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Bioaccumulation of Petroleum Hydrocarbons by *Melanopsis nodosa* (Gastropoda) in River Tigris within the City of Baghdad, Iraq

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A B S T R A C T

The levels of petroleum hydrocarbons in the tissues and shells of *Melanopsis nodosa* from Tigris River within the City of Baghdad were investigated. Forty eight samples of snails and sediments collected once every two months for the period November 2014 to May 2015 from two stations (AL-Kadhimiya and AL-Qadisiyah) along Tigris River were analyzed by using Gas Chromatography. The levels of total petroleum hydrocarbons ranged from 0.22 µg/g to 3.48 µg/g in tissues, from 0.10 µg/g to 2.65 µg/g in shells, and from 0.14 µg/g to 2.58 µg/g in sediments. Results of statistical analysis showed significant differences in total petroleum hydrocarbon levels between study stations. The levels at AL-Kadhimiya station were significantly higher than at AL-Qadisiyah station.

Introduction

Among many chemicals that are considered environmental contaminants, petroleum hydrocarbons are of special importance (Schwartz *et al*, 2012). The predominant and widespread use of petroleum-based products as main sources of energy for daily life and industrial activities has led to the release of these pollutants in to the environment through leakage and accidental spills (Al-Zahrani and Idris, 2010). Petroleum or crude oil is a naturally occurring liquid consists of a complex mixture of hydrocarbon and non-hydrocarbon compounds which are harmful to organisms (Lotfinasabasl *et al*, 2012). Hydrocarbon compounds which consist of hydrogen atoms linked to carbon atoms by high energy bonds (Patel and Shah, 2013), are the major component of petroleum-based products and crude oil (Edwin-Wosu and Albert, 2010). Crude oil hydrocarbons are mostly alkanes, cycloalkanes (naphthenes), and aromatic hydrocarbons (asphaltenes) while non-hydrocarbon compounds are nitrogen, sulfur, and oxygen with trace amounts of heavy metals particularly nickel, iron, vanadium, and copper (Kathi and

Khan, 2011).Hydrocarbons enter aquatic environments either from natural origins (natural hydrocarbons) (Klenkin *et al*, 2010) or from anthropogenic sources (anthropogenic hydrocarbons) such as accidental spillages during transport of petroleum-based products and industrial effluents (Al-Hejuje *et al*, 2015). Because of their hydrophobic properties, petroleum hydrocarbons tend to bind to sediment particles (Veerasingam *et al*, 2015).

Many alterations in properties of sediment such as increasing in viscosity or decreasing in oxygen availability can happen as a result of accumulation of petroleum in sediment and ultimately this affect organism that are use sediment as habitat (Anson *et al*, 2008). Many aquatic organisms such as mollusks, mussels, fishes and other mammals have the ability to bio accumulate petroleum hydrocarbons in their tissues by ingesting these pollutants for a period of time (Ahmed *et al*, 2014). The city of Baghdad, Iraq is among several cities which have been built on the Tigris river banks since the dawn of civilization (Ali *et al*, 2012).

As a result of this Tigris River is suffering from a problem of different agricultural drainage, industrial discharge, and domestic's disposal during its flowing through major Iraqi cities in addition to Diyala River and Tharthar lake impacts (Hassan *et al*, 2013). Since the city of Baghdad is a highly populated urbanized area in which intense activities take place mostly depending on oil and oil products as source for energy, bio accumulation in *Melanopsis nodosa* occurring in the area was a scientific necessity.

The study Area

Two stations located on Tigris River north and south of Baghdad city were selected. These stations as follows (Figure-1):

AL-Kadhimiya station S1

River bank in this station is natural and no rocks are present but the bank is heavily inhabited by aquatic plants especially *Ceratophyllum sp.* Many human activities are somewhat nearby this station such as tourist resorts.

AL-Qadisiyah station S2

River bank in this station is also natural and heavily inhabited by aquatic plants. Many human activities are also somewhat nearby this station especially AL-Dora power station and roads and bridges which are always crowded.

Station name	Symbol	Station area	Coordinates
S1	●	Kadhimiya	33°23'11" N 44°21'29" E
S2	●	Qadisiyah	33°16'12" N 44°21'54" E

Field Work

Samples were collected during the morning in the first week of November 2014, January, March, and May 2015.Snails were randomly collected by hand picking (Hossain and Abdul Baki, 2014) and they were put in vials with labels refer to time, date, and location of sampling.Sediment samples were collected by using core sampler (Benninger *et al*, 2011) and they were wrapped with aluminum foil with labels.Water temperature was measured directly in field by a thermometer.

