Veterinary Medicine and Public Health Journal (VMPH)

Volume.5, Issue.2, pp: 158-165 Article 17
May (2024)

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Received: 15/12/2023 **Revised:** 15/1/2024 **Accepted:** 17/2/2024

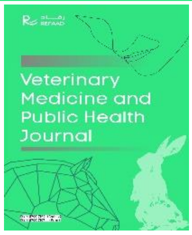
DOI: https://doi.org/10.31559/VMPH2024.5.2.17

www.refaad.com

Veterinary Medicine and Public Health Journal (VMPH)

Journal Homepage: https://www.refaad.com/Journal/Index/7

E-ISSN 2707-7195 | P-ISSN 2707-7187



Total Petroleum Hydrocarbons in Soil of Different Oil Fields at Basrah Governorate, Iraq

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How to cite this article: Resen, M., et al. (2024). Total Petroleum Hydrocarbons in Soil of Different Oil Fields at Basrah Governorate, Iraq. Veterinary Medicine and Public Health Journal, 5(2), 158-165.

Abstract:

Objectives: This study concentrated on determining the total hydrocarbon concentrations in soil at eleven stations of the oil field (Seba, Safwan, Majnoon, Ratawi, Bergezia, Qurna2, Qurna1, Shuaaba, South and North Rumaila, and Al Zubair).

Methods: Soil samples were freeze-dried, finely pulverised in an agate mortar, and sieved through a 62-um metal sieve and 150 ml mixture of methanol and benzene (1:1) was used to extract the soil. Determination of TPHs where determined by using Spectrofluroscence, Total organic carbons (TOC) in the soil of the oil fields were also determined.

Results: According to the TPH distribution used in this investigation, station 11 (Al Zubair) had the highest concentration of TPHs (162.53µg/g dry weight), while station 1(Seba) had the lowest concentration (21.4µg/g dry weigh). Additionally, the study's findings demonstrated that TPH levels varied spatially amongst sites. The highest amounts of total petroleum hydrocarbons detected in soil samples, as well as the findings of this investigation indicating that TPH levels varied geographically throughout stations.

Conclusions: There is significant correlation between the TPH in soil and TOC%. By comprising the result concentration of this study with literature reviews, the concentration levels lies within it and in other cases exceed it.

