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PHYSICO-CHEMICAL CHARACTERISTICS IN THE RED SEA COASTAL WATERS IN AL-HUDAYDAH CITY, YEMEN

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ABSTRACT

The present research aimed to study some of the physiochemical properties of seawater samples collected in December 2019 from eight beaches about the city of AL-Hudiedah, northern Yemen. The physicochemical properties ranged as follows: temperature (26-27.30°C), pH (7.90-8.33), salinity turbidity (1.5-16 NTU), electrical conductivity (59300-61900 us/ cm), Total dissolved solids (39731-41473mg/L), salinity (37.3-38.4ppt), dissolved oxygen (4.2-7mg/L), biochemical oxygen demand (0.30-2.95mg/L) and Chemical oxygen demand (1300-2300mg/L). The results of the study confirm the importance of protecting AL-Hudiedah coastal waters from several pollutants.

KEYWORDS

Analytical study, Physico-chemical properties, Red Sea and Pollution.

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INTRODUCTON

Marine environment is one of the most important sources for natural resources. Marine environment is not only one of the most essential commodities for our day to day life but this natural resource also plays a crucial role in the world economic and social development process. The rapid development of human activities during the last decades with in densely populated areas has continuously increased the risk of environmental deterioration, especially in coastal systems. The aquatic environment is being abused throughout the world by the introduction of a large number of xenophobic compounds derived from human activities in industry and agriculture[1,2].

Many of these substances have the potential to impact on the ecosystem at relatively low concentrations. One of the primary aims of environmental quality studies is to understand the impacts of anthropogenic compounds such as organic micropollutants on the ecosystem, in order to minimize or prevent adverse effects[3]. The rapid industrialization along the coastal area have brought considerable decline in the water quality particularly of brackish water and the estuaries producing increased pressures leading to environmental stress or even affect public health[4].

Marine pollution due to anthropogenic activities has now become a worldwide environmental concern[5]. Many researchers[6] mentioned the influence of indiscriminate discharge of untreated industrial effluent and municipal waste water on the marine environment in terms of danger to habitats, serious risk to marine life, deterioration of aesthetic values and limited access to coastal areas. Hence, monitoring of marine coastal environment is essential to formulate a viable management strategy[7].

Marine ecosystems around the world face degradation and collapse as a result of diverse threats (e.g. over fishing and environmental change), with potentially catastrophic consequences for biodiversity and ecosystem functions and ecosystem services[8]. Many offshore marine systems have undergone regime shifts in recent decades and reductions in commercial fishing[9]. The marine environment in the Republic of Yemen coastal area is subject to major contamination by persistent organic pollutants and heavy metals in largely unknown amounts from untreated domestic waste water, industrial waste water and agricultural drain water, run off during rainy periods, ship and boat traffic, oil transportation, oil spillage and atmospheric fallout[10]. Many areas along the coast are used as recreation areas by the public. The Coast is successfully used for commercial fish cultivation with a significant market in Yemen. The coastal waters of Yemen are characterized by its high primary and secondary productivity making it a basic feeding and nursery ground for marine species where more than 600 species and marine organisms were recorded in Yemen waters[10]. The present study aims to understand the dynamics of the microbiological component with special reference to bacteria and find out the relationship between phsico-chemical characteristics and microbiological components in the coastal area of Red Sea of Yemen.

MATERIAL AND METHODS

Study area

Al-Hodeidah Governorate is located on the Red Sea on the western part of the Republic of Yemen and extends on the western coastal strip overlooking the Red Sea coast between longitudes (42^o - 43^o) east of Greenwich and between latitudes (14^o - 16^o) north of the equator, It has approximately about 13,500 Km 2, with the estimated population of 979.000 in 2013[11]. The city of Hodeidah has a sewerage system of treatment plants. The municipal sewage is discharged daily about 18000 cubic meters into aseries of eleven oxidation ponds. The system of treatment serves nearly 35% of the residential population. The municipal sewage contains several types of liquid waste such as industrial liquid effluent and animal waste. About 70% of the municipal sewage is used for agriculture purposes. The remainder (30%) is discharged through a small open channel north of the city into the sea water close to khawr Al Kathib[12].