Laboratory Work

In laboratory, the species *Melanopsis nodosa* was identified depending on what is mentioned in (Ward and Whipple, 1959) and also on detailes description by (Naser,

2006). Adults of nearly uniform size of *Melanopsis nodosa* were isolated and rinsed with distilled water and snail and sediment samples were then storage at -20 °C until analysis (AL-Saad *et al*, 2009).Prior to extraction, tissues of snails were removed from shells by forceps. Three replicates of 10 g of shells and three replicates of 10 g of tissues were dried, grounded and sieved through a 63µ metal sieve (Farid *et al*, 2008).Sediment samples were homogenized to obtain finer texture. Three replicates of 10 g were dried, grounded and sieved

Soxhlet Extraction

Approximately 5 g of prepared sample were placed in a whatman cellulose thimble and Soxhlet extracted with 100 ml Dichloromethane (DCM) for 24 hours at a rate of 6 cycles per hour. The extract was collected and evaporated at 40 °C in a rotary evaporator (Paramanik and Rajalakshmi, 2013).

Determination the Quantity of Total Petroleum Hydrocarbons

10 ml of hexane was added to the extract. The micro-syringe of gas chromatography was rinsed with the blank hexane (3 times) and it was further rinsed with the sample before taking the sample for analysis and then 1 µl of the sample was injected in GC and total amount of petroleum hydrocarbons was resolved at a particular chromatogram in µg/g (Alinnor and Nwachukwu, 2013).

Results and Discussion

Results for the total petroleum hydrocarbons (TPHs) concentrations in sediment are summarized in table 1. The concentrations were in the range of 0.14 µg/g recorded during May at the station S2 to 2.58 µg/g recorded in January at the station S1. The concentrations of TPHs in sediment were within the range of values reported by (Douabul *et al*, 1984; Al-Saadon, 2002). Statistical test showed that the TPHs concentrations in sediment were significantly different ($P<0.05$) between study stations and also among study months. Higher concentrations were recorded at station S1 which located upstream of Tigris River compared to station S2 which located downstream of the River. The possible and major source of TPHs in station S1 is oil spills coming from north of Iraq as a result of accidents in oil pipelines. TPHs concentrations in sediment were significantly higher in January and lower in May as shown in figure 2.

Temperature is the most important factor governing the removal of hydrocarbons in the environment by evaporation (Farid *et al*, 2014). In addition to the direct influence of temperature on hydrocarbon evaporation, temperature increase the rate of microbial degradation processes by increasing the enzymatic activities of microorganisms and the solubility of hydrocarbons (Ezeonu *et al*, 2012). Maktoof *et al* (2014), recorded higher levels of TPHs in water during winter and lower levels during summer.

As shown in figure 3, results for TPHs concentrations in snail tissue were in the range of 0.22 µg/g recorded during May at the station S2 to 3.48 µg/g recorded during January at the station S1. The concentrations of TPHs in the snail tissue were within the range of values reported by (Burns and Smith, 1977; Farid *et al*, 2008). Hydrocarbons can enter snail tissues through water or from phytoplankton either from solution or absorbed to suspended particles while feeding (Farid *et al*, 2008). Results for the TPHs concentrations in snail shell were in the range of 0.11 µg/g recorded during May at the station S2 to 2.65 µg/g recorded during January at the station S1 as shown in figure 4.

Table.1 Monthly Means and LSD Test for the Total Petroleum Hydrocarbons Content µg/g in Sediment for the Study Stations in the Duration of the Study

Months	Stations		Mean
	S1	**S2**	
November2014	1.88	1.74	1.81 B
January2015	2.58	2.31	2.45 A
March	1.01	1.05	1.03 C
May	0.17	0.14	0.16 D
Mean	1.41 A	1.31 B	---

LSD $_{(Months, 0.05)}$ = 0.0908, LSD $_{(Stations, 0.05)}$ = 0.027,
LSD ($_{Months}$ x $_{Stations, 0.05}$) = 0.0553; *Means with the same letter are not significantly different

Figure.1 Map of Iraq and Baghdad showing Study Stations (Source: Ministry of Water Resources, General Directorate of Surveys, Maps Department, 2007)

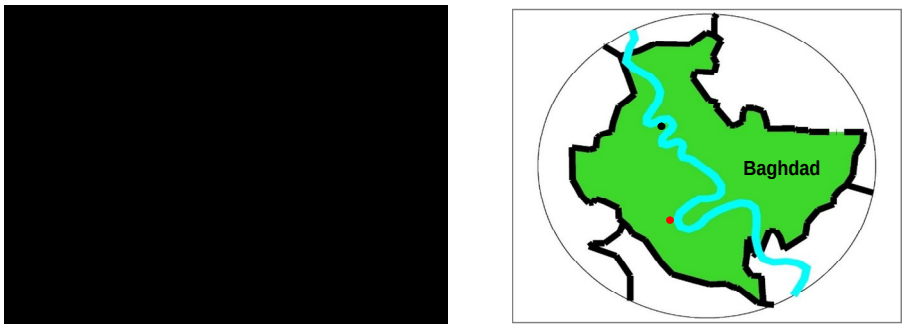

Figure.2 The seasonal variations of the Total Petroleum Hydrocarbons Content µg/g in Sediment and Water Temperature °C at the Study Stations During the Study Months

