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Petroleum Hydrocarbon Concentrations in Arabian Gulf Fish Tissues

M. A. Shriadah

Desert and Marine Environment Research Center, The United Arab Emirates University, Al-Ain, Post Office Box 17777, The United Arab Emirates

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In the Gulf, oil contamination of the marine environment comes mainly from oil tanker in addition to oil exploration. An environmental monitoring program, including examination of hydrocarbons in marine samples, was designated by the United Arab Emirates University to provide baseline data for measuring ecosystem recovery in the event of any oil spill which may affect fish and invertebrates (Esteves, 1993, Al-Zarouni, 1997, Shriadah, 1998).

Oil may enter fish through the skin or gills. In addition, contaminants such as tar balls may ingress through the intestine by water gulped in the physiological process of desalination (Al-Otaiba, 1996, Al-Zarouni, 1997). Although human health had not been considered to be at risk from concentrations of petroleum hydrocarbons in fish, the possible consequences of bioaccumulation cannot be ignored especially in communities consuming large quantities of fish like in the Gulf region.

The present paper reports the values for petroleum hydrocarbons in several fish species commonly consumed by the population in the Arabian Gulf. It also provides data on the relationship of total hydrocarbon concentrations in fish tissues with seasonal and lipid changes in the fish.

MATERIALS AND METHODS

A total of about 288 fish samples from 8 commercially marine fish species were collected from the U.A.E. waters along the Arabian Gulf (Fig.1) during winter (December-Marsh) and summer (June-September) seasons of 1995- 1996. The analyzed species are given in Table (1). All the samples were collected fresh from the fishermen. After collection, the samples were stored at -18 °C for subsequent analysis. In the laboratory the standard length of each of each fish to the nearest millimeters, and the total body weight to the nearest of one tenth of a gram were measured before dissection. Selected fish tissues including any liquid were homogenized and kept frozen until extraction process. Duplicate of animal tissues(10g) were extracted by soxhlet extraction using fluorescence free dichloromethane (100 ml) for 24 hours. Extracts from fish samples were

Present address: National Institute of Oceanography and Fisheries, Kayet Bey, El-Anfushi, Alexandria, Egypt

Table 1. General characteristics of fish species (after Sirasubramanian and Ibrahim, 1982).

Fish species	General characteristics
Rastrelliger kanagurta	*Family*: Scombridae. Medium sized species forming pleagic schools in inshore and off-shore waters. Feeds on plankton. Mainly caught off during cooler months.
Siganus canaliculatus	*Family*: Siganidae. Abundant inshore species, particulary in summer and early winter. Slow swimming shoals in inshore waters. Scrapes microogranisms from rocks.
Plectrorhynchus schotaf	*Family*: Pomadasyidae. Common offshore in 10-20 fathom depth. Bottom dweller, feeding on invertebrates.
Plectrorhynchus gaterinus	*Family*: Pomadasyidae. Abundant species. Mainly off-shore; on sandy bottom in the vicinity of Corals. Fished throughout the year, but high production in summer months.
Lethrinus miniatus	*Family*: Lethrinidae. Common on off-shore bottom. Large size in fish trawls and traps during winter. Feeds on crusteaceans and fish.
Nemipterus tolu	*Family*: Nemipteridae. Not abundant, but common in moderately deep water (20-40 Fm). Bottom dweller. Fast swimming carnivorous fish.
Scolopsis bimaculatus	*Family*: Nemipteridae. Common in trawiling grounds in moderate depth. Appears in trap catches also in winter months.
Lutianus johni	*Family*: Lutianidae. Found in fairly deep water. Feeds on bottom living invertebrates and fish.
Lutianus fulviflamma	*Family*: Lutianidae. Associated with muddy.rocky botrtom and coral reefs, feeding on invertebrates and fishes. Common during winter.

evaporated using a rotavapor,taken up in 10.0 ml hexane and then cleaned by silica gel and aluminum oxide column chromatography (Law *et al.* 1988) to remove biogenic lipid compounds. Total petroleum hydrocarbons concentrations (TPH) were determined by fluorescence using the fixed excitation (310 nm), emission (360 nm) technique on a Shimadzu RF-5000 spectrofluorometer. Chrysene was used as the standard reference compound according to Intergovernmental Oceanographic Commission (1982). For the determination of lipid contents in fish samples, 50 g of fish tissues were extracted with dichloromethane (100 ml) for 24 hours. After evaporation, the extractable organic materials were weighed with an electric balance.