Sample collection and preparation

Eight water samples were collected during December 2019 locations on the coastal area of Hodeidah Governorate /Yemen (Table No.1 and Figure No.1). The water samples were analyzed for some physical, chemical and biological parameters. Water temperature, pH, were measured according to[13] Salinity and electrical conductivity were measured directly in situ using graduated thermometer, pH-meter (HQ 40d multi/HACH), hand-held Salinity refract meter and EC-meter (HQ14d multi /HACH) respectively. Total Dissolved Solids were measured according to[14], by the following equation, depending on E. C. value: TDS mg/l = E.C. µS/cm X 0.67. A turbidity meter (2100 Q HACH) was used to measure the turbidity of the water samples. Dissolved oxygen was fixed

immediately after collection and then determined by Winkler's method, two samples were considered for this analysis. DO was determined for the first sample immediately. The second sample was incubated for five days and then the DO was determined. The BOD was determined using the relation, BOD = DO before incubation - DO after incubation. The oxygen requirement was determined for samples using spectrophotometer (model DRB 200 , HACH, USA) at 620nm after digesting it for 2 hours at 150oC using COD Reactor (DRB 200, HACH, USA)15.

RESULTS AND DISCUSSION

Water temperature (T)

The water temperature values ranged (26 to 27.30^{o}C) with a mean of (26.69^{o}C) (Table No.2). Temperature values of the seven stations were higher compared to the reference station, which recorded the lowest values (26^{o}C). The maximum value of T in the station 1, 4, 6 (27.30, 27 and 26.93^{o}C) respectively (Figure No.2). The reason is due to the biological pollutants in these stations. The results of statistical analysis showed that mean values of temperature for every station were significantly different at $p<0.05$.

Hydrogen Ion concentration (pH)

In the present study, PH values ranged from (7.90 to 8.33) (Figure No.3) with average values of (8.08) (Table No.2). The highest pH value was recorded at the reference station 8 (8.33) and the lowest pH value was at the stations 1, 2.6 (7.90, 7.95 and 8.01) the lower pH values were observed which may due to the increase in the rate of organic matter decomposition by the microbial respiration, which may be increase CO_2 level leading to lowering the pH values. The results of the study were higher than the results of the study that was in 2013 in the North western Gulf of Suze, which was with a range (7.23-8.20) and an average of (7.62). The results of this study were higher than those observed by[16] in Jeddah Coast, Saudia Arabia who found DO values ranging from (5.22-6.55mg/L). The results of statistical analysis showed that mean values of PH for every station were significantly different at $p<0.05$.

Turbidity (Tur)

As shown (Table No.2) the turbidity levels at the study stations ranged from (1.5 to 16 NTU). The maximum value of turbidity was recorded at station 1, 4 which was (16, 14 NTU) (Figure No.4), this may be due to high turbidity indicates the presence of colloidal particles arising from clay and silt during rain m discharges of sewage and industrial waste or the presence of a large number off all or microorganisms. The minimum value of turbidity was recorded at station 7, 8 which was (3.1, 1.5 NTU), that low level of turbidity could be attributed to low wave actions and minimal turbulence. The results of statistical analysis showed that mean values of turbidity for every station were significantly different at $p<0.05$.

Electrical Conductivity and Total Dissolved Solids

As shown (Table No.2 Figure No.5) the electrical conductivity values ranged between (58300 Us/cm to 61900 Us/cm) with a mean of 60462 Us/cm. The maximum value of electrical conrductivity was recorded at station 1, 4 which was (61900, 61700 Us/cm) this increase may be due to increase sewage discharge that contains ions such as chloride, nitrates and phosphates that contribute to increased conductivity as well as an increase temperature in these two stations[17,18]. Pointed out that the maximum electrical conductivity was because of the manifestation of dissolved salts. This was supported by[19]. It is also an indicator of pollution which shows the presence of more inorganic ions in the effluent discharges received by the water[20]. The minimum value of electrical conrductivity was recorded at station 8, 3 which was (59300, 59400 Us/cm). May be due to rain water runoff which decreases conductivity.

Total dissolved solids values ranged from (39731mg/L to 41473mg/L) with a mean value 40509mg/L (Table No.2 Figure No.6). The maximum value of total dissolved solids e was recorded at station 1, 4 which was (41473, 41339mg/L) (Figure No.6). Values related to conductivity values, as they increase and decrease with increasing and decreasing conductivity. The results of statistical analysis showed that mean

values of electrical conductivity for every station were significantly different at $p<0.05$.

