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Assessment of polycyclic aromatic hydrocarbons in surface sediments and some fish species from the Gulf of Suez, Egypt

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ABSTRACT

The present study evaluated the origin and distribution of sixteen polycyclic aromatic hydrocarbons (PAHs) included by the United States Environmental Protection Agency (US EPA) within the priority pollutants were considered in the surface sediment as well as eleven fish species of Suez Gulf, Egypt. Sediment samples were collected at 0.5 and 10 meter depth from ten stations in addition to eleven fish species (*Liza subviridis, Parupeneus forsskali, Upeneus japonicus, Lethrinus nebulosus, Stephanolepis diaspros, Epinephelus areolatu, Sphyraena chrysotaenia, Pomadasys stridens, Trachurus indicus, Saurida undosquamis, Engyprospon* sp.). The concentrations of PAHs were measured by gas chromatography (GC) equipped with FID detector.The total concentration ∑16 PAHs ranged from1667.02 to 2671.27ng/g with the highest levels recorded at stations IV, VII and X (Ras Gharib, Aion Mousa and Abu Zanima). While the total concentration ∑16 PAHs in collected fish species ranged from 621 to 4207 ng/g wet weight with the highest ∑16 PAHs found in species *Saurida undosquamis*, while the lowest found in the species *Stephanolepis diaspros.* The high molecular weight PAHs (HPAHs) were predominant if compared with the low molecular weight PAHs (LPAHs). With LPAHs/HPAHs values less than one for all studied species indicating anthropogenic origin of PAHs in fish. Furthermore, the study of the PAHs diagnostic ratios suggests the predominance of pyrolytic origin for the studied PAHs.

INTRODUCTION

Increasing developments of industrial activities near coastal areas have caused more concerns regarding risks to human health resulting of environmental pollution as well as seafood contamination (Shreadah *et al*., 2006a & b; Younis & Nafea 2012; Younis *et al.*, 2014; El Zokm *et al*., 2015; Okbah *et al*., 2015; Younis *et al*.; 2016)

Polycyclic aromatic hydrocarbons (PAHs) are ubiquitous environmental organic contaminants. PAHs are well recognized for carcinogenic and mutagenic effects. PAHs are relatively water insoluble and highly lipophilic.

Therefore, they can easily accumulate in fatty tissues of many marine species. Sources of PAHs could be anthropogenic or natural mainly because of incomplete combustion of petroleum as well as fossil fuel (Liang *et al*. 2007)

Suez Gulf was known to be one of the most important fishery grounds in Egypt. It is extends for about 250 km from Suez city in the north to Shadwan island in the south and it is relatively shallow with a mean depth of about 45 m while its width fluctuates between 20 and 40 km. As we know, fish are the most important aquatic products of Suez gulf cities. Lovers of seafood from all walks of life can be found surfing through the colorful variety of meat that offered from Red Sea (Said *et al*. 2006; Younis *et al*., 2015). In the recent years, the Egyptian government has constructed many projects around the northwestern of Suez gulf area through the planning of development for future economic (Snousy *et al*., 2016). These projects such as petroleum refining industries, shipyard, marinas, power stations, fertilizer, chemical industries, pipelines and establish the commercial harbors close to the industrial zone. Therefore, the Gulf of Suez coastal water exposed daily to high loads of oil wastes as well as various other anthropogenic discharges from the surrounding industrial areas (Nemr *et al*., 2006; Snousy *et al*., 2016).

Fish is an important source for protein, vitamins and unsaturated fatty acids. It is estimated that by 2020, the consumption of fish in some developing countries will rise by about 57% (Delgado *et al*. 2003). This high request for fish needs a sustainable supply of fish products. However, bad practices such as overfishing, discharge of agricultural and industrial waste in lakes and oceans not only decreases the fish stock but also leads to a health hazard due to consumption of contaminated fish. The determination of PAHs in different fish species can give useful information about quality of food supply. Therefore, regular monitoring of PAHs in fish and their environment is highly recommended. In this study the level of 16 priority pollutants PAHs recommended by U.S. EPA were determined in surface sediments and eleven fish species to assess the extent, distribution and source of PAHs contamination in the gulf of Suez.

