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Polycyclic Aromatic Hydrocarbons (PAHs) in Waters from Northern Part of Shatt Al-Arab River, Iraq

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ABSTRACT

The concentrations of PAH compounds at northern part of Shatt al-Arab River were evaluated quarterly, Water samples were collected from five stations (Al-Qurnah, Al-Sharish, Al-Shafi, Al-Daier and Al-Hartha). The PAH compounds were analytically determined with Gas Chromatography (GC). The highest concentration of PAH compounds in water was (31.254 ng/L) during winter and the lowest concentration was (3.62 ng/L) during summer. Some physicochemical parameters of water samples were also determined such as temperature, salinity and chlorophyll (a). The concentrations of PAH compounds in water samples revealed a slight level of contamination in the study area. Hence, there is a need for adequate regulation and control of all activities that contribute to increasing levels of hydrocarbons in the aquatic environment for the safety of the population, aquatic and wild lives in the area.

Key Words: PAH compounds, Water pollution, Hydrocarbons, Shatt Al-Arab River

Introduction

Large amounts of sewage, storm water, dredged spoils, and spilled oil, municipal and industrial wastes are discharged into the river with little or no measure of treatment, especially in the developing countries (Wu *et al*., 2001; Muthukumar *et al*., 2013).

Petroleum hydrocarbons (PHs) are one of the prominent organic pollutants present in organic wastes (R.H.B., 2004; Commendatore and Esteves, 2004). Reports indicate that oil spills from land-based sources (refineries, storage facilities, municipal and industrial wastes, river runoff etc.) and transportation activities (tanker oil transportation and shipping) are considered more damaging in cold regions than in the warmer areas (Rayner *et al.,* 2007) and its impacts on aquaculture could be very severe because oil has a tends to bioaccumulate in the fish tissues, molluscs, mussels and other mammals (Ahmed *et al*., 2014). The chronic effects of petroleum hydrocarbons are primarily due to the presence of aromatic hydrocarbons of rings 4 and 5 (PAHs), some of which are known to be carcinogenic (Neff, 2005).

The various physical and chemical properties affecting the survival of aquatic organisms in water depends upon: temperature, pH, salinity, electrical conductivity, chlorophyll and Organic Carbon (Hatje *et al*., 2003; Kumar *et al*., 2011). These qualities are very useful for assessing the level of damage to watercourses and their deviation from natural levels which can lead to the degradation of the ecosystem (Mustapha and Omotosho, 2005).

Shatt Al-Arab River is the most important source of water in Basrah City; it provides water for human consumption, and drinking water for animals and agricultural and industrial activities, in addition to being a source of water for local use by residents along its banks (Ali *et al*., 2013). The Shatt Al-Arab River is constantly exposed to contaminants, the most important of which is petroleum pollution. It is due to the existence of oil loading stations such as Muftia, Abu Flus and the Iranian refinery of Abadan, as well as the pollution caused by the phenomenon of natural effusion, especially in Ben Omar area (Ibrahim, 2004). In the study of Al-Saad and Bedair (1989) for the determination of hydrocarbons concentrations in the water of the northern part of Shatt Al-Arab River, the recorded rangs in the dissolved part between (6.5 - 23.5 μg / L), which is larger than suspended part, ranging between (1.6 - 7.5 μg /L).

Al-Khafaji (2006) studied total aromatic hydrocarbons (PAHs) of the water of three stations on the Shatt Al-Arab. The concentrations of aromatic hydrocarbons in water ranged from (2.7 - 93.3) μg /L. Al-Hejuje (2014) took in her study the concentrations of total petroleum hydrocarbons and polyaromatic compounds in the water of five stations of the Shatt Al-Arab river. The concentrations of (PAHs) compounds in the water ranged from (5.81- 47.96 ng / L). The indicators that were neglected in this study indicated that the origin of hydrocarbons were from both biogenic and anthropogenic sources. The study also included thirty-one environmental factors, such as temperature, pH and dissolved oxygen etc.

Study area

Shatt Al-Arab River consists of the confluence of the Tigris and Euphrates rivers north of Basrah City and runs for about 190 km until it flows into the Arabian Gulf (Abdullah, 1990). The waters of Shatt al-Arab River are affected by the two half-day tidal waves coming from the Arabian Gulf during more than 24 hours (Hussein *et al*., 1991). The drainage of Shatt Al-Arab waters ranges between (246-2923 m^3/s) (Hassan, 2002).