Salinity(S)

Through Table No.3 the results of the study showed that the range of salinity of the water was from (37.3 to 38.4ppt) and the average values were (37.86ppt) and the highest values of salinity were recorded in the stations (1, 4, 6) (38.4, 38.3, 38.2ppt) and (Figure No.7) the highest salinity values due to the following reasons: an increase in The rate of evaporation and that is when we headed north, where the salinity of those areas increased because there were no rivers that flowed into them and their distance from the Gulf of Aden. The lowest values of salinity were recorded in areas 7, 8 (37.3, 37.4) whenever we headed To the south of the Gulf of Aden and Bab al-Mandab sub-regions, the results of the study were higher than the results of the study that was conducted on the coast of the Gulf of Aden[21]. The results of statistical analysis showed that mean values of salinity for every station were significantly different at $p<0.05$.

Dissolved Oxygen (DO)

The dissolved oxygen values ranged between (4.2mg/L to 7mg/L) with a mean of (5.17mg/L) (Table No.3). The DO values of the seven stations were lower compared to the reference station, which recorded the highest values (7mg/L). The minimum value of DO observed at station 1, 4 and 6 which were (4.2, 4.3 and 4.9mg/L). The results of this study were higher than those observed by[16] in Jeddah Coast, Saudia Arabia who found DO values ranging from (5.22-6.55mg/L) and[22] who found the highest concentrations (DO) values (4.78 to 5.5mg/L) **in the Surface Coastal Waters along the Gulf of Aden and Arabian Sea, Yemen**. The results of statistical analysis showed that mean values of (DO) for every station were significantly different at $p<0.05$.

Biochemical Oxygen Demand (BOD)

Biochemical oxygen demand concentrations ranged from (0.3 to 2.95mg/L), with mean of (1.76mg/L) (Table No.3). The obtained BOD data showed that the maximum values recorded at stations 1 and 4 were (2.95 and 2.81mg/L) respectively, which have a higher pollution rate compared to other stations, this may be due to the abundance of nutrients that accompany waste water, which leads to an increase in the number of microorganisms, thus the request for dissolved oxygen increases in this waters, while the lowest concentration was (0.30mg/L) at station 8 (the reference station) that was farther from pollution sources. As shown in (Table No.2) BOD values in the seven stations were higher compared to the reference station. The results of statistical analysis showed that mean values of biochemical oxygen demand for every stations were significantly different at $p<0.05$.

Chemical Oxygen Demand (COD)

Chemical oxygen demand concentrations ranged from (1300 to 2300mg/L), with mean of (2025mg/L) (Table No.3). The obtained COD data showed that the maximum values recorded at stations 3 and 6 which were (2300mg/L) while the lowest concentration was (1300mg/L) at station 8 (the reference station) that was farther from pollution sources. As shown in (Table No.2) COD values in the seven stations were higher compared to the reference station. The results of this study were lower than those observed by[23] in the red sea coast near Jeddah, Saudi Arabia found COD values ranging from (88 to 7680mg/L). The results of statistical analysis showed that mean values of chemical oxygen demand for every stations were significantly different at $p<0.05$.

Table No.1: The samples locations on Hodeidah coastal

No. of station	Name of station	Latitude (North)	Longitude (East)
1	Radio building	14° 46' 36"	42° 56' 58"
2	Navy College	14° 47' 00"	42° 56' 59"
3	Four Season	14° 48' 28"	42° 55' 52"
4	Al - Salif	15° 20' 01"	42° 41' 31"
5	Ebnabase	15° 23' 23"	42° 48' 13"
6	Al - Khawbah	15° 32' 12"	42° 46' 46"
7	Al - Luhayyah	15° 44' 12"	42° 42' 37"
8	Al - Jabanah	14° 55' 44"	42° 56' 06"

Table No.2: Mean Values of Some Physicochemical in the study area

S.No	Parameters / Stations	T (C)	PH	Tur (TNU)	E.C (Us/cm)	T.D.S (mg/L)
1	Station 1	27.30	7.90	16	61900	41473
2	Station 2	26.82	7.95	7.5	59800	40066
3	Station 3	26.91	8.06	9.4	60800	40736
4	Station 4	27	8.09	14	61700	41339
5	Station 5	26.33	8.11	4.3	59600	39932
6	Station 6	26.93	8.01	12	61200	41004
7	Station 7	26.30	8.21	3.1	59400	39798
8	Station 8	26	8.33	1.5	59300	39731
9	Minimum	26	7.90	1.5	59300	39731
10	Maximum	27.30	8.33	16	61900	41473
11	Mean	26.69	8.08	8.475	60462	40509
12	S.D	.43888	.13885	5.296	1063.60	712.61

