IJABBR- 2014- eISSN: 2322-4827

International Journal of Advanced Biological and Biomedical Research

Journal homepage: www.ijabbr.com

Original Article

Evaluation of Nutrients Amounts in the Coastal Waters of Bandar Abbas

Mohammad Mehdi Esmaili*[1], Yadollah Nikpour Ghanavati[2], Kamal Ghanemi[2]

[1]M.sc. Student, Department of Marine Chemistry, School of Maritime and Oceanic Sciences, Khorramshar University of Marine Science and Technology, khorramshahr, Iran
[2]Assistance Professor, Department of Marine Chemistry, School of Maritime and Oceanic Sciences, Khorramshar University of Marine Science and Technology, Khorramshahr, Iran

ARTICLE INFO

Article history:
Received: 14 Apr, 2015
Revised: 28 May, 2015
Accepted: 29 Jun, 2015
ePublished: 30 Jul, 2015

Key words:
Bandar-abbas city
Chemical nutrients
Human health Pollutants
Water pollution

ABSTRACT

Background: Recently, water contamination is become a globally crisis for human health. Aquatic environments are encountered to different pollutant nutrients, for example which led to raise concerns about water contamination, especially through non-point sources considered as an important environmental issue for animals and human health. The aim of current study was to investigate the amounts of nutrients in coastal waters of Hormozgan Province. **Methods:** Eight stations have been chosen to do sampling in Bandarabbas city. In this research, nutrients such as phosphor (PO^{-}_{4}), ammonium (NH^{+}_{4}), Nitrate (NO^{-}_{3}), nitrite (NO^{-}_{2}), and SiO^{-}_{2} were detected by Spectrophotometer and physico-chemical properties including pH, temperature, salinity, and electric conductivity (EC) were measured. **Results:** The results of physic-chemical properties (mean ± SD) of stations indicated that the temperature was 27.3 ± 3.1 ^{0}C, salinity was % 37.8 ± 1.1, EC was 56112.5 ± 816.6 µS/cm. Also, nutrients were fond (µg/l) 0.08 ± 0.03, 11 ± 0, 1.1 ± 0.1, 0.02 ± 0, 0.3 ± 0.1 for NH^{+}_{4}, NO^{-}_{2}, NO^{-}_{3}, PO^{-}_{4}, and SiO^{-}_{2}, respectively. **Conclusions:** These findings impose us to perform interval risk assessments from physical and chemical properties of waters where located in industrial zones for water user's health.

1. Introduction

As the development of urbanization and industrialization rapidly is going forward, large volume of municipal and industrial sewages which contain various organic and inorganic compounds discharge to riverine areas (Conley *et al.,* 2009; Mills *et al.,* 2005; Ye and Ying, 2009). To safely live of aquatic residents (organisms and animals) and humans who are suited on top of trophic level, quality of water and its constituents should be appraised. Food web is a known path to bio-magnify elements that it causes damages such as eutherification and nitrification phenomenon through excess nitrogen and phosphorus loads. This incident results in reduction of sunlight and oxygen to water columns (Ye and Ying, 2009; Amos *et al.,* 2018; Diaz, 2008; Baharlooeian and Haq, 2020; Huang *et al.,* 2013; Wang and Liang, 2015). Nowadays, humans are facing to changes in water quality through the discharge of types of wastewaters to the water environments. Therefore, the risk assessments for human and organisms health are critical (Pond *et al.,* 2003). In particular, many populations are resided in coastal areas in recent years. Indirectly and directly humans exposure to detrimental chemical nutrients by swimming, consumption marine products and foods, inhalation, and drinking water can harm to their health (as mentioned above) (Nabizadeh *et al.,* 2012; Baharlooeian and Haq, 2020). Annually, the

***Corresponding Author:** Mohammad Mehdi Esmaili, M.sc. Student, Department of Marine Chemistry, School of Maritime and Oceanic Sciences, Khorramshar University of Marine Science and Technology, khorramshahr, Iran (mehdi_7558@yahoo.com)

reports of based on 120 million cases of gastrointestinal disease and 50 million cases of respiratory illnesses is witnessed for whom exposed swimmers to contaminated coastal waters (Curiel-Ayala *et al.,* 2012). From standpoint of environmentalists and environmental managers, steadily monitoring and measuring of nutrients amounts in the water bodies is a absolute way to protect water resources (Cassidy and Jordan 2011; Capodaglio *et al.,* 2016; Pesce and Wunderlin, 2000). In spite of adopted limitations to avoid of hazardous materials releasing, the nutrient enrichment of aquatic ecosystems is inevitable (Amos *et al.,* 2018). It is found atmospheric deposition and aerosols are the ways of entering different elements to water surfaces by wet particles (*e.g.,* snow and rain) and dry particles (*e.g.,* gases) (Bellmore *et al.,* 2018; Amos *et al.,* 2018). Bandar abbas city is a port and industrial city. This meets types of tourists and known to tourism destination in Persian Gulf. Coastal lines of Bandar abbas is connected to Persian Gulf which a water substrate for discharging types of wastewaters. Thus, providing safe water for drinking, swimming and fishery are an issue for human's health of this city.

