Concentrations of Polycyclic Aromatic Hydrocarbons (PAHS) in Sediments of Khowre-Musa System (Persian Gulf)

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Abstract: Polycyclic Aromatic Hydrocarbons (PAHs) which their carcinogenic and mutative effects have been proved are one of the major categories of pollutants entering the marine environment. Due to their hydrophobic, lipophilic characteristics, they accumulate in the sediments of coastal areas. Khowre-Musa System as a semi enclosed ecosystem receives high levels of contamination due to its location in the vicinity of industrial sites. This study was performed to determine concentrations of PAHs in the sediments of three creeks (Khowre-Jafari, Khowre-Ahmadi and Khowre-Ghannam) from the Khowre-Musa System. A total of 27 samples (3creeks x 3sites per each creek x 3 composited samples per site) were collected. 10 PAHs (acenaphylene, acenaphthene, fluorene, anthracene, fluorathene, pyrene, chrysene, benzo(b) fluoranthene and benzo(a)pyrene) were detected in the sediment samples using HPLC . Total concentrations of PAHs values were highest at Khowre-Jafari site. Most of 10 selected PAHs concentrations were higher than standards. The results of the study suggest the petrochemical industry play most important role in the contamination of the study area.

Key words: Polycyclic Aromatic Hydrocarbons %HPLC % Marine Sediment Contamination % Khowre-Musa

INTRODUCTION

Polycyclic Aromatic Hydrocarbons (PAHs) are one of the major categories of widespread pollutants entering the marine environment. Their occurrence raises major concerns for public health, having accumulating properties in many fish species tissues which consumed by people .Although carcinogenic and mutative effects of PAHs have been proved, their presence may result complex and combined adverse effects many of them still unknown[1,2]. It has been estimated that more than 230000 tons entering marine environments annually [1].

Although there are more than 100 types of PAHs, only 16 of them have been introduced as primary pollutants by US EPA which have been measured and monitored in land and aquatic environments [3].

The adverse effects of oil pollutants are much more in enclosed and semienclosed aquatic environments than open seas. Marine estuaries and coastal areas are exposed to different pollutants including PAH compounds, Organochlorine Compounds (OC) and heavy metals [4].

Khowre-Musa System is a semienclosed area in the North West Persian Gulf which characterized by a deep natural channel surrounded by complex of shallow creeks. Khowre-Musa as a typical intertidal mudflat zone is one of the most important ecosystems of Persian Gulf, which possess particular physical chemical and biological characteristics. Being surrounded by polluting industries (petrochemical complexes, shipping ports, shipyards, etc.) which deposit most of their pollutants directly into the creeks increased the importance and vulnerability of Khowre-Musa system. In spite of the importance of measuring and monitoring PAHs in this region, such information was not published so far. Hence the objective of this study was to determine relative concentrations of PAHs in the sediments of three creeks from the Khowre-Musa System to assess the pollution state.

MATERIALS AND METHODS

According to our past data three polluted creeks of Khowre-Musa System (Khowre-Jafari and Khowre-Ahmadi in the north part and Khowre-Ghannam in the south part of complex) was selected in this study for sampling (Fig. 1, Table 1).
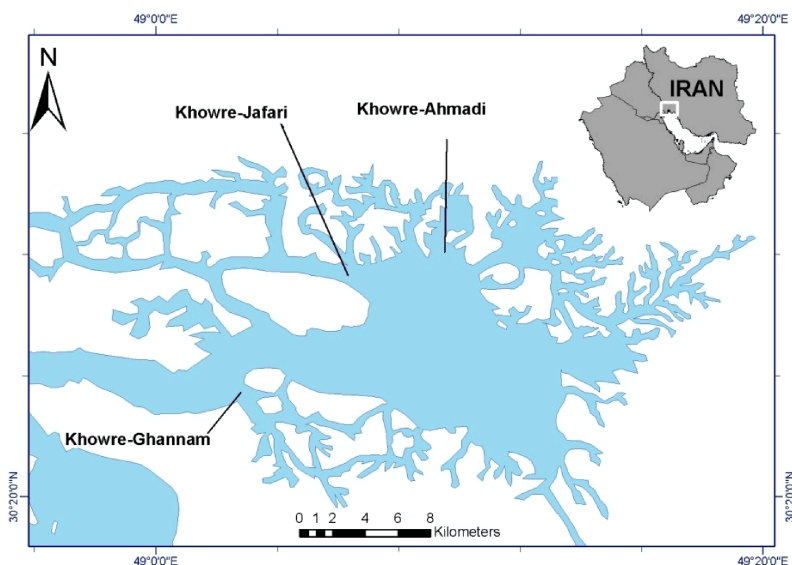
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Fig.1: Showing the sampling sites

