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Risk Analysis of Crude Oil Contamination on Quality of Drinking Water for Some Sources of Freshwater

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ABSTRACT

The main goal of this study was to see how water-soluble fractions of light crude oil from the Taq taq refinery influenced those physicochemical parameters in drinking water from the Dukan River and Sarchnar spring sources. According to statistical analysis, water quality parameters such as pH, electrical conductivity, temperature, turbidity, color, total solids, total dissolved solids, total suspended solids, ammonium, sulfide, and phosphorus have all been impacted by this crude oil when compared to controls (water resources) and drinking water quality standards. The results showed that the values of turbidity, color, ammonium, sulfide, and phosphorus in water samples that have been treated with various percent of crude oil water-soluble fractions are increased due to the high effects of crude oil on the physical and chemical characteristics of water resources (% 0 controls). According to our findings, the effect of crude oil contamination on water quality has been linked to a variety of factors.

Keywords: crude oil, contamination, water quality, the water-soluble fraction (WSF).

INTRODUCTION

Water quality is one of the most important aspects of any aquatic situation. The use of new technology in its discovery and development has resulted in long-term environmental harm. The environmental risk posed by oil extraction has been a major source of concern for residents in such areas, as vast amounts of this substance are released into water bodies from natural and anthropogenic sources, posing a danger to global and local ecosystems (Kadafa, 2012). Crude oil pollution of the marine ecosystem puts a real burden on aquatic life and creates water quality limitations (Omoregie *et al.*, 1997). During the oil spill, the effect of crude oil on current water quality restrictions and the biological situation is assessed (Tambekar, and Kale, 2005). Crude oil is made up of colloidal particles of hydrocarbon and non-hydrocarbon molecules (Cadwellaer, 1993). In the crude oil composite mixture of several altered chemical elements, hydrocarbons are the main structural component (Ite *et al.*, 2013). Crude oil is a highly toxic compound made up of up to 10,000 different altered hydrocarbons that can damage marine environments to a great extent (Dawes, 1998). The study concluded that oil pollution is a massive blowout that has severely harmed numerous environmental components (UNEP, 2011). Oil spills and the risks associated with them are not well known due to inadequate monitoring measures and insufficient record keeping. An oil spill in a seaside or coastal environment may introduce polyaromatic hydrocarbons, oil and grease, heavy metals, and other pollutants into the aquatic system. Streams and rivers may be contaminated by crude oil spills, as well as disrupt the water quality by dispersing in a thin layer over the surface. Since it is the portion of crude oil that reaches an aquatic environment with the greatest ease and can cause immediate, acute harm to aquatic species, most toxicological research on crude oil has centered on the water-soluble fraction (Martnez-Jernimo and Villase Cor, 2005).

MATERIALS AND METHODS

1. Samples collection

There were three types of samples taken: crude oil, river water, and spring water. The crude oil sample was taken from the Taq taq oil field, which is located 13 kilometers southwest of Koysinjaq district, approximately 60 kilometers northeast of Kirkuk, and 85 kilometers southeast of Erbil. It is located between latitude ($36^{\circ}\ 00'\ 22.48''$ N) and longitude ($44^{\circ}\ 31'\ 24.33''$ E) at an altitude of 604 meters. Despite the fact that the river water sample was obtained from Dukan river, which is located 60 kilometers northwest of Sulaimaniyah town in Iraq, between latitude ($35^{\circ}\ 56'\ 20.77''$ N) and longitude ($44^{\circ}\ 57'\ 38.74''$ E) at an altitude of 411 meters. Furthermore, the spring water sample was taken from the Sarchnar natural ingesting water source at ($35^{\circ}\ 35'\ 23.33''$ N) latitude and ($45^{\circ}\ 23'\ 00.99''$ E) longitude, which is located 5 kilometers northeast of Sulaimanyah town at an elevation of 756 meters above the level of the sea Figure 1.

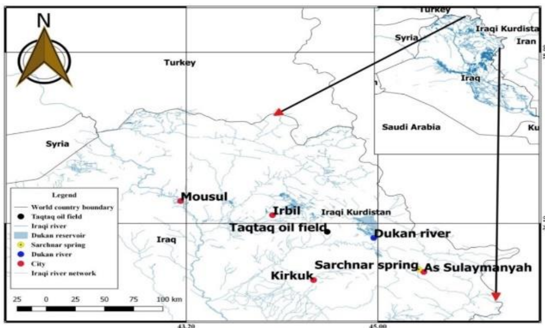

Fig. 1 a map of the study area.

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2. Preparation of the water-soluble fraction (WSF)

The WSF evolved into a method of structured rendering (Phatarpekar and Ansari, 2000). In a (1 liter) screw-cap conical flask, a sample of crude oil (50 ml) was gradually combined with an equal amount of deionized water. After normalizing the diluted crude oil sample with a magnetic stirrer at 200 rpm for 24 hours, the mixture was blended and allowed to stand overnight in a separating funnel. According to the method of (Rodrigues *et al.*, 2010), the lower phase was collected and used as the 100 percent WSF (stock solution) and diluted with water 0 percent controls to provide 25 percent, 50 percent, and 75 percent strength WSF, which were saved in screw-cap bottles prior to usage.