2. Materials and Methods

2.1 Sampling area

The sampling was carried out in 2015 in different stations of Bandar abbas city. Name and Geographical coordinates of the sampling stations are presented in Table 1.

Table 1: Geographical location of stations

N.	Station name	Latitude (N)	Longitude (E)
1	Shahid Haqqani dock	27°10`03.47"	56°15`51.11"
2	Opposite of plant power	27°08`47.75"	56°06`56.62"
3	Outlet of plant power	27°08`45.34"	56°14`16.62"
4	Steel dock	27°09`40.58"	56°06`01.00"
5	Outlet of refinery	27°09`55.72"	56°06`03.79"
6	Watering area	27°10`41.51"	56°17`01.19"
7	Control station	27°13`48.46"	56°20`20.86"
8	Opposite of refinery	27°11`35.70"	56°10`01.04"

2.2. Sampling process

To do sampling of water in the selected stations, One-liter sampling dark glass bottles were applied. At first, bottles were washed with seawater twice, and then filled with the same seawater. Water samples were collected by Rosset apparatus. In each station, samples were taken on three points. After recording sampling time and place, samples were transferred to the laboratory with no adding any material, for further measurements. The samples temperature was observed during sampling. All experiments were done in triplicate.

2.3. Analysis physic-chemical properties and nutrients

All analyzed process parameters are measured in accordance with the 2007 standard method water and wastewater (Eaton *et al.,* 2007).

2.3.1. Temperature

The water temperature at the sampling sites was measured using a rotation thermometer based on a rotor (0.1 °C accuracy). The air temperature was recorded using a mercury thermometer with an accuracy of 0.1 °C.

2.3.2. Salinity

This parameter was measured using the Russian Electro-solimer salinity meter (ЭЛЕКТРОСОЛЕМЕР, ГМ-65М: Russia) with an accuracy of 0.01 grams per thousand.

2.3.3. pH

The pH was measured by the portable device WTW320 with an accuracy of 0.01.

2.3.4. EC

Electrical conductivity was measured using Hatch electric conductivity meter with accuracy of 0.01 mS /cm.

2.3.5. NH^{+}_{4}

Overall, the existed NH_4 created a stable complex in blue color by adding phenol solutions and calcium hypochlorite. The absorption is measured at wavelength 630 nm.

2.3.6. Nutrients

Nutrients measurement such as nitrogen, phosphorus and silica was performed by spectrophotometer (model Cecil), which is in accordance with the following methods. And according to MOOPAM standard (MOOPAM).

Sampling of the designated stations was done according to the principles of sampling in one-liter plastic containers and then the samples were transferred to the laboratory under special conditions. Nitrite was measured by Bern Schneider and Robinson method. In this method, by adding sulfanil solutions Amide and *N*-(1-phenyl) ethylene diamine dihydrochloride, an existing nitrite ion created a color complex. The absorption is measured at 543 nm.

The nitrate was measured using a reducing column of cadmium, that nitrate ion is converted to nitrite, and then applied according to the method of measuring nitrite ion. Lastly, the obtained amount decreased from the initial NO^{-}_{2} concentration.

Phosphate was also measured by MOOPAM standard. The existed PO^{-}_{4} created a color complex present by adding antimony potassium Tartrate and scurbic acid. The absorption was measured at 885 nm.

Silica (SiO^{-2}) was measured by the molybdate (yellow complex) method. The existed Si created a color complex by adding ammonium molybdate and 50% sulfuric acid. The absorption was measured at 380 nm.

2.4. Statistical analysis
All above steps were calculated by y excel 2016. The average report with standard deviation (±SE) was shown.

3. Results
Measurement of physical and chemical factors of water samples including: water temperature, salinity, pH, electrical conductivity, ammonium ion, nitrite, nitrate, phosphorus and silica, which was done by standard method.

3.1. pH
The results of pH showed 8 ± 0.2. This varied 8-8.5 amongst stations (Table 2). pH was in order station 4>station 8 and 3> station 5 and 2> station 1> station 6> station 7.

3.2. Temperature
This is found averagely 27.3 ± 3.1. It ranged 24-34 (Table 2), which was presented station 3> station 5> station 2> station 4 and 8> station 6 and 7> station 1.

3.3. EC
The EC ranged 55100-57000. The average amount of EC in all stations was 56112.5 ± 816.6). EC was shown station 3> station 5> station 2> station 8> station 4> station 6> station 7> station 1 (Table 2).

3.4. Salinity
Salinity was observed 37.9 ± 1.1. This was from 37 to 40 among the stations. The salinity concentration were station 3> station 5> station 2> station 8> station 4> station 6, 7, and 1 (Table 2).