Table No.3: Mean Values of Some Physicochemical in the study area

S.No	Parameters / Stations	S (ppt)	DO (mg/L)	BOD (mg/L)	COD (mg/L)
1	Station 1	38.4	4.2	2.95	2100
2	Station 2	37.8	5.1	1.74	2150
3	Station 3	38	4.7	1.99	2300
4	Station 4	38.3	4.3	2.81	2000
5	Station 5	37.5	5.4	1.12	2100
6	Station 6	38.2	5.9	2.30	2300
7	Station 7	37.4	5.8	.90	1950
8	Station 8	37.3	7	.30	1300
9	Minimum	37.3	4.2	.30	1300
10	Maximum	38.4	7	2.95	2300
11	Mean	37.862	5.175	1.763	2025
12	S.D	.42741	.9098	.93688	318.74

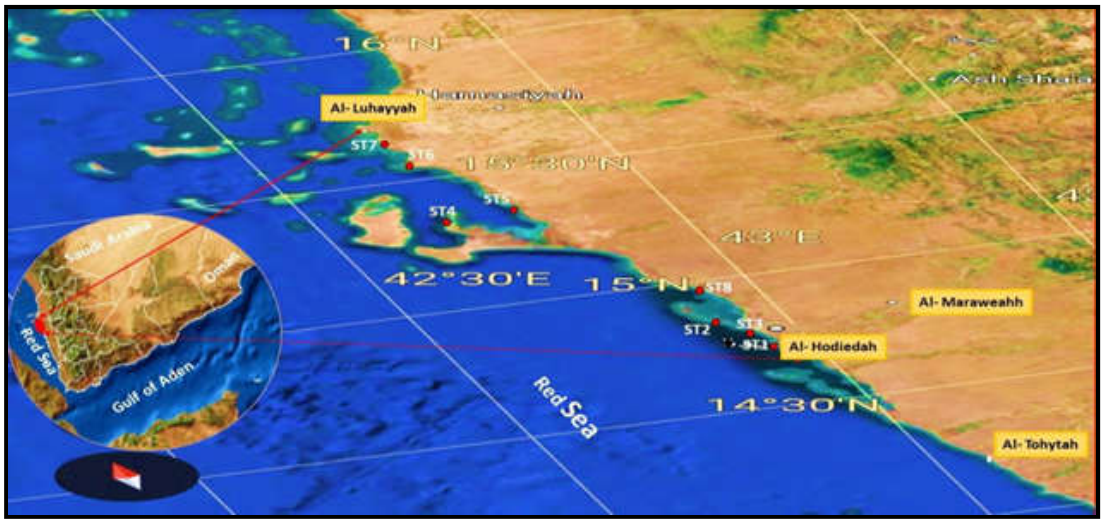

Figure No.1: Map indicating the position of sampling locations in the Study Area

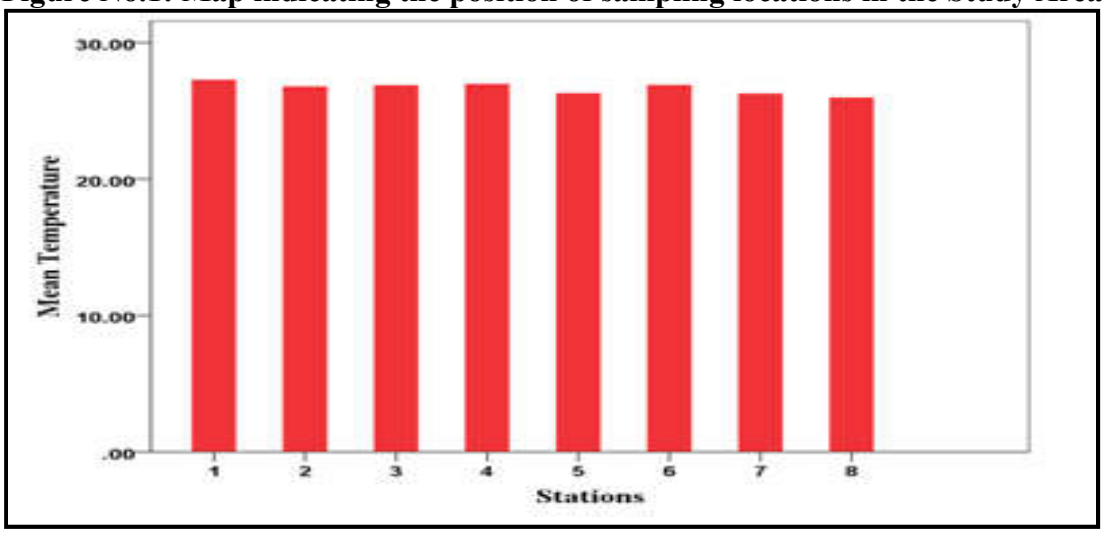

Figure No.2: Mean water temperature (^{o}C)