Keywords: *TPHs; TOC%; soil oil field; Pollution; Southern Iraq.*

1 Introduction

This should Petroleum is a complex mixture of both inorganic and organic substances. In an organic hydrocarbon, there are four to twenty-six carbon atoms or more arranged in various ways, such as cyclic rings or straight and branching aliphatic hydrocarbons. The characteristics of the petroleum depend on the location and geology of the crude oil's sources as well as the kind of cracking used in the refining process (Kareem et al, 2023). Crude oil and oil products are the primary sources of hydrocarbons in the environment. Additional sources, which come from natural sources, were found to exist, such as biogenic or natural hydrocarbons (Al-Saad et al.,2022). The vast range of natural biochemical processes is responsible for the diversity of composition found in biogenic hydrocarbons (Klenkin et al., 2010). Because they have the potential to cause cancer, petroleum hydrocarbons—in particular, PAH compounds—are classified as hazardous materials. (Bakhtiari et al., 2009). All hydrocarbon mixtures contained in crude oil are referred to as total petroleum hydrocarbons, or TPHs (Douben, 2003).In terms of soil microorganisms, total petroleum hydrocarbons (TPHs) can be both hazardous and advantageous as a source of carbon. TPHs are characterised as a blend of aromatic and aliphatic hydrocarbons derived from crude oil products utilised in industry and transportation (Sutton et al., 2013). Petroleum hydrocarbons can enter the environment as a result of mishaps, spills, leaks, industrial discharges, or products from residential or commercial jobs (Ines et al., 2013). Low concentrations of hydrocarbons from "biogenic" natural sources, such as higher plants, can be retained by soil (Zhang et al., 2012). The hydrocarbons can be extracted from soil via a number of processes, including volatilization, photo-oxidation, chemical reactions, leaching, and biodegradation (Grimalt & Olive, 1993). According to Barakat et al., (2001), certain processes could take a very long time, and some of these compounds will stay in the soil and become more resistant over time. Petroleum hydrocarbons are a problem in the environment because they can have detrimental effects on human and animal health (Nuhad et al., 2014). Hydrocarbons have become a global issue in both developed and developing nations because of their abundance, persistence, toxicity (they are listed as dangerous substances), harmful impacts on aquatic life and human health, and long-lasting air transportation (Ukalaska & Smreczak, 2020). The word "contamination" refers to alterations brought about by human activity, in one form or another, from materials and other careless inputs to the environment, which pose a risk to public health and harm ecosystems and living things. The majority of human-caused environmental problems stem from the production of hydrocarbon pollutants; over 60% of the world's energy needs are met by oil and natural gas; as modern civilization has advanced over the previous ten years, pressure on energy sources has increased. (Ahmed & Fakhruddin, 2018), yet they negatively impact ecosystems along transportation lines and refinery sites if they leak into the environment during extraction, treatment, transport, and storage (Sari et al., 2018). Moreover, anthropogenic hydrocarbons are linked to combustion, the thermal breakdown of fossil fuels, unburned petroleum products, fuel waste, and man-made fuels. According to Medeiros et al. (2005), anthropogenic hydrocarbons seem to be more prevalent in water-related sites like refineries and oil dispensers, as well as in sewage and shipping activities like dry docking. The primary sources of all petroleum hydrocarbons, particularly in port locations such as Basrah Governorate, are the petrochemical industry, refinery-related pollution, natural gas flaring and leaks, oil and gas producing activities, and crude oil spills and leaks(Garabedian 2023). The objective of the present study is to determine the spatial concentrations of Total Petroleum hydrocarbons in oil fields at Basrha Southern Iraq and to analyze with reference to its adverse health effects.

2 Materials and Methods

Soil samples were collected from eleven oil feild stations in (Seba, Safwan, Majnoon, Ratawi, Bergezia, Qurna2, Qurna1, Shuaaba, South and North Rumaila, and Al Zubair) at Basrah city as shown in (Figure 1).

Soil samples were freeze-dried, finely pulverised in an agate mortar, and sieved through a 62 um metal (stainless steel) sieve before analysis. Based on Al-Saad's (1995) method, the extraction and cleanup process was used to determine the presence of petroleum hydrocarbons in the soil. Soil was put in a cellulose thimble that had already been extracted, for 24 hours, a 150 ml mixture of methanol and benzene (1:1) was used to extract the soil. Once this time frame had passed, the extract was moved to a storage flask and the samples were extracted once more using a new solvent. Using a rotary evaporator, the mixed extracts were decreased in volume to 10ml. After that, it was saponified for two hours using a 4N KOH solution in a 1:1 methanol to benzene ratio. The unsaponified material was extracted using hexane, and the resulting extract was dried over anhydrous sodium sulphate before being concentrated for UVF. Total organic carbons (TOC) in the soil of the oil fields were also determined. To calculate the total organic carbon in soil, dry soil samples were ground finely in a mechanical mortar and sieved through a 63 µm mesh sieve. This process was done using the burning method (Ball, 1964), which involved placing 5 g of soil in a dried, pre-weighed crucible and burning it for 48 hours at 550°C. The soil was then placed in desiccators and weighted multiple times to achieve a constant weight. The TOC was estimated by comparing the weight of the soil sample and crucible before and after burning.

