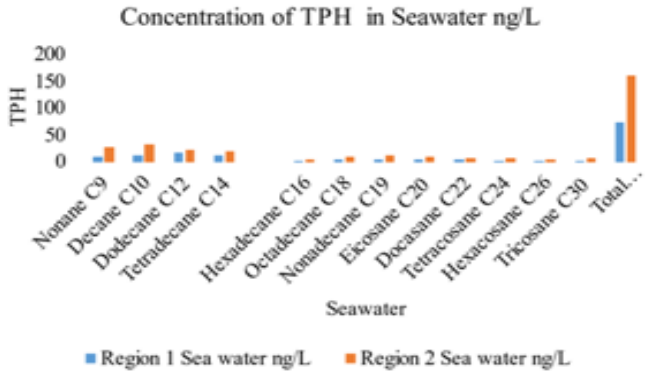
in various conditions and geographical areas. Later, concentration factors were used to forecast radioactivity in organisms and model radioactive distribution and transfer in aquatic settings [20]. In China, it was found that humans ingested the aquatic animals at a determined committed effective dose of 0.06 mSv-2.99 mSv. The artificial nuclides ^{90}Sr and ^{137}Cs had minimal dose contributions, but ^{210}Po was the main source of radiation damage in both marine creatures and humans [21].

Petroleum hydrocarbons in seawater and sediments

The findings of TPH show varying results in seawater and sediments of both sites. The highest value of Decane C10 was 31.6 ng/g DW followed by N (**TABLE 3**).





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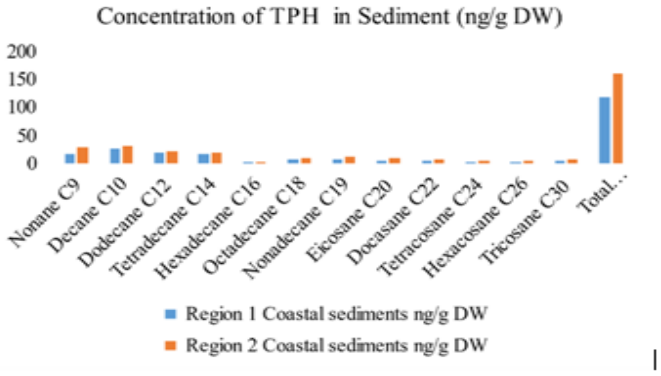

(B)

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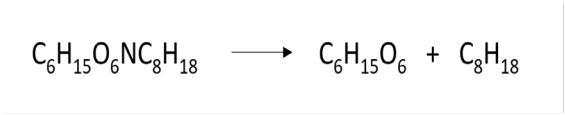
FIG.4 A) **Red Sea sediment concentration of TPH**. B) **Red Sea water concentration of TPH.**

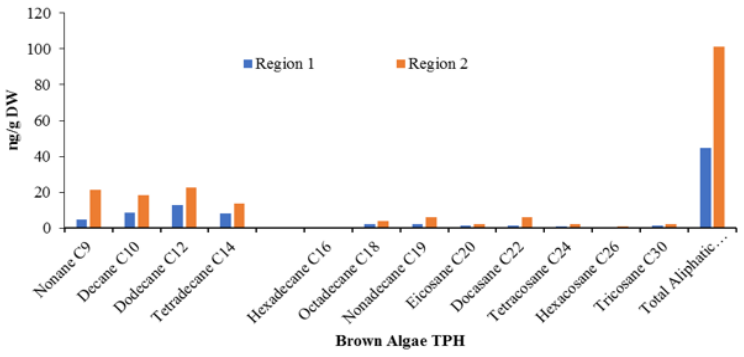
Nonane C9 at 28.3 ng/g DW was found in Region 2 of Ras Ghareb among the TPH. The overall values of TPH were observed high in region 2 as compared to Region 1 (**FIG. 4**). The TPH 160.2 ng/g DW was found in the Region 2 coastal sediments (**TABLE 4**).