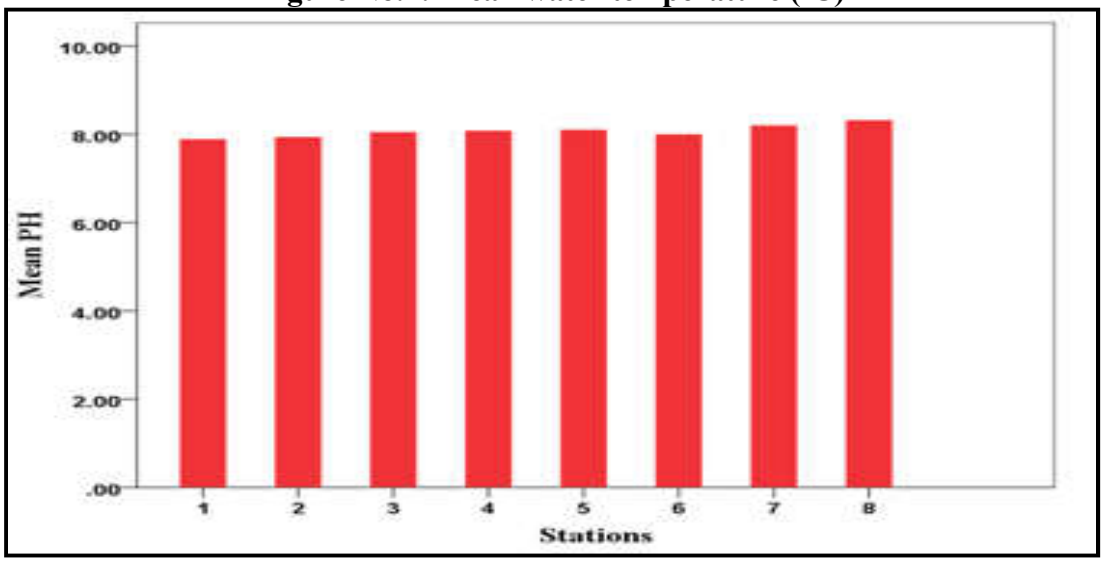

Figure No.3: Mean hydrogen ion concentration

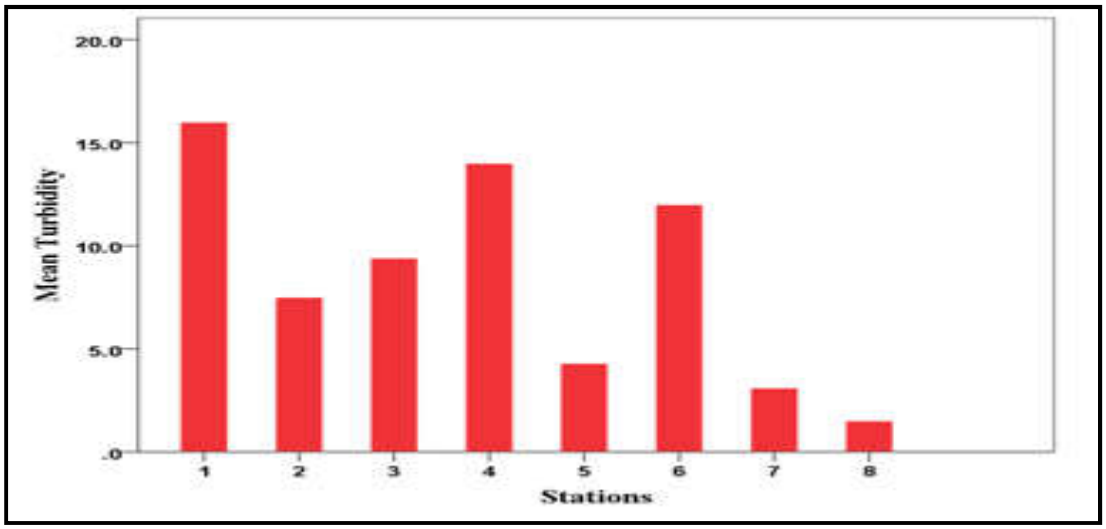

Figure No.4: Mean turbidity (NTU)

