The Impact of Petroleum Hydrocarbon Contamination on Some Commercially Important Fish Species (Case Study Port Sudan-Red Sea)

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Abstract:
Red Sea water is subjected to pollution by petroleum hydrocarbons through the navigation activities or through leakage of some petroleum product during loading or off loading process, so this may lead to many environmental problems such as contamination of fish and other marine products, and due to this fact the human health may be at a risk.
The study was conducted to investigate the presence of petroleum hydrocarbons in muscles of two commercially important fish in the Red Sea, Mugils and lethrinus species and the correlation between fish age and the concentration of hydrocarbons in the fish muscles. For this study eight samples of every species were collected randomly from the fish market at Port Sudan city. The study revealed that all samples of both Mugils and Letrinth species were contaminated with petroleum hydrocarbons. Mugils species of four years old showed the highest level of hydrocarbon (2.40ug·g⁻¹), and higher concentration of hydrocarbons in the Lethrinus species muscles (3.01ug·g⁻¹, 2.85ug·g⁻¹, 2.99ug·g⁻¹) of five years old. The study found that, there is a correlation between the consternation of hydrocarbon contents and the fish age. In comparison with many previous studies the concentration of petroleum hydrocarbons in sampled fish tissues does not represent a risk for human health. Extensive field and lab investigations are recommended for risk assessment of petroleum hydrocarbons on other important fish and marine animals.

Keywords: Hydrocarbon, Pollution, Mugils, Lethrinus

Introduction:
Oil pollution has been contaminating a vast area in the Red Sea around Port Sudan city. Pollution sources are from petroleum and its derivatives; they form a thin layer which
gradually spreads on the water surface. Oil released into the sea water from tankers, off shore platforms, fuels used by ships, most oil components are water – soluble. These contaminants persist for long periods in the environment, and accumulate to toxic level in aquatic ecosystems and fish [13].

Fish is low in saturated fat. A good source high quality protein and a healthy alternative to red meat. It provides the body with essential vitamins and minerals [13], so consumption of fish is an important part of aquatic path way for transfer of contaminant. The pollutants accumulate in fish flesh or fatly tissue, exposing people who eat them [13].

The effect of energy production and waste combustion emission are bioaccumulation in our natural resources. When fish consumption patterns are considered, this risk is particularly threatening to indigenous communities [1].

The toxic effects of oil depend on the concentration of the light aromatic component in the oil and the duration of exposure to these components. Toxicity effects can range from sub-lethal behavioral effect to localized mass mortalities of marine life [6].

[5] said that the harmful effect of pollutants on fish liver histology may depend upon the duration of the exposure (chronic or acute) and the concentration level of the specific pollutants as well as other factors such as temperature, age of fish, interaction with other pollutants, water chemistry and metabolic activity of the fish.

[10] studied the four days lethal concentration of petroleum hydrocarbons (PHCs) to chanos chanos (Lc50-96h). Then this species exposed to sub lethal concentration of petroleum hydrocarbon and the liver histological alteration was studied after different exposure time. This histological alteration can used as early biological markers for evaluation of polluted aquatic ecosystem and the result showed that, the intensity of histological changes was influenced by the extent of the exposure period and concentration of pollution.

Fish absorb heavy metals from the surrounding environment depending on a variety of factors such as the characteristics of the species under consideration, the exposure period, the concentration of the element, as well as a biotic factors such as temperatures salinity, pH. Heavy metals, released by anthropogenic activities will be accumulated in marine organisms through the food chain, so human health can be at risk because of consumption of fish contaminated by toxic chemicals [4].

[3] Found that fish caught in Siracusa, nearby a petrochemical industrial area, were more contaminated by cadmium, lead and chromium than these from the other sites in Sicilian area in the Mediterranean Sea.

The level of total petroleum hydrocarbon and lipid contents have been reported for eight commercially fish species from the Arabian Gulf. Scarus Ghabon species showed the highest level of petroleum hydrocarbon ( 7.4 ± 3.2 ug – g⁻¹) in the muscle tissue followed by Epine - phelies Touvrna ( 6.8 ± 3.6 ug –g⁻¹). The study found that petroleum hydrocarbon levels are not as high as could be expected in the Gulf and the consumption of these fish species does not pose a significant health risk to the local population [2].
Aromatic hydrocarbons of dissolved petroleum are readily absorbed by aquatic organisms and are bio-concentrated in fish [18]. Fish have been often used as appropriate bio indicators of chemical contaminants [17].

The concentration of petroleum hydrocarbons in fish and shrimp species from Suez Gulf were investigated during 2012. The results showed that the contamination is more likely occurred as a result of their ingesting contaminated materials than direct body exposure to oil residues in water column, the lethal effect of oil concentration occurs in the range (1 – 10 mg/L) and the sub lethal effect occurs of very low concentration (0.1 – 1.0 mg/L), and extremely toxic to phytoplankton especially in bay area where concentrations of both oil phytoplankton's tends to accumulate [12].