According to a study in the Southern China sea on TPHs and n-alkanes. Here it was found that TPHs were higher than those on the far shore in the central and northern waters along the shoreline. The concentration of n-alkanes in the water samples ranged from C10 to C38, and they were primarily produced by higher terrestrial plants [22]. The TPH levels found in Pulicat Lake in India throughout the study period present less of an ecological threat to the environment and biota [23].

Total aliphatic hydrocarbons in brown and red algae

The results of TAH demonstrate that both sites of water and sediments have different outcomes. In Region 2 of Ras Ghareb, among the TAH, the highest concentration of Dodecane C12 was found at 29.7 ng/g DW, followed by Nonane C9 at 28.2 ng/g DW of Chondria seticulosa. When comparing the TAH of area 1 which was 45.5 and 82.7 with region 2 which was 101 and 134, it was found that region 2 has a high concentration of aliphatic hydrocarbons (**FIG. 5**). Correspondingly, it was also observed that *Chondria seticulosa* has a high absorption capacity of TAH than *Sargassum dentifolium* (**TABLE 5**). The F3 and F4 fractions of *Fucus viroids* were found to have good radical scavenging properties *in vitro*, and zebrafish embryos showed a protective effect against oxidative stress brought on by hydrogen peroxide (**FIG. 6)** [24]. The two species of algae *Taonia atomaria* and *Padina pavonica* of the central Adriatic Sea were significantly found to be primary oil composition constituents[25] (**TABLE 6**)





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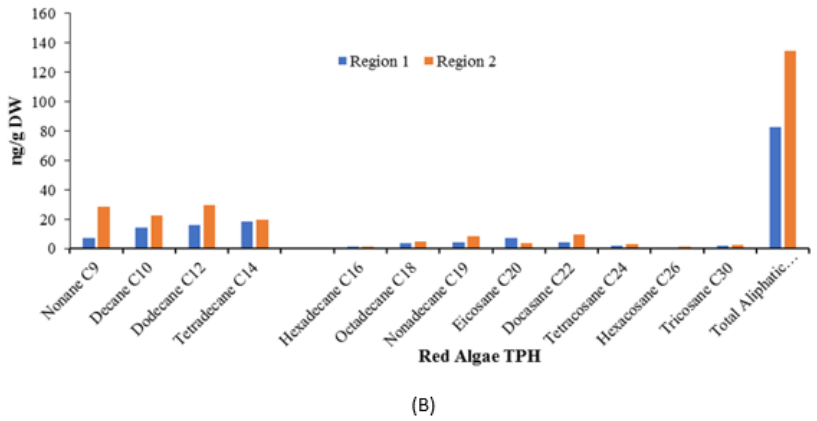

(B)