Table 2: Physico-chemical properties of coastal waters of Bandar Abbas (mg/L)

Number	Station name	Water temperature °C	Salinity S%	EC (µS/cm)	pH
1	Shahid Haqqani dock	24	37	55100	7.9
2	Opposite of plant power	28	38.5	56900	8
3	Outlet of plant power	34	40	57200	8.1
4	Steel dock	27	37.2	55700	8.4
5	Outlet of refinery	29	39	57000	8
6	Watering area	25	37	55500	7.8
7	Control station	25	37	55400	7.7
8	Opposite of refinery	27	38.2	56100	8.1

3.5. PO^{-}_{4}
The concentration of phosphate in different stations averaged about 0.03 mg /l and generally from 0.05 mg/l (Table 3). PO^{-}_{4} concentration were station 1< station 2, 4, 5, and 7< station 3 and 6> station 8 (Table 3).

3.6. Nitrogen compounds
Nitrogen is found in water and sewage in various forms of ammonia, nitrate, and nitrite. All of the above forms undergo biochemistry and are considered to be components of nitrogen (Table 3).

3.6.1. NH^{+}_{4}
The amount of water in the eight stations varies between 0.01 and 0.09 mg / l. $NH^{+}_{4}$was shown station 5 and 6< station 1, 2, 3, and 8< station 4 and 7 (Table 3).

3.6.2. Nitrite
Nitrite amount was measured in different seasons in eight stations and except for station 4, its value in other stations is less than 10 micrograms per liter (Table 3).

3.6.3. Nitrate
The amount in selected stations is often higher than one milligram per liter in all stations and rarely reaches less than one milligram per liter milligrams per liter in station 4 and 8 (Table 3).

Table 3. Nutrient mounts in properties of coastal waters of Bandar abbas (µg/L)

number	stations	NH^{+}_{4}	NO^{-}_{2}	NO^{-}_{3}	PO^{-}_{4}	SIO^{-}_{2}
1	Shahid Haqqani dock	0.07	<10	1.2	0.01	0.41
2	Opposite of plant power	0.07	<10	1	0.02	0.36
3	Outlet of plant power	0.07	<10	1	0.03	0.34
4	Steel dock	0.15	11	<1	0.02	0.66
5	Outlet of refinery	0.06	<10	1	0.02	0.34
6	Watering area	0.06	<10	1.1	0.03	0.42
7	Control station	0.15	<10	1.3	0.02	0.2
8	Opposite of refinery	0.07	<10	<1	0.04	0.34

3.6.4 Silica

The study of silica levels at different stations was measured between less than 0.1 to 0.66 mg /l. Large amounts of silica were commonly observed at station 4> station 6< station 1> station 2> station 3,5, and 8> station7 (Table 3).

4. Discussion

Seawater usually has an alkaline pH and its range is 7.5-8.4. The alkalinity of seawater stabilizes the amount of calcium carbonate in the water because it is directly involved in the formation of the aquatic shell of aquatic animals. Phosphate substance is found in various forms such as ortho, pyro, meta and polyphosphate, and in aqueous solutions, meta and pyro types are converted to a stable state of ortho. The sources of phosphate in water are due to the dissolution of phosphate compounds and the decomposition and decomposition of organic matter and the discharge of industrial and sanitary effluents. Phosphate plants need orthos, while animals use organic form. The concentration of phosphate in the middle part of the Persian Gulf is reported to be between 0.03 and 0.06 mg /l and.

In the nature, bort is an ammonium day and all its salts are water-soluble as ammonium day. Also, the presence of nitrite in water is usually due to the oxidation of ammonia and nitrogenous organic matter, the consumption of corrosion inhibitors, and like ammonia is a sign of contamination with organic matter because nitrite. Additionally, this product is a mediator of the decomposition of organic matter. The end product of nitrogen oxidation is nitrate compounds and enter into environment through various ways such as agricultural drains, chemical fertilizers, sewage etc. It is not high in surface water because most of it is consumed by plants and converted to organic nitrogen. On the other side, silica is found in water in various forms due to the decomposition of silica rocks such as quartz.

5. Conclusions

It is recommended to accurately estimating nutrient concentrations and understanding their relationships with changes in environmental factors is critical to improve the nutrient management strategies to mitigate their impact of nutrients. In aquatic environments, several factors affect water quality and aquatic biological conditions, in other words, a large number of physical, chemical, and environmental parameters play a role in the structure of aquatic ecosystems and the conditions that govern them. Therefore, sampling and testing of the above parameters is required in any aquatic ecosystem, because fluctuations in each of these factors can have a significant impact on water quality and aquatic life. Salinity in the Persian Gulf increased from east to west and also from north to south, and on the shores of Bandar abbas. Results illustrated the salinity and electrical conductivity. Also, the salinity and electrical conductivity of power plants outlet is higher than the refinery outlet and ultimately its effects can be seen on stations 2 and then 5. In addition, the temperature of the power plant outlet differs from the seawater temperature between 3-14 °C, and this difference for the output of the refinery is between 3 and 8 °C. Also, the depth and changes of PH, transparency, water of different stations are as follows.

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