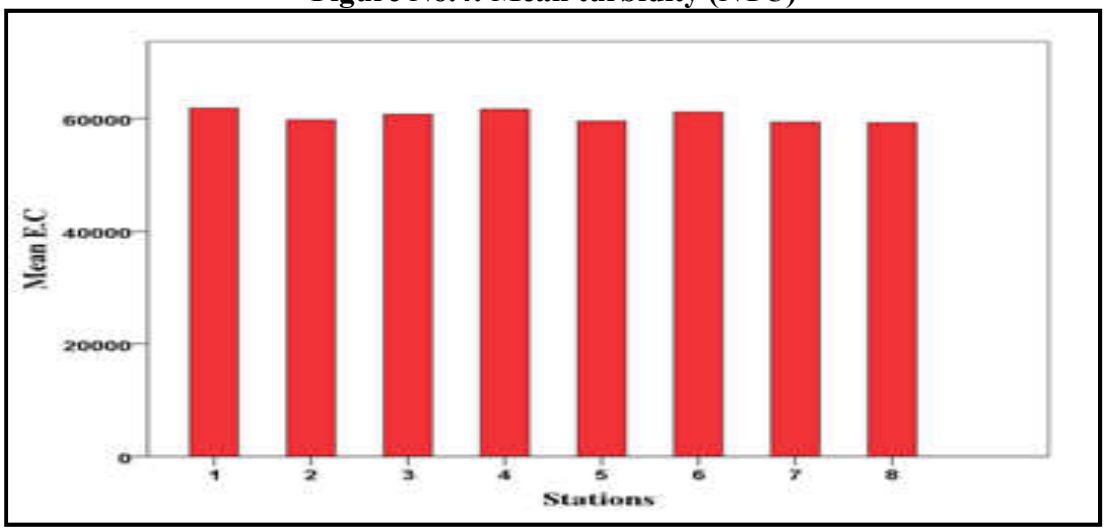

Figure No.5: Mean electrical conductivity (Us/cm)

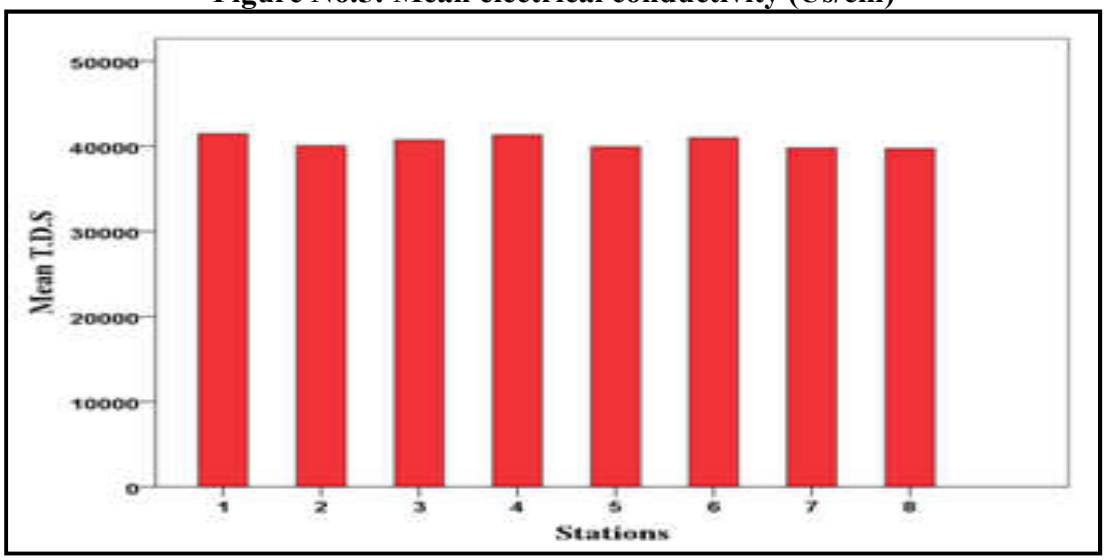

Figure No.6: Mean total dissolved oxygen (mg/L)