Table 1: Specifications of the chosen stations

Station	Geographical Coordinates	Main Pollutant activity in the region
Khowre-Jafari	30°26'48"N 49°06'58"E	Petrochemical industry, shipping port, municipal and industrial sewages
Khowre-Ahmadi	30°27'59"N 49°09'24"E	Oil Terminal
Khowre-Ghannam	30°27'59"N 49°09'24"E	Cargo and Oil Shipping, Petrochemical industry

For each Creek Three sampling sites was determined, first in the upper, second in the middle and third in the lower part of the creek. Three composited samples were collected at each site for 9 samples per creek (3 sites x 3 composited samples per site).Thus for three creeks a total of 27 samples were collected.

The samples were taken at low tide from central section of the creeks channel. The sediment sampling was performed using Van Veen grab and Samples were taken from top 5 cm of the sediments, placed into prelabeled dark jars and shipped to the laboratory in a cooler on ice [5].

Coarse and excess materials were separated from samples and then freeze dried (using ZIRBUS model VaCo5o freeze dryer) for 24 hrs. Dried samples were kept in glass jars till chemical digestion. MOOPAM digestion method was performed [6].

Soxhlet extraction was performed using a 10 grams portion of dried sediments using 250 ml of hexane-dichloromethane 50:50 as solvent for 8 hours. Using rotary system (Heidolph model TPY4902) solution volume extended to 15ml (water temperature under 30°C). 2-3 grams of active cupper was added to extract for elimination of sulphur components. After 24 hours the extract was filtered using filtering paper and was then concentrated in a rotary evaporator. The column of systems contained 10ml of silica powder, 10 ml hydrated alumina, 1-2 grams of sodium sulphate. After passing the extract through the system 30 ml of hexane-dichloromethane 1:9 was added, then the extract was placed in 5 ml vials.

Before injection of extract to HPLC it was dried under flow of nitrogen gas and then dissolved in 1ml acetonitrile. The extracts were finally injected to HPLC model KANURE operating with ChromGate software version 2.8 with UV detector. The column of HPLC: reverse phase C18 with 25cm length and mobile phase (0.7 ml/min speed) of 40% water, 60% acetonitrile which was alter to 100% acetonitrile through 40min. Accuracy determination of samples preparation was performed using CRM soil standard of IAEA 417 [7]. 10 PAHs were selected for detection in this study (acenaphylene, acenaphthene, fluorene, anthracene, fluorathene, pyrene, chrysene, benzo (b) fluoranthene and benzo (a) pyrene). SPSS 11.5 was used to statistical data analysis.

RESULTS

All 10 selected types of PAHs were detected at all three creeks. Levels were variable between creeks (sites)
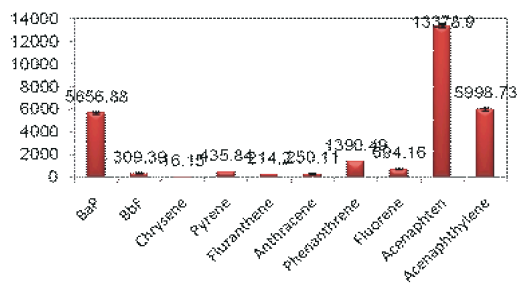
Fig. 2: PAHs concentrations in sediments of Khowre-Jafari (ng/g dw)
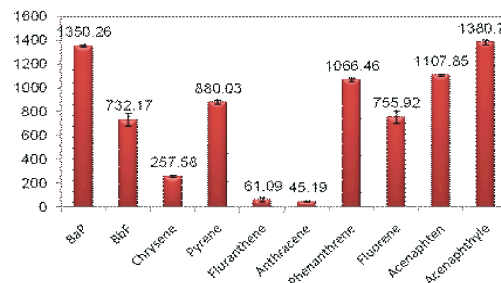