RESULTS AND DISCUSSION

The results for the total body weight, length, lipid contents and concentrations of petroleum hydrocarbons in different fish species, which represent an important food for the Gulf populations, are given in Table 2. Except for *Lethrinus*

Table 2. Ranges and mean values (± sd) of TPH ($\mu g.g^{-1}$) and lipid contents (%) in different fish species.

Fish species	n	Length (cm)	Weight (gm)	Lipid	TPH
Rastrelliger kanagurta	60	17.1-20.0 18.13±0.9	106.2-185.6 128.1±18.7	0.78-2.81 1.09±0.4	0.13-0.83 0.41±0.2
Siganus canaliculatus	50	12.1-29.9 22.8±4.2	81.4-394.1 237.4±73.8	0.81-2.68 1.00±0.5	0.02-0.77 0.28±0.1
Plectrorhynchus schotaf	46	14.5-20.5 17.6±1.4	84.8-198 138.5±30.6	0.96-2.35 1.09±0.4	0.19-0.98 0.50±0.2
Plectrorhynchus gaterinus	40	14.1-25.5 19.15±3.7	69.3-381.3 190.7±105.8	0.75-3.07 1.11±0.8	1.03-1.78 0.63±0.3
Lethrinus miniatus	20	28.9-33.5 31.01±1.4	589.3-699.3 632.0±29.8	0.85-2.57 1.97±0.3	1.03-1.78 1.38±0.1
Nemipterus tolu	24	14.2-19.2 16.88±1.4	96.3-136.2 114.8±12.9	0.98-2.01 1.37±0.3	0.21-0.87 0.43± 0.2
Scolopsis bimaculatus	24	19.8-30.1 25.0±2.9	243.2-451.2 345.1±60.9	1.46-3.01 2.03±0.4	0.99-1.88 1.38±0.17
Lutianus johni	24	14.6-19.0 16.98±1.3	91.3-135.4 114.0±15.5	0.78-1.52 1.16±0.2	0.19-0.48 0.33±0.1
Lutianus fulviflamma	24	15.0-18.5 16.55±1.2	96.1-181.3 135.3±29.0	1.01-3.25 1.78±0.3	0.14-1.52 0.92±0.2

miniatus (1.38μg.g^{-1}),*Lutianus Johni* (1.38μg.g^{-1}) and *Lutianus Fulvilamma* (0.92μg.g^{-1}), no significant differences in the concentration of petroleum hydrocarbons between other fish species are observed. The presence of hydrocarbons in significantly (P=0.01) higher concentrations in these species are probably due to the higher lipid content of their muscle tissues (EL-Deeb and EL-Ebiary,1988). According to Fossato and Canzonier (1976) and Pruell *et al.* (1986) hydrocarbons and other lipophilic compounds are accumulated by simple equilibrium between seawater and body lipids. The higher concentrations in these fish species may also reflect the differences in the feeding habits, habitats and the different water levels in which they live in the marine environment (Table 1). It has been stated (GESAMP, 1982) that fish tend to concentrate petroleum hydrocarbons in their tissues when exposed to oil, but they do not retain it indefinitely. Impressive positive relationships between lipid contents and petroleum hydrocarbons and between total fish weight and petroleum hydrocarbons(Table 3) were observed in most fish revealing the ability of fish to

Table 3. Relationships between total fish weight and TPH as well as between lipid contents and TPH in different fish species.