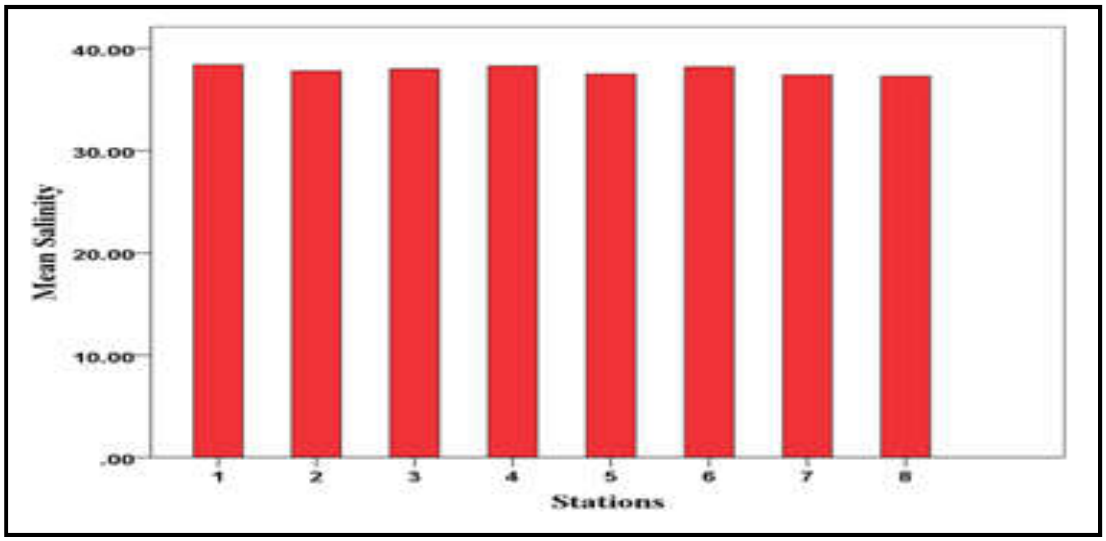

Figure No.7: Mean salinity (ppt)

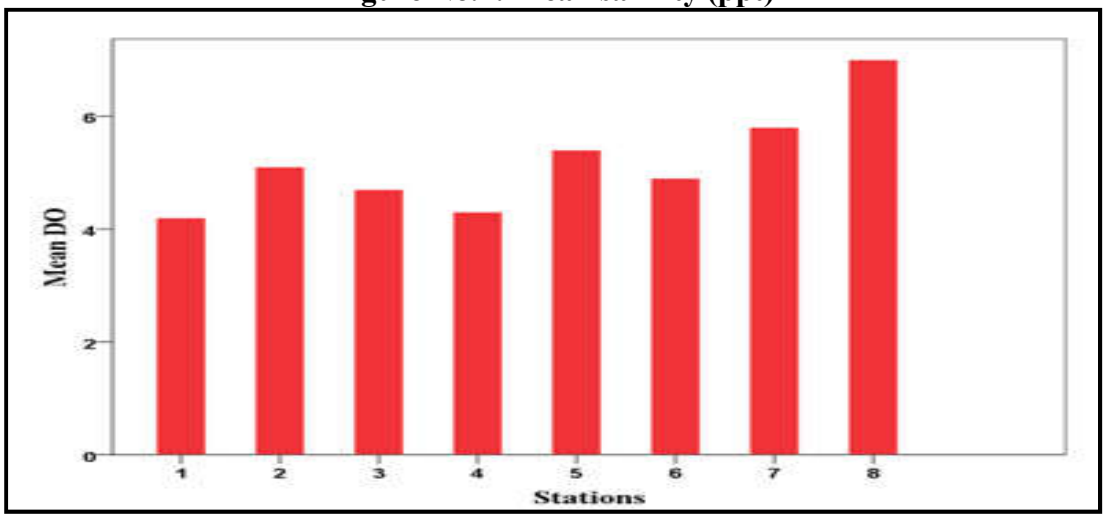

Figure No.8: Mean dissolved oxygen (mg/L)