MATERIALS AND METHODS

Sediments samples

Sediment samples were collected from ten stations; (I) Adabia (II) El-Sokhna (III) Zafrana (IV) Ras Gharib (V) Ras Shokar (VI) Jemsha (VII) Eion Mousa (VIII) Ras Sader (IX) Hamamat Pharons (X) Abu Zanima by van deer grab. Dried samples (10-20 g) were extracted in a Soxhlet-apparatus with dichloromethane. The cycle of siphonation was around 30 min with repetition for at least 10 times. As the process of soxhlet extraction was completed, the solvent was evaporated to about 1 ml using the rotary evaporator. Activated copper powder was used to remove sulfur compounds from the extract (UNEP, 1991).

The final extracted volume (1 ml) of sediment were injected in the Gas chromatography (Hewlett Packard, 5890 series II), with a capillary column, (25m length x 0.2 mm i.d x 0.5 µm thickness), Ultra-1, coated with 100% dimethyl polysiloxane; non-polar. Nitrogen gas was used as the carrier gas at 4 ml/min flow rate. The temperature-programming rate was 8^oC/min from initial hold of 50^oC to a final hold of 290^oC. The blank used for the GC analysis was a group of standard PAHs mixture including [naphthalene, acenahthylene, acenaphthene, fluorene, phenanthrene, anthracene, fluoranthene, pyrene, benzo (a) anthracene, chrysene, benzo (a) fluoranthene, benzo (k) fluoranthene, benzo (a) pyrene, dibenzo (a,h) anthracene, benzo (ghi) perylene and indeno (1,2,3-cd) pyrene)] each of which has a concentration of 10 ppm dissolved in n-hexane.

Fig. 1: Sampling locations of surface sediment in the area of study

Fish samples

Eleven fish species (*Liza subviridis, Parupeneus forsskali, Upeneus japonicus, Lethrinus nebulosus, Stephanolepis diaspros, Epinephelus areolatus, Sphyraena chrysotaenia, Pomadasys stridens, Trachurus indicus, Saurida undosquamis, Engyprospon* sp.) were collected from different location of Suez gulf in summer of 2016. The fish samples were individually wrapped in previously hexane cleaned aluminium foil, The transferred to the laboratory and frozen (-20^{o}C) until analysis. An identified number of each organism species were collected and the filet of each fish was homogenized to obtain a representative sample for each species of fish before the analysis. Fish muscle was obtained after cleaning the fish with ethanol, and removing the skin. The samples were analyzed for polycyclic aromatic hydrocarbons according to USEPA (1994).

Extraction and cleanup

All chemicals used for gas chromatographic analyses were chromatography grade and purchased from Merck. Exactly 10 g of fish muscle from each sample was treated with 2 g of anhydrous sodium sulfate and the mixture was blended at high speed for 5 min. Then the mixture was extracted with 250 ml of n-hexane in a soxhlet extractor for 8 h and then re-extracted for 8 h into 250 ml of methylene chloride. The mixture was filtered and the tissue was extracted twice more. Organic solvent fractions were combined and filtered through filter paper with 1 g anhydrous sodium sulfate and concentrated down using a rotary evaporator at 30 ^{o}C. The extract was transferred to a round bottom flask, then was saponified the lipids, using dark glass vials, with 10 mL of 1 M KOH in an ethanol solution for 3 h.

Clean-up was an fractionation achieved by flowing the concentrated extract through alumina/silica column. Aromatic hydrocarbons were eluted with 30 ml of a mixture of methylene chloride and n-hexane (50:50) (v/v). The volume of the eluted fraction was reduced to a volume of 1 ml by concentration under a gentle stream of nitrogen and analyzed by a gas liquid chromatography equipped with a flame ionization detector GC/FID.

Analytical Quality Controls

In order to study the assure recovery efficiency, three analyses were conducted on PAH standard reference materials (SRM 2974) provided by national institute of standards and technology (NIST, USA). Recovery studies showed that the efficiency ranged from 90 to 105% with a coefficient of variation (CV) of 6–10% for all 16 PAHs.

The quality assurance was also carried out by analyzing blanks sample spiked with known quantity of each PAHs standard. The values of PAHs in the blanks samples were below the detection of the instrument (0.01 µg/ml).

Apparatus

The examined samples were measured using a Hewlett Packard 5890 series II GC equipped with a flame ionization detector (FID). The apparatus is equipped with splitless injector (3µl). The detector maintained at 300^{o}C,while the injection port maintained at 290 ^{o}C. A fused silica capillary column (30m, 0.32mm, 0.17µm) coated with HP-1 (100% dimethyl polysiloxane). The oven temperature program was ranged from 60 to 290^{o}C, ramped at 3^{o}C/min and maintained at 290^{o}C for 25 min. Nitrogen gas was used at 1.2 ml/min.