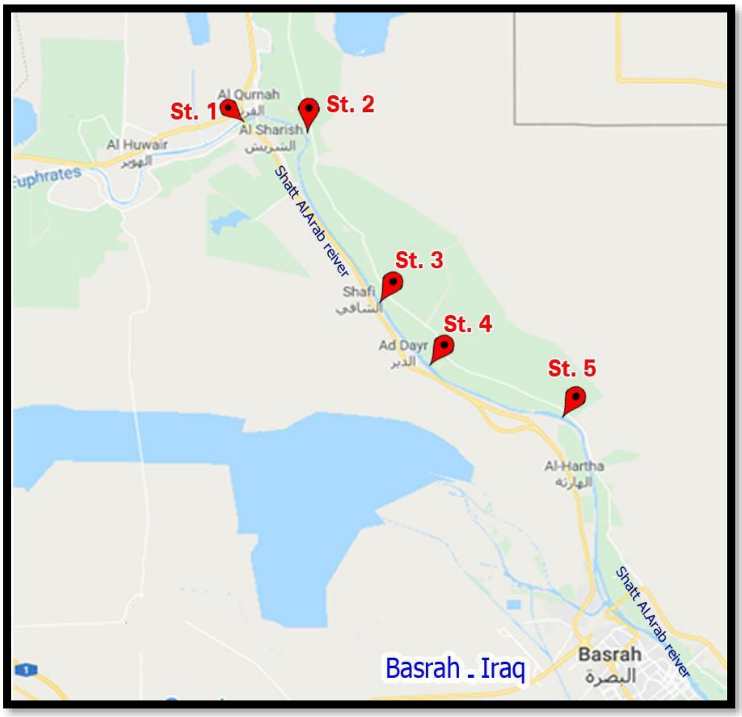

Figure 1: Stations of Present Study

Materials and methods

Water samples were collected seasonaly from five stations from the northern part of Shatt al-Arab, namely: Al-Qurnah (St.1), Al-Sharish (St.2), Al-Shafi (St.3), Al-Daier (St.4) and Al-Hartha (St.5). (Figure 1).

Surface water samples were collected (20-30 cm) deep below the surface of the water at the middle of the river during the period of the low tide. The samples were not taken in the event of rainfall. About (5 liters) were collected from each station and were stored in dark glass containers to analyze hydrocarbons. About (4 liters) were collected and placed in polyethylene containers for water quality analysis and chlorophyll (a). Water temperature, pH and salinity were conducted in the field using WTW multi- meter. The samples transferred directly to the laboratory in a cool box.

One liter of the water sample was filtered by using GF/F filter paper and extract the chlorophyll (a) by digesting the filtration papers with (10 mL) acetone (90% v/v). The concentration of chlorophyll (a) was estimated by measuring absorbance at a wavelength of (664 nm) and (750 nm) before adding one drop of hydrochloric acid (1N), and measuring absorbance at a wavelength of (665 nm) and (750 nm) after adding the acid (APHA, 1999). Hydrocarbons were extracted depending on methods of UNEP (1989) from the sample of water taken at a volume of about (5liters) and Polycyclic Aromatic Hydrocarbons were measured with Gas Chromatography.

Data were statistically analyzed using the analysis of variance (ANOVA). Data were collected statistically using the software Minitab ver.17, below the probability level of 0.05.

Results and Discussions

Physical and Chemical Parameters

Water temperature in the current study at St.1 ranged between (13 – 23 C°), At St.2, St.3 and St.4 ranged between (14 - 24 C°), While at St.5 ranged between (15 - 25 C°). There were significant differences (p <0.05) between the seasons, due to the nature of the climate of Iraq in general, as it is hot dry in the summer and cool in winter (Fahad, 2006 ; Al-Hejuje, 2014; Al-Atbee, 2018).

pH values ranged from (7.51) in St.2 during the autumn and the highest (8.61) at the St.5 station during the winter. The results showed significant differences (p <0.05) between the seasons, that pH values decreased during the autumn in general, this may be due to the decomposition of aquatic plants, phytoplankton, organic matter and the production of dissolved carbon dioxide (Al-Kenzawi, 2007 ; Al-Bidhani, 2014 ; Al-Mosawi, 2019), While values increase during winter which may be due to rainfall, Rubio-Arias *et al.* (2013) indicates that during precipitation, pH values in the aquatic ecosystem are increased due to runoff of alkaline materials. The results of pH were within the allowable limits: 6.5-8.5 (WHO, 2018).

The highest value of electrical conductivity at St.5 during summer was (4.58 msm/cm) and the lowest value at St.2 during autumn was (1.635 msm/cm), While the highest concentration of salinity during summer (2.5 PSU) in St.5 and the lowest concentration (1.1 PSU) St.1 and St.2 during autumn. In the current study there were significant differences (p <0.05) between the seasons for both electrical conductivity and salinity, as it decreased during winter due to the increase in precipitation as the water was reduced and the salinity decreased and increased during the summer which may be due to increased evaporation rates and low water level (Abowei, 2010 ; Al-Bidhani, 2014). The results of EC were higher than the allowable limits: 2.5 msm/cm (WHO, 2018).