Fish species	n	Correlation	Coefficients
		weight - TPH	lipid - TPH
Rastrelliger kanagurta	60	0.79	0.67
Siganus canaliculatus	50	0.63	0.69
Plectrorhynchus schotaf	46	0.33	0.32
Plectrorhynchus gaterinus	40	0.69	0.73
Lethrinus miniatus	20	0.15	0.83
Nemipterus tolu	24	0.69	0.41
Scolopsis bimaculatus	24	0.61	0.59
Lutianus johni	24	0.70	0.52
Lutianus fulviflamma	24	0.86	0.82

concentrate hydrocarbons in their tissues. Most fish acquire higher concentrations of petroleum hydrocarbons in the winter seasoncompared to the summer season (Table 4) indicating that the concentration of petroleum hydrocarbons did not vary only between the tissues of different fish species but also it varied in sam specimen depending on the season. The increase in the concentration of hydrocarbons during winter is probably due to the active intake during the cooler season and consequently the storage of increasing amounts. In

Table 4. Seasonal variations of TPH ($\mu g.g^{-1}$) and lipid contents (%) in different fish species.

Fish species	Winter Season			Summer Season		
	n	Lipid	TPH	n	Lipid	TPH
Rastrelliger kanagurta	30	0.65-2.31 1.48±0.4	0.25-0.84 0.50±0.2	30	0.88-2.11 1.30±0.4	0.13-0.83 0.37±0.2
Siganus canaliculatus	22	0.67-2.41 1.81±0.7	0.04-0.77 0.33±0.2	28	0.96-2.01 1.59±0.4	0.09-0.60 0.26±0.2
Plectrorhynchus schotaf	22	0.75-1.98 1.38±0.3	0.36-0.85 0.57±0.1	24	0.66-2.26 1.20±0.5	0.19-0.98 0.43±0.2
Plectrorhynchus gaterinus	20	0.25-2.64 1.54±0.8	0.22-1.22 0.76±0.3	20	0.18-2.65 1.07±0.8	0.19-1.01 0.50±0.3
Lethrinus miniatus		1.45-2.58 2.22±0.3	1.39-1.78 1.56±0.1	10	1.15-2.28 1.53±0.3	1.03-1.38 1.20±0.1
Nemipterus tolu	12	0.98-1.99 1.53±0.3	0.31-0.79 0.51±0.2	12	0.78-1.95 1.21±0.3	0.21-0.87 0.36±0.2
Scolopsis bimaculatus	12	1.29-2.59 1.89±0.4	1.22-1.88 1.61±0.2	12	0.96-2.61 1.57±0.5	0.99-1.47 1.15±0.2
Lutianus johni	12	0.87-1.46 1.22±0.2	0.25-0.63 0.40±0.1	12	0.69-1.39 1.10±0.2	0.19-0.38 0.25±0.1
Lutianus fulviflamma	12	1.29-2.65 1.91±0.4	0.14-0.52 0.37±0.1	12	0.71-2.55 1.00±0.7	0.15-0.48 0.26±0.1

during the cooler season and consequently the storage of increasing amounts. In addition; the slackness of movement of fish particularly the demersal species near the bottom provides a convenient condition for the accumulation of hydrocarbons in their muscle tissues (El-Deeb, 1998). The decrease in the concentration of hydrocarbons, on the other hand, during summer is due to the increase in the activities and changes in the metabolic processes of fish leading to depuration of hydrocarbons burden in the fish tissues (El-Deeb, 1998). Another important reason for the seasonal variations of hydrocarbons in the muscle tissues is the changes which took place in the environmental conditions of the habitat (Shriadah, 1999, Shriadah and Al-Ghais, 1999).

Comparing concentrations of hydrocarbons($\mu g.g^{-1}$ wet weight) in fish tissues examined here with the data reported by Badawy *et al.* (1993) for _Epinepehelus_