FIG. 5. **TPH bioaccumulation in A) Brown algae and B) Red algae.**

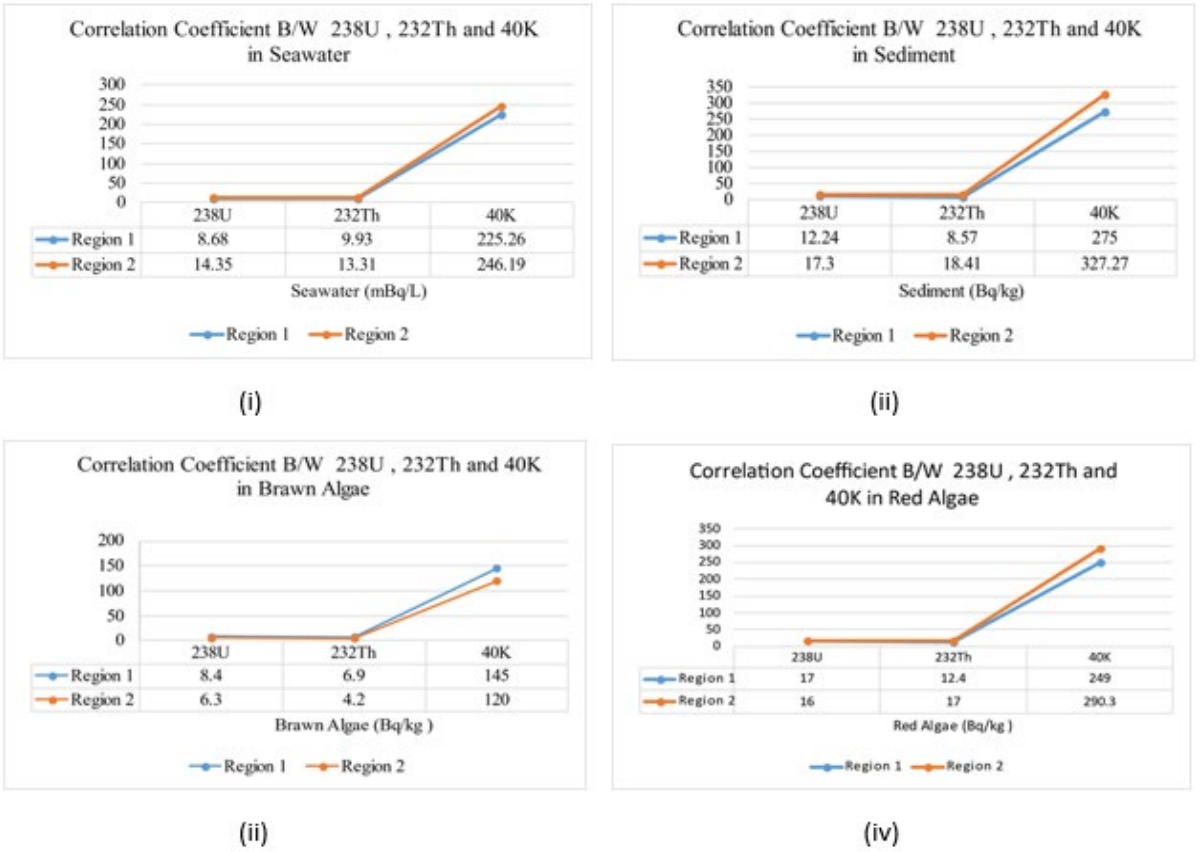

FIG. 6. The correlation of absorption and adsorption of ^{238}U, ^{232}Th, ^{40}K in i Seawater, ii Sediments iii Brawn algae iv) Red algae.

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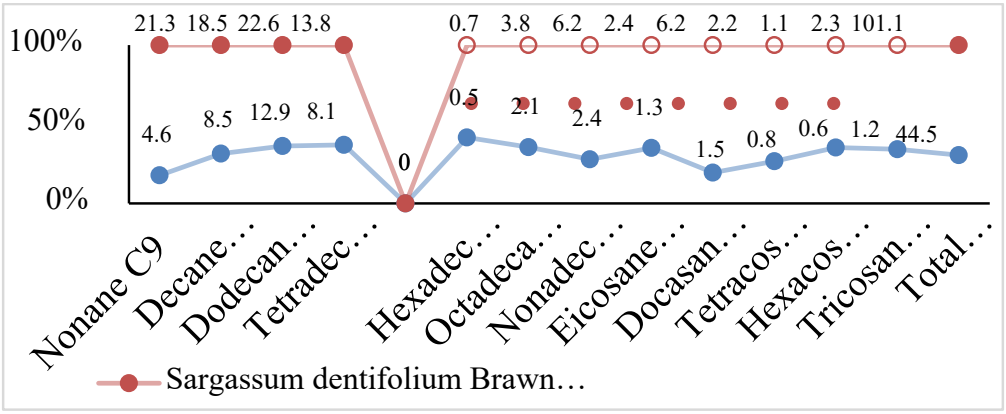

FIG.7. **Correlation coefficient B/W TPH with brown, red algae.**

Bioconcentration factor for total aliphatic hydrocarbons in brown and red algae

The BCF of Region 1 6.8, 14.7 has greater than region 2, while Chondria seticulosa was shown a higher value of TAH in both sites. Eicosane C20 was the highest BCF in Chondria seticulosa of Region 1. The high bioconcentration of aliphatic compounds in Chondria seticulosa indicates its absorption capacity(**TABLE 7**).