RESULTS AND DISCUSSION

Hydrocarbons in sediment samples

Table 1: Total concentration of PAHs (ng/g wet weight) in sediment and fish samples

Sediments sample	Total PAHs	Fish samples	Fish species	Total PAHs
I	1894.35	1	*Liza subviridis*	3470.33
II	2200.48	2	*Parupeneus forsskali,*	1014.30
III	1667.02	3	*Upeneus japonicus*	658.82
IV	2661.56	4	*Lethrinus nebulosus*	1311.94
V	2102.73	5	*Stephanolepis diaspros*	621.96
VI	2083.79	6	*Epinephelus areolatus*	1427.49
VII	2671.27	7	*Sphyraena chrysotaenia*	2309.43
VIII	1875.30	8	*Pomadasys stridens*	1378.75
IX	1685.97	9	*Trachurus indicus*	2655.30
X	1894.35	10	*Saurida undosquamis*	4207.56
-	-	11	*Engyprospon* sp.	851.80

Total average values of Σ16 individual PAHs concentrations in sediments samples ranged from (1667.02-2671.27ng/g). The maximum concentration (2671.27ng/g) was noticed at stationVII. In contrast, the minimum concentration (1667.02ng/g) was noticed at location III (Table 1).

The highest concentrations along the gulf of Suez were recorded at stations IV (Ras Gharib), VII (Aion Mousa) and X (Abu Zanima) respectively. This observation may be due to heavy shipment of oil tanker and oil drilling activities concentrated at Suez Gulf. Acenaphthyle, acenaphthene, fluorene, anthracene, phenanthrene, pyrene, chrysene, benzo (b) fluoranthene, benzo (k) fluoranthene, benzo (a) pyrene and dibenzo (a,h) anthracene not directed in the area during 2016.

Table 2: Sediment characterizations, organic matter percent, high and low molecular weight of PAHs

Stations	Sand	Silt	Clay	WT	TOM	ΣLMW	ΣHMW
	%					ng/g	
1	74.64	10.55	14.81	21.52	0.52	5.37	1888.98
2	91.33	5.89	2.69	14.32	0.28	6.24	2194.24
3	88.50	7.44	4.06	17.33	0.61	4.73	1662.29
4	70.55	14.33	15.12	23.89	1.89	7.54	2654.02
5	77.81	9.48	12.71	20.66	0.94	5.96	2096.77
6	89.56	5.66	4.78	18.45	0.88	5.91	2077.88
7	68.55	10.58	20.87	26.33	2.01	7.87	2663.4
8	83.24	9.88	6.88	19.64	0.57	5.3	1870.0
9	80.47	6.65	12.88	20.45	1.03	4.78	1681.19
10	69.22	10.55	20.33	25.33	1.95	7.09	2493.45

The concentrations of PAHs in sediment have been previously classified as low, moderate, high and very high contaminated (0–100, 100–1000, 1000–5000, >5000 ng/ g (Baumard *et al*., 1998). The levels of PAHs in exanimated sediments of the present study ranged between 1667.02 and 2671.27ng/ g therefore, the surface sediments of Suez gulf can be classified from moderate high contaminated.

The pattern of PAHs based on number of aromatic rings shows four rings as the predominance in all examined sediments (Table 3). These results are significantly lower than those reported by Wang *et al*. (2001) for Boston Harbor, United States and La Rocca *et al*. (1996) for Venice, Italy. However, the results of the present study are also close to the concentrations in the Hellenic coastal zone, eastern Mediterranean (Botsou & Hatzianestis, 2011) .

Table 3: Percent of PAHs collected sediment samples based on the number of aromatic rings

Sample	2-3 rings (%)	4 rings (%)	5 rings (%)	6 rings (%)
I	0.283	90.859	0.852	8.005
II	0.284	90.859	0.852	8.006
III	0.284	90.859	0.852	8.005
IV	0.283	90.859	0.852	8.005
V	0.283	90.859	0.852	8.005
VI	0.284	90.859	0.852	8.006
VII	0.295	94.408	0.885	4.413
VIII	0.283	90.860	0.853	8.004
IX	0.284	90.859	0.852	7.197
X	0.284	90.859	1.263	10.675

A significant correlation was found in the present study between total organic matter (TOM), grain size and PAHs.This observation confirms that TOM and grain size play the most important role in the behaviour of PAHs distribution in the sediment (Nudi *et al*., 2007; Mostafa *et al*., 2009).