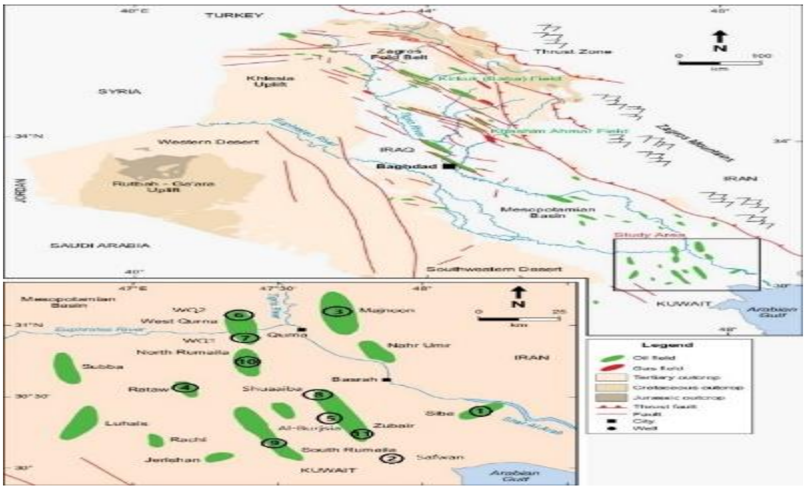

Figure 1: Sample Locations

3 Results and Discussion

At eleven different stations, the TPH concentrations in soil samples ranged at stations 1 (20.41-22.53µg/g), stations 2 (25.23-28.63µg/g), stations 3 (46.89-48.53µg/g), stations 4 (30.31-31.25µg/g), stations 5 (50.23-53.63µg/g), stations 6 (70.52-72.64µg/g), stations 7 (90.03-91.62µg/g), stations 8 (123.20-128.58µg/g), stations 9 (36.52-38.42µg/g), stations 10 (138.62-140.73µg/g), and at stations 11 (160.95-164.03µg/g) dry weight as shown in (Table 1).

The mean concentration range in station1 (21.4µg/g), while station2 (27.03µg/g), station3 (47.48µg/g), station4 (30.74µg/g), station5 (51.84µg/g), station 6 (71.61µg/g), station 7 (90.63µg/g), station8 (125.8µg/g), station 9 (37.65µg/g), station10 (141.66µg/g), and at station11 (162.53µg/g). (Table 1 and Figure 2).

Total Organic Carbon (TOC) were range from 2.703% in station 1 to 10.670% at station 11 as shown in Table 2.

According to the TPH concentration distributions used in this investigation, station 11 (AL- Zubair) had the highest concentration of TPHs (162.53µg/g dry weigh), whereas station 1 (Seba) had the lowest concentration (21.4µg/g dry weigh).

Anthropogenic hydrocarbons may have come from the following sources in the sampled stations: crude oil extraction and production (oilfields), neighboring oilfields (West Qurna-1, Majnoon, and Nahr Umr), refined oils and gas creation plants, electrical producing stations, oil wastes discharges, transportation, internal combustion in industrial and vehicle motors, natural gas flares and explosions, breathing air at petrol stations and local exercises (Al-Saad et al., 2016). According to Al-Saad et al. (2015), each of these contributed to the rise in TPH concentration.

Temperature was the primary factor influencing the evaporation-based removal of hydrocarbons from the environment (Wang et al., 2005). Temperature was also found to favour the microbial breakdown process (Coulon et al., 2007). Photo-oxidation broke down the components of oil (Garrett et al., 1998). The subtropical parts of Iraq are characterised by a climate that is mostly hot and humid due to excessive sun radiation. Particularly in the summer, temperature and photo-oxidation may be the cause of the relatively low hydrocarbon levels observed (Farid et al., 2014) such phenomena was observed in the seba and Safwan oil field. Many investigations into the effects of organic carbons and petroleum hydrocarbon concentrations in sources such surface waters, groundwater, and soil/sediment matrices have already been carried out. However, the presence of total organic carbon in any area devoid of a concrete geological source is likewise regarded as aberrant and influenced by industrial and anthropogenic activity (Dhananjayan and Karthikeyan, 2019). Total organic carbon (TOC) concentration in the sediment samples from the current study showed a mean concentration of 2.703% at station 1 and a high concentration of 10.760% at station 11. Additionally, there is a positive correlation (r=0.818) between total hydrocarbons and total organic carbons in the soil of oil fields. There's a favorable Similar to this study, Al Darwish (200 found 4) looked at the distribution of total organic carbon and total petroleum hydrocarbon in oil-contaminated sediments from Dubai. He found a positive relationship (r = 0.98) between these parameters and suggested that TPH and TOC could both be useful markers for oil contamination, also karem(2016) and Kadhim (2019) fond a positive correlation (r=0.814) and r=(0.816) between total hydrocarbons and total organic carbons in the soil of West Qurna -2 and West Qurna 1 oil field at Basrah respectively. The concentrations of total organic carbon and petroleum hydrocarbons found in the current study indicate the need for additional research to fully comprehend the state of the environment, as these two indicative parameters can be useful in assessing the ecosystem's health.