The ability of mangroves to absorb and store heavy metals in their tissue lower heavy metals in the aquatic environment because of their capacity to do so (**FIG. 7**). According to the review, the mangrove species have a promising potential to be employed for biomonitoring in the aquatic environment[26-32] (**TABLE 8**). Perennial herbs species were identified as sensitive that can be produced to lessen soil contamination in Pazanan, based on their frequency and resistance to adverse conditions is a suitable option for the phytoremediation of soil contaminated with nickel and TPHs [33-44] (**TABLE 9**) .

TABLE 1. **Concentration of ^{238}U, ^{232}Th, and ^{40}K in seawater and coastal sediments collected from different locations along the Ras Ghareb region coastline.**

Radionuclide's	Sites			
	Ras Ghareb Station 1		Ras Ghareb Station 2	
	Latitude 28° 21′ 13″	Longitude 33° 5′ 40″	Latitude 28° 20′ 19″	Longitude 33° 6′ 45″
	Water (mBq/L)	Sediment (Bq/kg^{-1})	Water (mBq/L)	Sediment (Bq/kg^{-1})
^{238}U	8.68 ± 0.12	12.24 ± 0.13	14.35 ± 0.14	17.3 ± 0.15
^{232}Th	9.93 ± 0.11	8.57 ± 0.35	13.31 ± 0.35	18.41 ± 0.38

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^{40}K	225.26 ± 2.7	275.26 ± 2.4	246.19 ± 1.9	327.27 ± 3.1

TABLE 2. **Concentration $^{of\ 238}$U, ^{232}Th, and ^{40}K in marine organisms collected from different locations along the Ras Ghareb region coastline.**

Radionuclide's	**Sites**			
	Ras Ghareb region 1		**Ras Ghareb region 2**	
	Sargassum dentifolium Brawn algae (Bq/kg)	*Chondria seticulosa* Red algae (Bq/kg)	*Sargassum dentifolium* Brawn algae (Bq/kg)	*Chondria seticulosa* Red algae (Bq/kg)
^{238}U	8.4 ± 0.14	17.5 ± 0.16	6.3 ± 0.13	16.1 ± 0.24
^{232}Th	6.9 ± 0.11	12.4 ± 0.26	4.2 ± 0.15	17.4 ± 0.21
^{40}K	145.18 ± 1.7	249.7 ± 2.8	120. 8 ± 1.6	290.31 ± 2.5
^{238}U: Isotope of uranium, ^{232}Th: Naturally occurring isotope of thorium, ^{40}K: Radioactive isotope of potassium, Bq/kg^{-1}: Becquerel per kilogram				

Investigated marine organisms ^{238}U: Isotope of uranium, ^{232}Th: naturally occurring isotope of thorium, ^{40}K: radioactive isotope of potassium, BCF: Bio-concentration factor[45-57] .