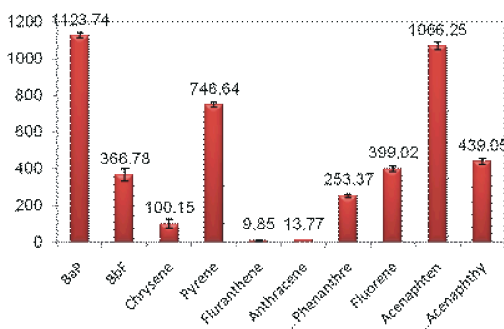Fig. 4: PAHs concentrations in sediments of Khowre-Ghannam (ng/g dw)

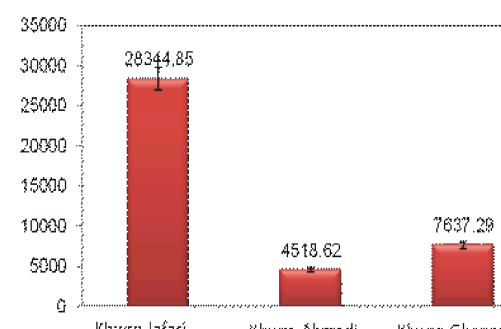Fig. 3: PAHs concentrations in sediments of Khowre-Ahmadi (ng/g dw)

Fig. 5: Comparison of total PAH (ΣPAHs) concentrations in sediments of sampling sites (ng/g dw)

Table 2: Concentrations of PAHs in contrast with PEL and ISQG standards

PAH Type	PEL (ng/g dw)USA	ISQG (ng/g dw)Canada	This study (ng/g dw)
Acenaphthylene	128	5.87	2606.17
Acenaphthene	88.9	6.71	5184
Fluorene	144	21.2	616.36
Phenanthene	544	86.7	903.44
Anthracene	245	46.9	103.02
Fluoranthene	1494	113	95.04
Pyrene	1398	153	687.5
Chrysene	846	108	124.62
Benzo(a)pyrene	763	88.8	2710.29

and between samples within the same creek. Mean level concentrations of detected PAHs in Khowre-Jafari, Khowre-Ahmadi and Khowre-Ghannam are presented in Figures 2-4. In general PAH values were highest at Khowre-Jafari site in comparison to other Khowre-Ahmadi and Khowre-Ghannam (Fig.5) with total concentration of PAHs (ΣPAHs) 28344.85 ng/g dw,4518.62 ng/g dw and 7637.29 ng/g dw respectively.

DISCUSSION

Sediments represent the final sink of lipophilic chemicals in coastal environments [8]. PAHs like many of other lipophilic pollutants characterized by low vapor pressure, high octanol water partition coefficient and low solubility in water [9], thus they can be rapidly absorbed by suspended organic materials and accumulate in sediments [10]. Table (2) presents mean concentrations of detected compounds at the study area and Interim marine Sediment Quality Guidelines (ISQG) and Probable Effect Levels (PEL) for comparison [11,12]. Except for fluoranthene, all PAHs concentrations were higher than ISQG. Probable Effective Levels of most compounds except fluorathene, anthracene, pyrene and chrysene were higher than standard which demonstrate that Khowre-Musa is very contaminated region in comparison to these standards.

Concentrated sediment contamination of the study area may be due to intense industrial activities in particular petrochemical plants besides cargo and oil

shipping activities. Levels of total concentration of PAHs at Khowre-Jafari are generally higher. Khowre-Jafari is adjacent to two petrochemical sites: Imam Petrochemical Co. and Razi Petrochemical Co. Taking in consideration that more values of contaminations detected in sediments adjacent to petrochemical sites, the findings of present study suggest these plants are from the main sources of contamination in the study area. In addition shipping activities may cause releasing of contaminant to the aquatic environment of the Khowre-Musa System.

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