The present investigation indicates somewhat greater and lower concentrations of TPH in most of the analyzed oil fields. By comprising the result concentration of this study with literature reviews Table (3) the concentration levels lies within it and in other cases exceed it.

Table 1: Concentration of Total Petroleum Hydrocarbons in soil oil felids at Basra city

Station	TPHs (µg/g)	Range	Mean	±SD	SE
1	20.41 22.53 21.68	20.41-22.53	21.4	1.066	0.615
2	25.23 28.63 27.24	25.23-28.63	27.03	1.709	0.986
3	48.53 46.89 47.03	46.89-48.53	47.48	0.909	0.524
4	30.31 31.25 30.68	30.31-31.25	30.74	0.473	0.273
5	50.23 51.68 53.63	50.23-53.63	51.84	1.706	0.985
6	70.52 72.64 71.68	70.52-72.64	71.61	1.061	0.612
7	90.26 90.03 91.62	90.03-91.62	90.63	0.859	0.496
8	123.2 125.63 128.58	123.20-128.58	125.8	2.694	1.555
9	36.52 38.42 38.03	36.52-38.42	37.65	1.003	0.579
10	138.62 145.64 140.73	138.62-140.73	141.66	3.601	2.079
11	160.95 162.62 164.03	160.95-164.03	162.53	1.541	0.890

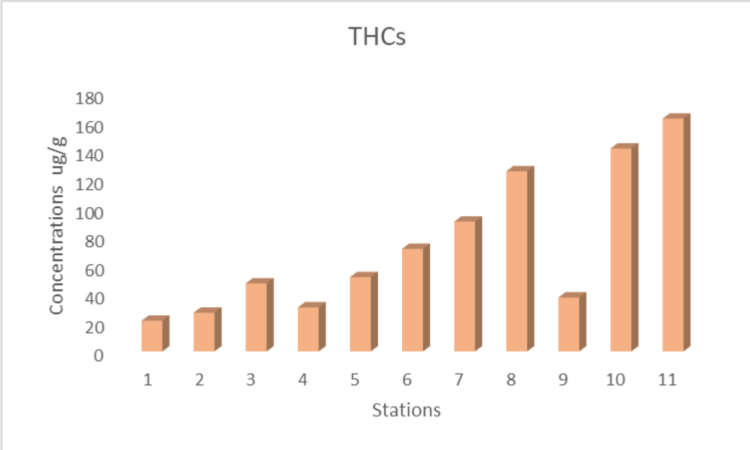

Figure 2: Means concentration Total Petroleum Hydrocarbons in soil oil felids at Basra city.

Table 2: Concentration of Total Organic Carbon (TOC%) in soil oil felids at Basra city.

Station	TOC%	Range	Mean	SD	SE
1	2.021 3.098 2.990	2.021-3.239	2.703	0.593	0.342
2	3.714 3.689 3.773	3.689-3.773	3.725	0.043	0.024
3	3.368 3.239 3.567	3.239-3.567	3.391	0.165	0.095
4	3.438 3.460 4.002	3.438-4.002	3.633	0.319	0.184
5	4.545 4.980 4.324	4.324-4.980	4.616	0.333	0.192
6	5.736 5.031 5.872	5.031-5.873	5.546	0.451	0.260
7	7.707 7.656 6.963	6.963-7.707	7.442	0.415	0.239
8	9.396 9.206 9.296	9.206-9.396	9.229	0.095	0.054
9	9.316 9.230 9.871	9.230 -9.316	9.472	0.347	0.200
10	9.818 9.783 9.853	9.818-9.853	9.818	0.035	0.020
11	10.409 11.001 10.870	10.409-11.001	10.760	0.310	0.179