Moreover, significant correlation was found in the present study between clay sediments and PAHs (ΣLMW+ ΣHMW), the same occurred to water content (WC) (Table 2). Actually, there is a great affinity between the levels of low molecular weight PAHs and organic matter whether it's autochthonous organic matter from living origin or allochthonous organic matter from terrestrial origin.

Table 4: Levels of PAH (ng/g) in sediment of Suez Gulf during 2016.

Sediment sample number	PAHs															
	Indeno(1,2,3-cd) pyrene (IcdP)	Benzo (a) Anthrathene (BaA)	Acenaphthylene (ACY)	Naphthalene (NP)	Pyrene (PYR)	Dibenzo (a,h) Anthracene (DahA)	Fluoranthene (FLA)	Benzo(b) Fluoranthene (BbF)	Acenaphthene (ACE)	Chrysene (CHR)	Benzo(a) pyrene (BaP)	Fluorene (FL)	Benzo(K) fluoranthene (BkF)	Benzo (ghi) Perylene (BghiP)	Anthracene (ANT)	Phena-nthrene (PHE)
I	151.65	870.13	ND	5.37	ND	ND	851.06	ND	ND	ND	16.14	ND	ND	ND	ND	ND
II	176.16	1010.74	ND	6.24	ND	ND	988.59	ND	ND	ND	18.75	ND	ND	ND	ND	ND
III	133.45	765.71	ND	4.73	ND	ND	748.93	ND	ND	ND	14.2	ND	ND	ND	ND	ND
IV	213.07	1222.53	ND	7.54	ND	ND	1195.74	ND	ND	ND	22.68	ND	ND	ND	ND	ND
V	168.33	965.84	ND	5.96	ND	ND	944.68	ND	ND	ND	17.92	ND	ND	ND	ND	ND
VI	166.82	957.14	ND	5.91	ND	ND	936.17	ND	ND	ND	17.75	ND	ND	ND	ND	ND
VII	117.87	1274.91	ND	7.87	ND	ND	1246.97	ND	ND	ND	23.65	ND	ND	ND	ND	ND
VIII	150.1	861.4	ND	5.3	ND	ND	842.5	ND	ND	ND	16	ND	ND	ND	ND	ND
IX	134.97	774.42	ND	4.78	ND	ND	757.44	ND	ND	ND	14.36	ND	ND	ND	ND	ND
X	200.18	1148.57	ND	7.09	ND	ND	1123.4	ND	ND	ND	21.3	ND	ND	ND	ND	ND

Hydrocarbons in fish samples

Results for PAHs analysis in the eleven fish species are summarized in Table 5. The distribution of PAHs studied shows different patterns for the eleven species studied. The total concentration of the PAHs varies in the range of 621.92 to 4207.56 ng/g wet weight (Table 1). The fish species *Stephanolepis diaspros* showed the lowest concentration 621.29 ng/g, while the highest (4207.56 ng/g) was found in *Saurida undosquamis* species.

Table 5: Concentration of individual PAHs (ng/g wet weight)

	Fish sample number										
PAH	1	2	3	4	5	6	7	8	9	10	11
Naphthalene (NP)	5.22	11.11	10.51	2.39	4.93	8.55	6.10	23.63	10.78	18.57	12.64
Acenaphthylene (ACY)	ND	1.98	ND	ND	ND	5.42	1.56	ND	ND	ND	ND
Acenaphthene (ACE)	ND	4.16	ND	ND	ND	5.92	1.80	ND	3.02	ND	ND
Fluorene (FL)	ND	6.99	ND	ND	ND	8.45	1.13	1.45	ND	ND	ND
Phenanthrene (PHE)	ND	1.86	ND	1.42	ND	10.22	8.51	ND	24.06	95.66	ND
Anthracene (ANT)	140.54	1.90	10.73	5.66	ND	3.99	12.67	2.41	ND	ND	9.84
Fluoranthene (FLA)	1932.05	628.98	254.66	364.61	348.95	589.77	418.15	697.41	598.40	1001.29	402.66
Pyrene (PYR)	636.78	38.99	ND	ND	ND	19.24	188.40	ND	479.44	633.62	ND
Chrysene (CHR)	27.85	14.36	ND	230.21	ND	ND	ND	26.06	295.70	44.04	ND
Benzo(a) anthrathene (BaA)	84.81	256.82	215.18	197.94	179.23	441.64	211.03	299.40	175.92	476.08	132.15
Benzo(K)fluoranthene (BkF)	3.53	3.24	ND	11.73	ND	1.67	1.40	2.42	90.81	ND	ND
Benzo(b)fluoranthene(BbF)	12.11	12.57	ND	11.49	ND	9.32	26.92	ND	133.59	5.37	ND
Benzo(a)pyrene (BaP)	4.62	2.77	2.39	3.88	1.24	6.11	3.02	3.10	22.59	6.74	1.08
Dibenzo(a,h)anthracene (DahA)	457.78	12.40	99.50	356.33	82.24	191.28	1364.56	128.81	595.63	1796.83	284.70
Benzo(ghi) perylene (BghiP)	139.74	5.20	55.07	105.44	ND	91.67	12.94	55.43	191.43	64.88	2.91
Indeno(1,2,3-cd)pyrene (IcdP)	25.30	10.97	10.78	20.84	5.37	34.24	51.24	138.63	33.93	64.48	5.82
Total	3470.33	1014.30	658.82	1311.94	621.96	1427.49	2309.43	1378.75	2655.30	4207.56	851.80
ND not detected											