TABLE 3. **Bioconcentration Factor (BCF) for radionuclides in marine organisms along the Ras Ghareb region coastline.**

Radionuclide's	**Sites**			
	Ras Ghareb region 1		**Ras Ghareb region 2**	
	Sargassum dentifolium Brawn algae	*Chondria seticulosa* Red algae	*Sargassum dentifolium* Brawn algae	*Chondria seticulosa* Red algae
BCF ^{238}U	0.967	2.016	0.439	1.121

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BCF ^{232}Th	0.694	1.248	0.315	1.307
BCF ^{40}K	0.644	1.108	0.490	1.178
^{238}U: Isotope of uranium, ^{232}Th: Naturally occurring isotope of thorium, ^{40}K: Radioactive isotope of potassium, BCF: Bio-Concentration Factor				

TABLE 4. **Distribution and concentration levels of Total Petroleum Hydrocarbons (TPH) found in seawater and coastal sediments on *Ras Ghareb* coastline.**

TPH	**Sites**			
	Ras Ghareb region 1		**Ras Ghareb region 2**	
	Sea water ng/L	Coastal sediments ng/g DW	Sea water ng/L	Coastal sediments ng/g DW
Nonane C9	9.4	18.3	21.4	28.3
Decane C10	12.6	26.1	26.9	31.6
Dodecane C12	17.5	19.3	18.2	22.4
Tetradecane C14	11.9	17.9	14.6	19.3
Hexadecane C16	0.9	2.7	1.9	3.6
Octadecane C18	4.7	6.8	8.6	9.4
Nonadecane C19	3.2	7.4	9.4	11.6
Eicosane C20	2.8	4.6	7.2	9.3
Docasane C22	4.2	6.2	6.5	7.2
Tetracosane C24	1.3	3.1	4.4	6.1
Hexacosane C26	1.1	2.9	2.7	4.6
Tricosane C30	2.4	4.6	5.8	6.8
Total Petroleum hydrocarbon	72	119.9	127.6	160.2
ng/L: Nanogram per litre, ng/g DW: Nanogram per gram of dry weight				

TABLE 5. **Concentration levels of total aliphatic hydrocarbons TAH found in marine organisms collected from different locations along the Ras Ghareb region coastline.**

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TAH	Sites			
	Ras Ghareb region 1		Ras Ghareb region 2	
	Sargassum dentifolium Brawn algae ng/g DW	*Chondria seticulosa* Red algae ng/g DW	Sargassum dentifolium Brown algae ng/g DW	*Chondria seticulosa* Red algae ng/g DW
Nonane C9	4.6	7.3	21.3	28.4
Decane C10	8.5	14.2	18.5	22.3
Dodecane C12	12.9	15.8	22.6	29.7
Tetradecane C14	8.1	18.3	13.8	19.4
Hexadecane C16	0.5	1.1	0.7	1.2
Octadecane C18	2.1	3.8	3.8	4.9
Nonadecane C19	2.4	4.1	6.2	8.2
Eicosane C20	1.3	7.3	2.4	3.8
Docasane C22	1.5	4.2	6.2	9.6
Tetracosane C24	0.8	1.7	2.2	3.4
Hexacosane C26	0.6	0.9	1.1	1.3
Tricosane C30	1.2	1.9	2.3	2.6

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Total Aliphatic hydrocarbon	44.5	82.7	101.1	134.8
ng/L: nanogram per litre, ng/g DW: nanogram per gram of dry weight.				

TABLE 6. **Bio-Concentration Factor (BCF) for the investigated TAH in the investigated marine organisms in the water.**

BCF TAG	**Sites**			
	Ras Ghareb region 1		**Ras Ghareb region 2**	
	Sargassum dentifolium Brawn algae	*Chondria seticulosa* Red algae	*Sargassum dentifolium* Brawn algae	*Chondria seticulosa* Red algae
Nonane C9	0.489	0.776	0.995	1.327
Decane C10	0.674	1.12	0.687	0.828
Dodecane C12	0.737	0.902	1.241	1.631
Tetradecane C14	0.680	1.537	0.945	1.328
Hexadecane C16	0.555	1.222	0.368	0.631
Octadecane C18	0.446	0.808	0.441	0.569
Nonadecane C19	0.75	1.281	0.659	0.872
Eicosane C20	0.464	2.607	0.333	0.521
Docasane C22	0.357	1	0.953	1.476
Tetracosane C24	0.615	1.307	0.5	0.772
Hexacosane C26	0.545	0.818	0.407	0.481
Tricosane C30	0.5	0.791	0.396	0.448
BCF Total Aliphatic hydrocarbon	6.812	14.169	7.29	10.884
BCF: Bio-Concentration Factor, TAH: Total Aliphatic Hydrocarbons				