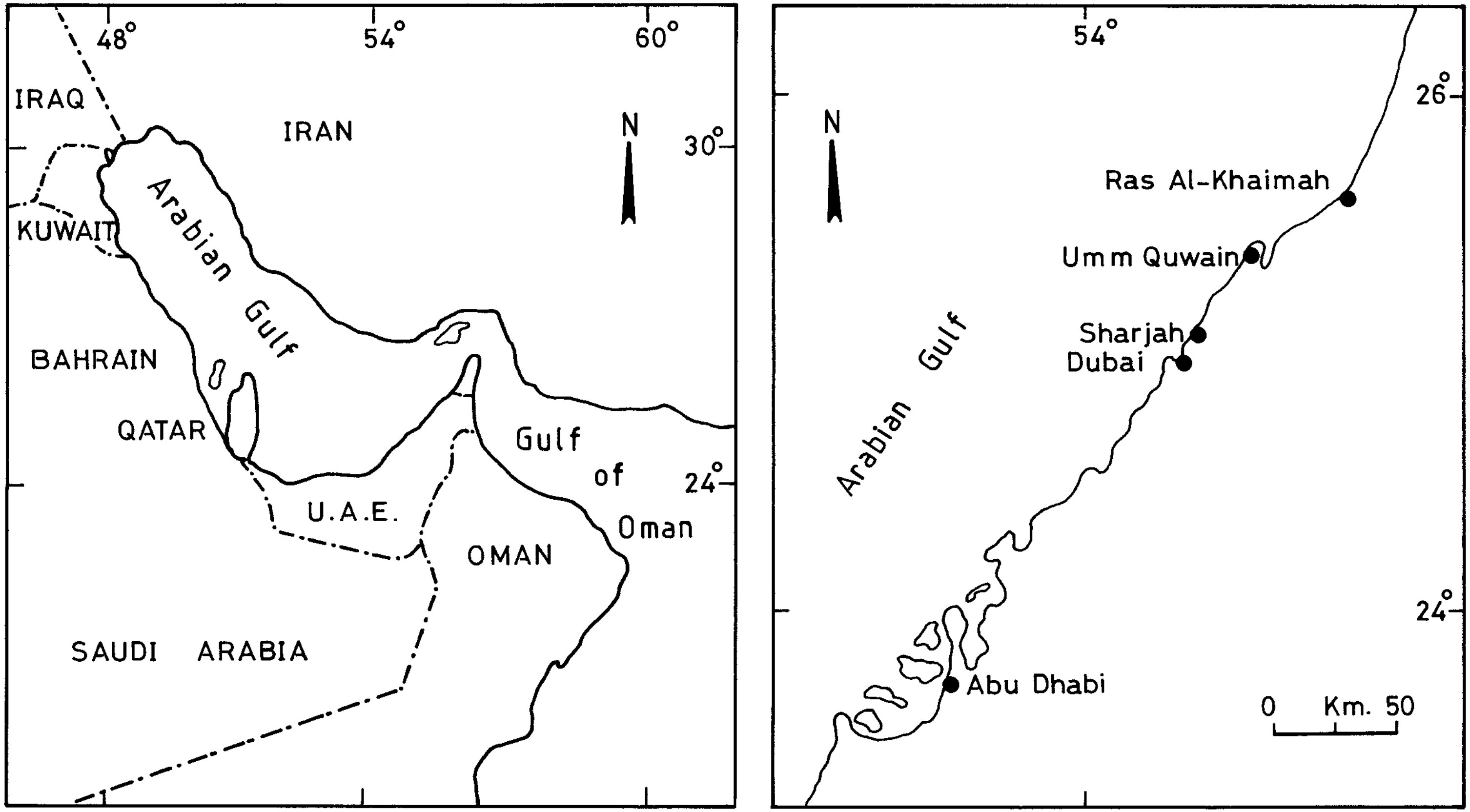

Figure 1. The Arabian Gulf region and the study area.

tauvina (2.5 ±0.3) and *Lelhrinus miniatus* (0.19 ±0.02) from the Mina al-Fahal of Oman, and those reported by EL-Deeb and EL-Ebiary (1988) for fish tissues of *Argyrops sp.* (24.7) and *Malio sp.* (53.4) from the eastern and southern coasts of Qatar in the Gulf region or concentrations of hydrocarbons in *Siganaus Rivlatus* (0.43), *Sardinella aurita* (0.17), *Diplodus Vulgaris* (0.12), and *Boop boops* (0.05) from the Egyptian water along the Mediterranean sea (El-Deeb, 1998), in *Mytilus edulis* (295), *Cardium edule* (198), *Ensis siliqua* (199), *Amigdala degussata* (208) and *Venus verirtucosa* (185) from Italian central Mediterranean coasts(Cocchieri *et al.* 1990), It is obvious that hydrocarbons found here are not as high as might be expected in and outside the Gulf. This finding suggests that there is no indication of a health risk from the human consumption of these fish species.

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