The percent distribution of PAHs based on number of aromatic rings indicated the predominance of four rings PAHs in all studied species except with *Sphyraena chrysotaenia* species where the five membered rings prevailed (Table 6). Among the different components of PAHs, fluoranthene was the most abundant one with the highest value found in *Liza subviridis* (1932.05 ng/g) and lowest value found in *Upeneus japonicus* (254.66 ng/g), with stark contrast found in species *Sphyraena Chrysotaenia* and *Saurida undosquamis* where dibenzo (a,h) anthracene was the highest PAHs with concentrations 1364.56 ng/g and 1796.83 ng/g respectively. Generally the HPAHs were highly prevail compared with LPAHs. This finding is consistent with that reported by Nwaichi and Ntorgbo(2016) for PAHs assessment in some fish and seafood from Niger Delta.

Table 6: Percent of PAHs collected fish species based on the number of aromatic rings

Sample	Fish species	2-3 rings (%)	4 rings (%)	5 rings (%)	6 rings (%)
1	*Liza subviridis*	4.200	77.269	13.775	4.756
2	*Parupeneus forsskali,*	2.761	92.591	3.054	1.594
3	*Upeneus japonicus*	3.224	71.315	15.466	9.995
4	*Lethrinus nebulosus*	0.722	60.427	29.226	9.625
5	*Stephanolepis diaspros*	0.793	84.922	13.422	0.863
6	*Epinephelus areolatus*	2.981	73.601	14.598	8.820
7	*Sphyraena chrysotaenia*	1.376	35.402	60.443	2.779
8	*Pomadasys stridens*	1.994	74.188	9.743	14.075
9	*Trachurus indicus*	1.426	58.353	31.734	8.487
10	*Saurida undosquamis*	2.715	51.218	42.993	3.074
11	*Engyprospon* sp.	2.639	62.786	33.550	1.025

Depuration or biotransformation may be the cause of the absence of some PAHs (Deb *et al*. 2000). These concentrations seem higher than that reported by Malik *et al*. (2008) (0.207-3.365 ppm) and those reported for fish muscles from Pearl river delta (49.59 ng/g wet wt; Kong *et al*., 2005) and Red Sea fish (12.29 ng/g wet wt; DouAbul *et al*., 1997), where the authors found high concentration of LPAHs. However, comparing the PAHs concentration between different studies is limited by several variables, such as the methodology used, number of samples taken, biological variability (age, diet, size) and environmental parameters (Meador *et al*.,1995; Vives *et al*., 2004).

PAHs composition and sources.