TABLE 7. **Comparison of activity concentration of ^{226}Ra, ^{232}Th, and ^{40}K (Bq/kg) in algae in other studies.**

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Location	^{238}U Series Bq/kg	^{232}Th Series Bq/ kg	^{40}K Bq/ kg	Reference
Nigeria	33	45	420	
Egypt	8.4	6.9	145.18	Present study

TABLE 8. **Comparison of activity concentration of ^{226}Ra, ^{232}Th, and ^{40}K (Bq/L) in Seawater those in other studies.**

Location	^{238}U Series Bq/l	^{232}Th Series Bq/l	^{40}K Bq/l
Egypt	0.971– 1.6	0.21– 1.1	0.97–23
Iran	0. 53	2.08	7. 17
Jordon	3. 7	2.41	24. 20
Pakistan	0.00175	0.00235	0.04708
Yemen	3. 47	2.02	15. 05
Turkey	0. 72	0. 53	2. 40
Iraq (Nineveh province)	0.842	0.93	25.92
Present work	8.68 ± 0.12	9.93 ± 0.11	225.26 ± 2.7

TABLE 9. **Comparison of activity concentration of ^{226}Ra, ^{232}Th, and ^{40}K (Bq/ Kg) in Sediments those in other studies.**

Location	^{238}U Bq/Kg	^{232}Th Bq/ Kg	^{40}K Bq/ Kg
World average	32	45	412
Egypt (Gulf of Suez)	13.79	14.55	128.67
Egypt (Red Sea)	23.80*	19.60	374.90
Egypt (Mediterranean Sea)	8.80 *	30.80	106.9

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Oman	20.49	2.26	44.83
Iran (Caspian Sea)	34.40*	11.40	310.00
Serbia (Boka Kotorska Bay)	37.00	35.00	580.00
Cyprus (East coast region)	23.00*	19.00	628.10
China (Beibu Gulf)	25.90	37.6	263
India (Tamilnadu)	47.04	26.63	372.49
Bangladesh (Bay of Bengal)	31.20	51.90	686.40
Turkey (Kocaeli- black sea)	8.85	8.93	219.41
Ghana (Tema Harbour)	34.00	30.00	320.00
Nigeria (Akwa Ibom)	23.00	36.00	145.00
Turkey	25.50 ± 21.50	27.90 ± 2.40	590.30 ± 28.60
Bangladesh	28.67 ± 3.09	49.46 ± 3.58	560.87 ± 81.40
Malaysia	41.00 ± 2.00	45.00 ± 4.00	680.00 ± 59.00
Saudi Arabia	26.40 ± 2.80	16.30 ± 2.20	451.00 ± 15.00
Oman	22.68 ± 0.32	21.38 ± 0.37	222.89 ± 3.52
Indonesia	47.29 ± 4.14	52.73 ± 5.28	744.00 ± 29.45
Saudi Arabia	3.50*	5.90**	113.50
Present study	12.24 ± 0.13	8.57 ± 0.35	275.26 ± 2.4

Conclusion

The chemical analysis of seawater, sediments and marine algae was performed to investigate their adsorption and absorption capacity of radionuclides, total petroleum hydrocarbons, and total aliphatic hydrocarbons. the concentration and bioaccumulation of radionuclides, TPH, and TAH were observed with high levels in the coastal sediments and red algae of Ras Gareb as compared to water and brown algae. The value of radionuclides was found within the acceptable range of international limits. The *Chondria seticulosa* were found with significant absorption of

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TPH, TAH, and radionuclides. So, it could be used to lower the concentration of these chemicals in seawater.

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