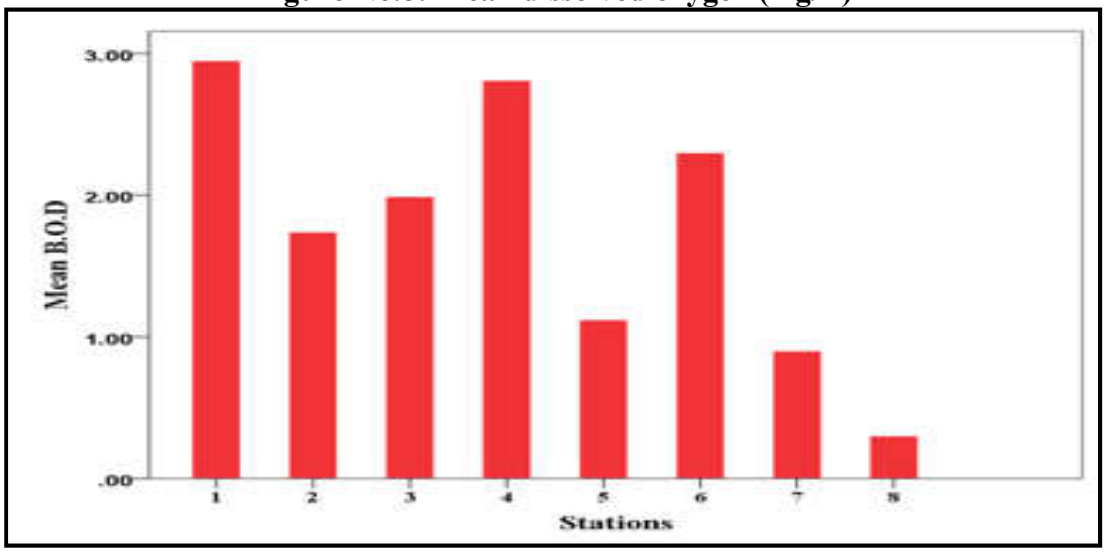

Figure No.9: Mean biochemical oxygen demand mg/L

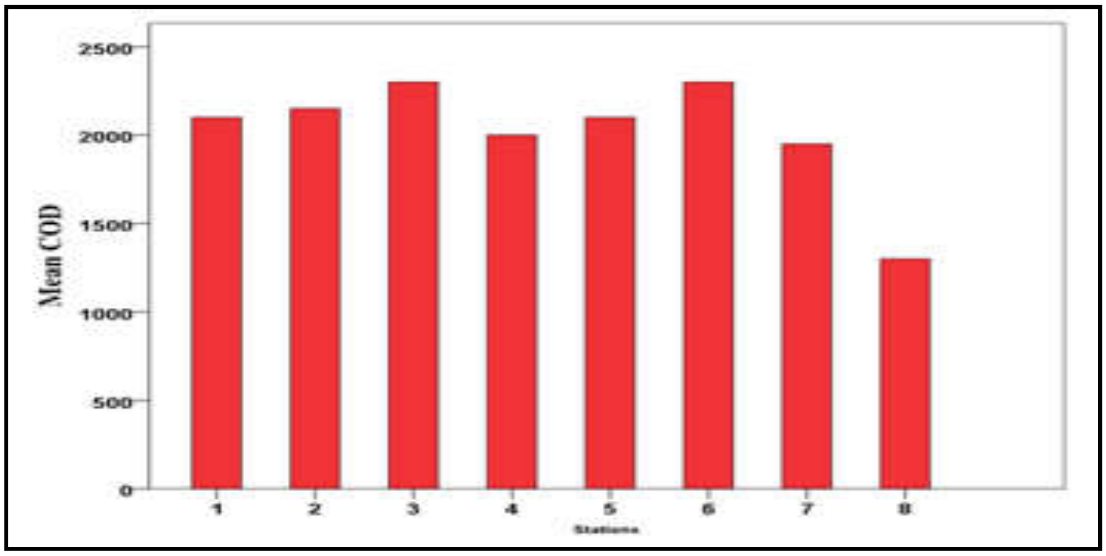

Figure No.10: Mean chemical oxygen demand (mg/L)

CONCLUSION

Monitoring and data collected from water at the Northern Red Sea Coast during 2019 revealed slight seasonal variations for each of salinity and pH values, well oxygenated seawater, low levels for biological oxygen demand and biological oxygen demand in seawater of the different studied sites but higher at (ST1- ST4) and (ST3-ST6) respectively. These results can be used to evaluate possible risks associated with increasing the anthropogenic effects on the Red Sea.

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CONFLICT OF INTEREST

We declare that we have no conflict of interest.

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