Petroleum hydrocarbons accumulate more in the organism than the environment, so fish are used for the assessment of the quality of aquatic environment and can be used as bio indicator to evaluate the environmental contamination level [8].

The aim of the present study was to determine the impact of oil contamination on the Red Sea around Port Sudan city by examining the accumulation of oil derivatives in the muscle tissue of commercially important fish species. *Mugilis* and *lethrinus* species.

**Material and Methods:**
Eight fish samples of *Mugilis* species and eight fish samples of *Lethrinus* species were collected randomly from the fish market at Port Sudan city. Sampling was carried out during September November 2014. This study investigates the presence of oil contaminant in the fish tissues and the relationship between the oil contaminant and organism age, according to [17]. Fish samples were stored frozen till analysis.

**Age Determination:**
Marking on the scales of the *Mugilis* species and *Lethrinus* species give indication of age. The surface of the scale bears large number of small calcareous as the scale grows. Fish grow faster in summer than in winter, due to higher temperature and increased food availability. Patterns in the scale and otoliths reflect this change: summer zones are wide and winter zone
are narrow. The scale were kept dry and clean by immersing in light lime soda solution and washed by ethanol 70% and examined microscopically.

Fish can be aged by counting the number of paired summer /winter growth zone, called annuli. A fish with three annuli, therefore, would be three years old, [11, 9, 15].

**Sample analysis:**

In the laboratory length and total body weight of each fish were measured. About 50 g of the muscle of each individual were soxhlet extracted for 8 hours with 250 ml of methanol. Saponification of the extract was carried out by adding 20 ml of 0.7M KOH and 30ml of water and refluxing for about 2 hours. The resulting mixture was transferred to separating funnel and extracted twice with hexane. Then the extract filtered through glass wool and dried with anhydrous sodium sulfate. The extract was carried out by rotary evaporation down to 15 ml, which was further reduced to 5 ml under gentle flow of pure nitrogen [17].The extract cleaned up by passing it through a silica / alumina column [7].The presence of petroleum hydrocarbon compound was determined using gas chromatograph.

**Gas chromatography analysis:**

All extracted oil from fish samples were injected into a gas liquid chromatography (model 6890N Primer Company, Serial No: US1670321H), equipped with flame ionization detector (FID) and a capillary column of 30 × 0.320mm ×0.25m. The stationary phase was:HP-5. Detector, injector and oven temperatures were; 250 c split less. Nitrogen (N₂) was used as carrier gas at flow rate of 20 ml/min.

**Result and discussion:**

The result showed that the length of the eight fishes samples of *Mugils* species ranged from 14 to 15.5 cm., their weight ranged from 1 to 1.55 kg., and their age ranged from 3 to 4 years old table (1). the presence of petroleum hydrocarbon in both *Mugils* and *Lethrinus* species. *Mugils* species of four years old showed the highest level of hydrocarbon (2.40ug-g⁻¹) and(2.31ug-g⁻¹),followed by *Mugils* species of three years old (2.00 ug-g⁻¹,1.88 ug-g⁻¹,1.81ug-g⁻¹) table (1),on the other hand *Mugils* species of two years old showed low level of hydrocarbons (1.01ug-g⁻¹,1.60 ug-g⁻¹,1.80 ug-g⁻¹).Higher concentration of hydrocarbons in this species may be due to their high lipid solubility [18], and/or may be related to lipid contents of muscle tissues and other physiological factors [14].There were a significant correlation coefficients (p>o.70) between hydrocarbons content in the fish muscle and it’s age table 2. This indicates the accumulation of hydrocarbon may increases with age. [5] said, Harmful effect of pollutants on fish liver histology may depend on many factors such as age of fish.
Table 1: length, total body weight, age, and total hydrocarbons in Muscles of Mugils species.

<table>
<thead>
<tr>
<th>Fish species</th>
<th>No.</th>
<th>length (cm)</th>
<th>weight (kg)</th>
<th>age (year)</th>
<th>TPH ug·g⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mugils</td>
<td>1</td>
<td>14.5</td>
<td>1.00</td>
<td>4</td>
<td>2.31</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>14.0</td>
<td>1.01</td>
<td>3</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>15.1</td>
<td>1.10</td>
<td>4</td>
<td>2.40</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>15.3</td>
<td>1.50</td>
<td>3</td>
<td>1.88</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>14.3</td>
<td>1.50</td>
<td>2</td>
<td>1.01</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>15.5</td>
<td>1.54</td>
<td>2</td>
<td>1.60</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>15.3</td>
<td>1.55</td>
<td>3</td>
<td>1.81</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>15.0</td>
<td>1.31</td>
<td>2</td>
<td>1.80</td>
</tr>
</tbody>
</table>

Table 2: Correlation between age and hydrocarbon content in Muscles of Mugils species.