The most important sources of PAHs in the marine environment are either petrogenic or pyrogenic. Petrogenic source comes from natural seep of petroleum or petroleum products into the environment, while pyrogenic comes from incomplete combustion of fossil fuels. (Neff 1979; Brown 2002). Several studies have used various PAHs concentration diagnostic ratios to study the source of PAHs (Hoffman *et al*. 1984; Brown and Peake 2006). For example, the low molecular weight PAHs (LPAHs)/high molecular weight(HPAHs) ratio. The LPAHs include two to three rings while the HPAHs contain four to six rings and are highly carcinogenic. With LPAHs/HPAHs> 1 indicates petrogenic while more than one indicates pyrogenic (Zhang *et al*., 2008). In our result for all stations as well as the eleven species we found the ratios are less than one which is suggested a pyrogenic origin (Table 7). Several authors used the ratios of individual PAHs levels for identification the source of these concentrations (Kavouras *et al*., 2001; Katsayiannis *et al*., 2007; Kim *et al*., 2008). Sicre *et al*. (1987) indicated that fluorancene/pyrene (FLA/PYR)<1 suggested petrogenic origin, while higher than one refers to pyrolytic source. Table 6 shows FLA/PYR ratios for the analyzed species, all detectable values were higher than 1 indicated pyrolytic origin. More significant diagnostic ratios applied to the present results were PHE/ANT, with PHE/ANT>10 indicates petrogenic and lower than 10 indicates pyrogenic source, Budzinski *et al*. (1997). The PHE/ANT ratios for our samples were all less than 10 again suggested pyrogenic source. Moreover, ANT/(ANT+PHE) diagnostic ratio suggested pyrogenic origin with value <0.1 indicate petrogenic source while values higher than 0.1 suggest pyrogenic (Pies *et al*. 2008). The values of ANT/(ANT+PHE) for species *Parupeneus forsskali*, *Lethrinusn ebulosus Epinephelus areolatu* and *Sphyraena chrysotaenia* were 0.505, 0.799, 0.281

and 0.598 respectively which confirm pyrogenic origin. BaA/ (BaA+CHR) ratio has been implemented to identify the source of PAHs with values higher than 0.35 indicating combustion source and less than 0.2 indicating petrogenic (Ynker *et al*., 2002; Akyüz and Çabuk, 2010).

Two more diagnostic ratios were used in this study FLA/(FLA+PYR) and IcdP/(IcdP+BghiP). The former with ratio <0.4 for petrogenic, 0.4-0.5 fossil fuel combustion and >0.5 for wood and coal combustion (De La Torre-Roche *et al*. 2009). While the later with ration <0.2 indicating petrogenic, 0.2-0.5 petroleum combustion and >0.5 for wood and coal combustion (Yunker *et al*., 2002).

Table 7: PAHs diagnostic ratios for source identification in the collected fish species.

Sample no.	Fish species	LPAHs/ HPAHs	PHE/ ANT	FLA/ PYR	ANT/ (ANT+PHE)	BaA/ (BaA+CHR)	FLA/ (FLA+PYR)	IcdP/ (IcdP+BghiP)	Origin
1	*Liza subviridis*	0.043843	ND	3.034	ND	ND	0.752	0.153	Pyrogenic
2	*Parupeneus forsskali,*	0.028389	0.979	16.132	0.505	0.947	0.942	0.678	Pyrogenic
3	*Upeneus japonicas*	0.033313	ND	ND	ND	ND	ND	0.164	Pyrogenic
4	*Lethrinus nebulosus*	0.007271	0.251	ND	0.799	0.462	ND	0.165	Pyrogenic
5	*Stephanolepis diaspros*	0.00799	ND	ND	ND	ND	ND	ND	ND
6	*Epinephelus areolatu*	0.030723	2.561	30.653	0.281	ND	0.968	0.272	Pyrogenic
7	*Sphyraena chrysotaenia*	0.013949	0.672	2.219	0.598	ND	0.689	0.798	Pyrogenic
8	*Pomadasys stridens*	0.020344	ND	ND	ND	0.920	ND	0.714	Pyrogenic
9	*Trachurus indicus*	0.014465	ND	1.248	ND	0.373	0.555	0.151	Pyrogenic
10	*Saurida undosquamis*	0.027906	ND	1.580	ND	0.915	0.612	0.498	Pyrogenic
11	*Engyprospon sp*	0.027107	ND	ND	ND	ND	ND	0.667	Pyrogenic

CONCLUSION

In this study, 16 polycyclic aromatic hydrocarbons (PAHs) were tested in ten samples of surface sediment as well as eleven fish species collected from Suez gulf. The result indicated the total average levels in sediments samples ranged from 1667.02 to 2671.27ng/g. The results for PAHs analysis in the eleven fish species showed the predominance of PAHs with high molecular weight (4-6 rings). The smallest total PAHs found in *Stephanolepis diaspros* (621.9 ng/g), while the highest found in *Saurida undosquamis* (4207.5ng/g). The identification of the source based on the results obtained from several diagnostic ratios suggested pyrogenic source for PAHs in the studied fish. This study provides useful information about the extent and source of PAHs pollutants in different fish species from the Gulf of Suez, which will be helpful for future comparison.

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