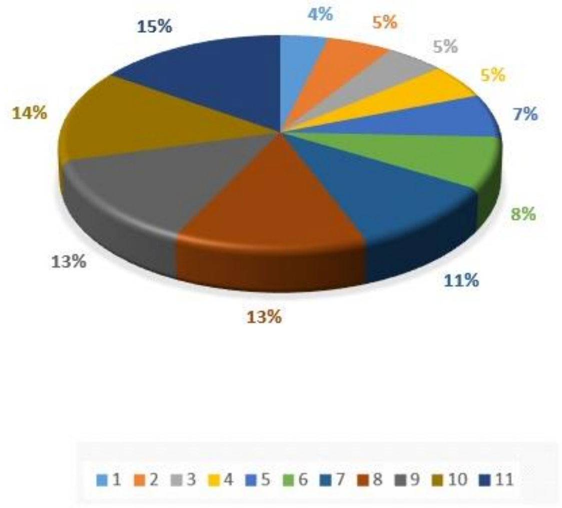

Figure 3: Percentage of total organic carbon in each station

Table 3: The Comparison of The Current Concentrations of Surface Soil Total Petroleum Hydrocarbons (ug g-1 dw) With Previous Studies at Basrah province.

Studied Areas	Total Hydrocarbons(μg/g)	References
Shat Al-Arab estuary and northwest Persian Gulf	2.55-26	Hantoush,2006
Shatt Al-Arab River, Northern	7.37-24.41	Al-Imarah et al , 2010
Iraqi Coast Region	2.39- 30.88	Al-Khion,2012
Euphrates River /Nasiriya city	4.74-12.32	Abed, 2013
Shatt Al-Arab River	4.76 – 45.24	Al-Hejuje,2014
Shatt Al-Arab River	0.94-26.27	Al-Mahana,2015
Umm Qasser	26.27	Al-Saad et al ,2017
Shatt Al-Arab River	6.52-7.01	Al-Gizzi et al ,2021
Shatt Al-Basrah	3.87-57.5	Glou et al, 2022
Abu Floos Port	15.00	Garabedian, 2023
Khor Al- Zubair Port	9.032	Garabedian, 2023
Umm Qasr Port	22.10	Garabedian, 2023
Al-Fao Port	7.082	Garabedian, 2023
West Qurna-2 Oil field	14.82- 41.86	Al-Saad et al ,2017
Basrah city	8.33 – 16.83	Al-Hassen (2011)
Basrah city	13.0 - 38.8	Douabul et al., (2012)
Basrah city	2.2 - 75.05	Al-Ali et al, (2016)
West Qurna-2 Oil Field	16.657 - 37.372	Karem (2016)
West Qurna-1 Oil Field	9.52 - 31.04	Kadhim (2019)
Rumaila Oil Field	0.5 – 93.95	Al-Halfy et al., 2021
Basrah city	4.95 - 685.19	Saleem (2022)
Oil field in Basrah	21.40-162.53	Present study

4 Conclusions

TPH concentrations were found to be highest at Location 11(Al-Zubair) and lowest at Location 1(Seba) There is a significant correlation between the TPH in soil of the oil field and TOC%.

Recommendations:

Remediation Strategies: Examine and put into practice efficient remediation techniques such soil vapor extraction to lower the overall hydrocarbon concentration, bioremediation- which uses microorganisms to remove contaminants- or phytoremediation- which uses plants to remove toxins.

Health Advisory and Awareness: Health cautions should be sent to the neighborhood, outlining the dangers of living in or close to the polluted area (Zubair Oil Field). Inform individuals about the risks to their health that excessive concentrations of total hydrocarbons can bring.

Restriction of Access: To minimize human exposure, consider limiting access to the polluted area until remediation operations have sufficiently lowered the total hydrocarbon concentration to safe levels.

Collaboration and Advocacy: Work together with regional administrations, environmental organizations, and neighborhood associations to push for more stringent pollution control regulations as well as funding for restoration and remediation projects.

Green Spaces and Reclamation: After the region has been successfully cleaned up, think about turning some of it into parks or green areas to encourage natural restoration and enhance the quality of life for the surrounding population.

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