<table>
<thead>
<tr>
<th>Species</th>
<th>n</th>
<th>Correlation coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Age – hydrocarbon content</td>
</tr>
<tr>
<td>Mugils</td>
<td>8</td>
<td>0.873 (**)</td>
</tr>
</tbody>
</table>

Table 3, showed the length of the eight fishes samples of Lethrinus species ranged from 16.71 to 19 cm., their weight ranged from 1.09 to 1.59 kg, and their age ranged from 3 to 5 years old. Higher concentration of hydrocarbons in the Lethrinus species muscles (3.01ug·g⁻¹, 2.85ug·g⁻¹, 2.99ug·g⁻¹) of five years old, followed by Lethrinus species of four years old (2.80ug·g⁻¹, 2.81ug·g⁻¹, 2.99ug·g⁻¹). This study found that the hydrocarbons concentration were higher in Lethrinus species of four years old than that of Mugils species of the same age table 1. This higher hydrocarbon concentration in Lethrinus species muscle tissue may be due to feeding habits and different places in which they live. On the other hand Lethrinus species of three years old showed lowest concentration of hydrocarbon (2.00ug·g⁻¹) table 3. Also the result showed that the accumulation of hydrocarbons in the muscle tissue of Lethrinus species increases with age, there was a significant correlation coefficient (p>0.70) between the hydrocarbon content in the fish muscle and its age table 4.
Table 3: length, total body weight, age, and total hydrocarbons content in Muscles of *Lethrinus* species.

<table>
<thead>
<tr>
<th>Fish species</th>
<th>No.</th>
<th>length (cm)</th>
<th>weight (kg)</th>
<th>age (year)</th>
<th>TPH ug·g⁻¹</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Lethrinus</em></td>
<td>1</td>
<td>19.0</td>
<td>1.50</td>
<td>5</td>
<td>3.01</td>
</tr>
<tr>
<td></td>
<td>2</td>
<td>19.0</td>
<td>1.53</td>
<td>5</td>
<td>2.85</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>18.14</td>
<td>1.59</td>
<td>3</td>
<td>2.00</td>
</tr>
<tr>
<td></td>
<td>4</td>
<td>17.91</td>
<td>1.09</td>
<td>4</td>
<td>2.80</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>19.01</td>
<td>1.40</td>
<td>4</td>
<td>2.81</td>
</tr>
<tr>
<td></td>
<td>6</td>
<td>18.20</td>
<td>1.66</td>
<td>4</td>
<td>2.99</td>
</tr>
<tr>
<td></td>
<td>7</td>
<td>18.50</td>
<td>1.81</td>
<td>5</td>
<td>2.99</td>
</tr>
<tr>
<td></td>
<td>8</td>
<td>16.71</td>
<td>1.55</td>
<td>3</td>
<td>2.00</td>
</tr>
</tbody>
</table>

Table 4: correlations between age and hydrocarbon content in muscles of *lethrinus* species.

<table>
<thead>
<tr>
<th>Species</th>
<th>n</th>
<th>Correlation coefficients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Age – hydrocarbon content</td>
</tr>
<tr>
<td><em>Lethrinus</em></td>
<td>8</td>
<td>0.866 (**)</td>
</tr>
</tbody>
</table>

Depending on the previous studies, the lethal effect of oil concentration occurs in the range (1-10mg/L) [12]. And the result reported for commercial fish species from Arabian Gulf [2], the highest level of petroleum hydrocarbon (7.4±3.2ug·g⁻¹) in the muscle tissue followed by *Epinephelus Touvrna* (6.8±3.6 ug –g⁻¹). The study found that petroleum hydrocarbon levels are not as high as could be expected in the Gulf and the consumption of these fish species does not pose a significant health risk to the local population [2]. So from the present study we found that the concentration of hydrocarbon in the sampled fish tissues compared to the previous studies do not represent a risk for human health. So these results indicated that the Red Sea water is not highly contaminated by Petroleum Hydrocarbon although there are high navigation activities and some ports for petroleum and petroleum products imports and exports.

**Conclusion:**

1- From the present study we found that the concentration of hydrocarbon in the sampled fish tissues, compared to the previous studies, do not represent a (high) risk for human health. So these results indicated that the Red Sea water is not highly contaminated by Petroleum Hydrocarbons although there are high navigation activities and some ports for petroleum and petroleum products imports and exports.

2- Hydrocarbon levels in fish tissues can be used as indicators of the fate of hydrocarbon pollutant in the marine environment.

3- Current efforts to monitor petroleum hydrocarbon pollutant levels in the marine environment should be consolidated.
4- The results of this study can be used as a base for comparison with the future changes in the Red Sea water around Port Sudan city regarding hydrocarbon pollution.

5- It is recommended that further studies and regular monitoring of the red sea water along Red Sea coast is needed.

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