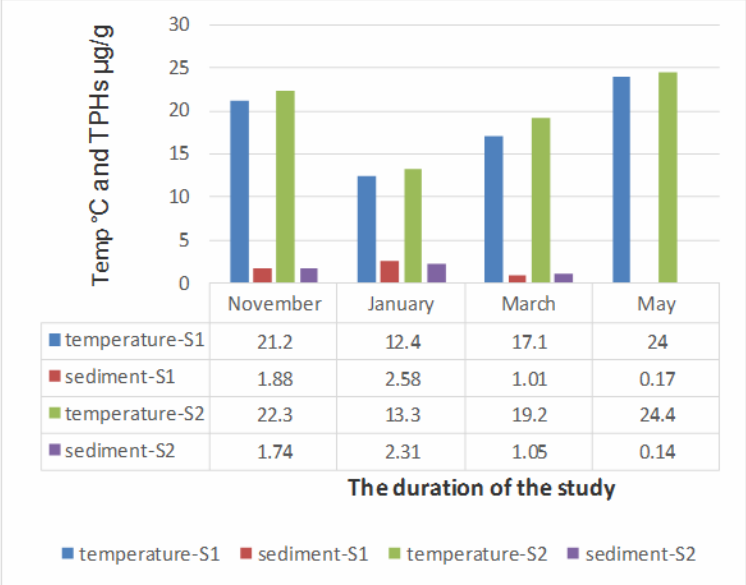

Figure.3 The Seasonal Variations of the Total Petroleum Hydrocarbons Content µg/g in Sediment and Snail Tissue at the Study Stations During the Study Months

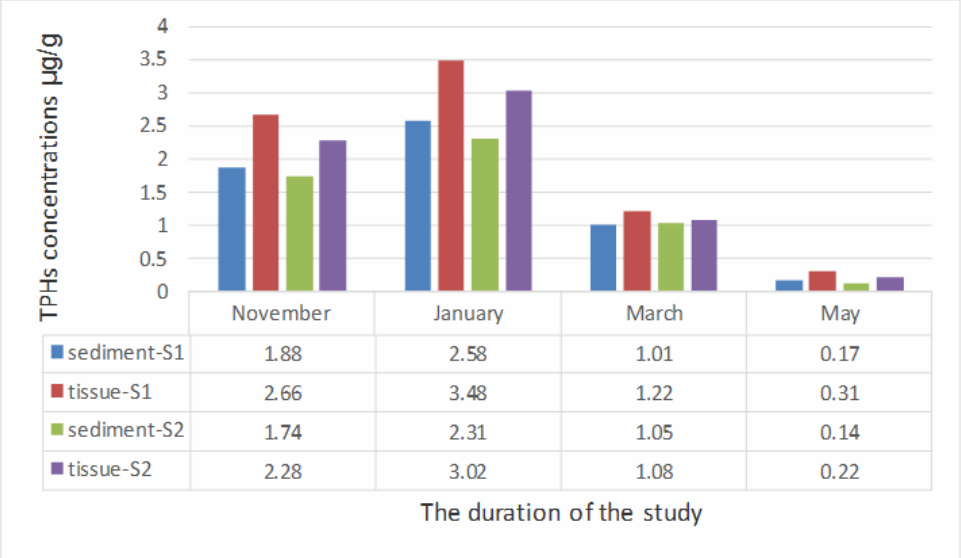

Figure.4 The Seasonal Variations of the Total Petroleum Hydrocarbons Content µg/g in Snail Tissue and Shell at the Study Stations during the Study Months

TPHs concentrations were higher in snail tissue and lower in snail shell. In spite of that many authors suggested that shell provide a more accurate indication of environmental change and pollution, most metals are generally accumulated many times over within tissues rather than the shells (Kesavan *et al*, 2013). Tyokumbur and Okorie (2014) found that the viscera of the freshwater snail, *Melanoides tuberculata*

having the highest concentrations of all studied trace metals compared to the shell.

In conclusion, this study shows that the freshwater snail *Melanopsis nodosa* is capable to bio accumulate PHs in its tissues and its Potency to bio accumulate is strongly dependent on the amount of PHs in the sediments.The levels of PHs in the snails were positively correlated with the sediment samples. Tissues concentrations of PHs were higher than what was present in shells.

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