Table 1 : Physical and Chemical Parameters in Present Study

Stations	Seasons	St.1	St.2	St.3	St.4	St.5	±SD
Temperature (C°)	Summer	23	24	24	24	25	0.707
	Autumn	20	20	21	21	21	0.548
	Winter	13	14	14	14	15	0.707
	Spring	18	18	18	18	18	0.000
pH	Summer	7.9	7.85	7.89	7.86	7.95	0.039
	Autumn	7.66	7.51	7.77	7.88	7.8	0.143
	Winter	8.3	8.3	8.56	8.5	8.61	0.146
	Spring	7.74	8.22	8.1	8.28	8.2	0.216
EC (mS/cm)	Summer	3.88	4.32	4.45	4.51	4.59	0.281
	Autumn	1.65	1.64	1.71	1.99	2.23	0.259
	Winter	2.78	2.86	2.88	2.84	3.01	0.085
	Spring	2.42	2.71	2.77	2.87	2.95	0.203
Salinity (mg/L)	Summer	2.3	2.4	2.4	2.4	2.5	0.071
	Autumn	1.3	1.4	1.43	1.4	1.52	0.079
	Winter	1.1	1.1	1.2	1.3	1.53	0.180
	Spring	1.64	1.7	1.6	1.66	1.66	0.036
Chlorophyll (a) (mg/m³)	Summer	3.26	5.83	5.35	6.38	7.33	1.171
	Autumn	2.45	6.32	5.53	7.93	9.46	2.630
	Winter	2.24	3.85	2.79	4.93	4.7	4.930
	Spring	9.31	16.45	18.12	20.33	20.91	1.516

The results of the present study showed that the highest concentration of chlorophyll (a) (20.91 mg/m^3) in St.5 during spring, while the lowest concentration (2.24 mg/m^3) at St.1 during winter. There were significant differences ($p < 0.05$) between seasons. The increase in concentrations during spring may be due to increased nutrients, relatively high temperature and increased light intensity, which stimulates growth of green algae and green vegetables with high chlorophyll (a), while the decrease in concentrations during winter may be due to the low activity of algae and phytoplankton due to low temperature (Al-Suwaij, 1999; Bhasker *et al.*, 2000).

Polycyclic Aromatic Hydrocarbons (PAHs)

The highest concentration of PAHs compounds in water (31.254

ng/L) at St.5 during winter and the lowest concentration (3.62 ng/L) at St.3 during the summer. Table 2

Table 2 : Total concentrations of PAHs (ng/L) in water for the study stations during the study period

Seasons	Stations					±SD
	St.1	St.2	St.3	St.4	St.5	
Summer	5.517	4.101	3.62	10.388	12.368	3.94
Autumn	7.266	3.91	4.529	18.884	20.133	7.93
Winter	18.393	15.437	12.969	26.528	31.254	7.71
Spring	16.46	7.549	9.435	25.824	25.509	8.62

A negative correlation was found (r = -0.567) for PAH concentrations in water with temperature, Low concentrations in summer may be due to high temperature, as high temperatures lead to PAHs evaporation from water (Al-Saad *et al*., 1998). High temperatures also stimulate microorganisms to destroy these compounds, especially low molecular weights (Al-Timari, 2000; Al-Dossari, 2008), and the process of optical oxidation is even greater because of the length of the day and the intensity of the brightness of solar radiation (Al-Tamari *et al*., 2003). While increase the concentrations of PAHs in winter is due to the increase in burning of fuel and wood used in heating (Al-Khatib, 2008). The results of PAHs were within the allowable limits: 100ng/L (WHO, 2018).

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الهيدروكربونات الاروماتية متعددة الحلقات (PAHs) في مياه الجزء الشمالي من شط العرب ، العراق

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الملخص

تم تقييم تراكيز مركبات PAH في الجزء الشمالي من شط العرب كل ثلاثة أشهر ، وتم جمع عينات المياه من خمس محطات (القرنة ، الشرش ، الشافي ، الدير ، الهارثة). تم تحديد مركبات PAH تحليليًا باستخدام كروماتوغرافيا للغاز (GC). كان أعلى تركيز لمركبات PAH في الماء (31.254 نانوغرام / لتر) خلال فصل الشتاء وأقل تركيز كان (3.62 نانوغرام / لتر) خلال فصل الصيف. كما تم تحديد بعض العوامل الفيزيائية والكيميائية لعينات المياه مثل درجة الحرارة والملوحة والكلوروفيل (أ). كشفت تركيزات مركبات PAH في عينات المياه عن مستوى طفيف من التلوث في منطقة الدراسة. وبالتالي ، هناك حاجة إلى تنظيم ومراقبة كافية لجميع الأنشطة التي تسهم في زيادة مستويات الهيدروكربونات في البيئة المائية من أجل سلامة السكان والأحياء المائية والبرية في المنطقة.

الكلمات المفتاحية: مركبات PAH ، تلوث المياه ، الهيدروكربونات ، شط العرب