3. Sample analysis

pH, electrical conductivity (EC), temperature (T), turbidity (NTU), color (Hazen), total solids (TS), total dissolved solids (TDS), total suspended solids (TSS), ammonium (NH_4-N), sulfide (S^{2-}), and phosphorus (PO_4-P) were all investigated using normal methods for water and wastewater investigation (APHA, 2005).

i. A portable pH meter (Multi 340i/SET multi-parameter instrument WTW Company-Germany) was used to calculate the pH of the water on site.

ii. The conductivity of the water was measured in the field using an electrometric method and a portable EC-meter (Cond 330i, 82362 Weilheim WTW Company-Germany).

iii. A digital thermometer was used to calculate the temperature on the day of the sample collection.

iv. A portable turbidity meter (Photo Flex/Photo Flex Turb.WTW Company-Germany) was used to calculate the turbidity of the water.

v. A photoLab spectral (82362 Weilheim WTW company-Germany) model was used to determine color, ammonium, sulfide, and phosphorus.

vi. The method defined by (Hussein, 2013) was used to calculate the total solid, total dissolved solid, and total suspended solid.

RESULTS AND DISCUSSION

The outcomes of the physicochemical limitations of crude oil's water-soluble fraction, the Dukan River, and Sarchnar spring water are presented in Tables 1. A crude oil sample has light because an API (American Petroleum Institute) index is greater than 38 degrees. Using the API index, different types of petroleum were identified; Light (^{o}API ≥ 31), Medium (22 ≤ ^{o}API < 31), Heavy (10 ≤ ^{o}API <22), Extra-heavy (^{o}API ≤ 10) (Santos *et al.*, 2014).

Table 1. Shows the results of the physicochemical characteristics of the water and crude oil sample sites (WSF).

Location	WSF	Temp.	Turbidity	Color	pH	EC25oC	TS	TDS	TSS	NH4-N	S2-	PO4-P
		oC	NTU	Hazen	-	µS cm-1			mg l-1			
	0% control	11.9	2.46	<0.2	7.62	233	215	202.5	12.5	0.044	0.04	0.3
	25%	14.9	3.39	31.5	7.39	199	262	190	72	0.038	0.05	0.3
	50%	14.8	7.64	62.1	7.49	113	158	127.5	30.5	0.051	0.06	0.6
Dukan	75%	15.3	11.70	94.8	7.48	74	62	42.5	19.5	0.090	0.07	0.6
River	100%	14.7	15.70	126.3	5.59	13	22	17	5	0.053	0.07	1.0
	Mean	14.32	8.18	62.98	7.11	126.40	143.80	115.90	27.90	0.055	0.06	0.56
	STDEV	1.37	5.59	49.89	0.86	90.03	100.96	84.10	26.38	0.02	0.01	0.29
	SEM	0.61	2.50	22.31	0.38	40.26	45.15	37.61	11.80	0.01	0.01	0.13
	0% control	16.60	<0.01	5.5	7.28	326	307.5	280	27.5	0.039	0.04	0.2
	25%	14.80	2.97	30.3	7.00	275	332	282.5	49.5	0.028	0.05	0.3
	50%	15.00	7.02	62.6	7.21	195	222	165	57	0.049	0.06	0.4
Sarchnar	75%	15.50	11.30	93.2	7.25	99	94	75	19	0.070	0.07	0.5
spring	100%	14.70	15.70	126.3	5.59	13	22	17	5	0.053	0.07	1.0
	Mean	15.32	7.40	63.58	6.87	181.60	195.50	163.90	31.60	0.05	0.06	0.48
	STDEV	0.78	6.29	48.20	0.72	127.48	134.43	119.40	21.50	0.02	0.01	0.31
	SEM	0.35	2.81	21.56	0.32	57.01	60.12	53.40	9.61	0.01	0.01	0.14

Table 1 shows that values of the physicochemical characteristics of (Dukan River) water sample 0% control and crude oil's water-soluble fraction that mixed at different percent with water were confirmed a variety of (11.9-15.3) ^{o}C for temperature, (2.46-15.7) NTU for turbidity, (<0.2-126.3) Hazen unit for color, (5.59-7.62) for pH, (13-233) µS cm^{-1} for EC, (22-215) mg l^{-1} for TS, (17-202.5) mg l^{-1} for TDS, (5-12.5) mg l^{-1} for TSS, (0.044-0.053) mg l^{-1} for HH_4-N, (0.04-0.07) mg l^{-1} for S^{2-}, and (0.3-1) mg l^{-1} for PO_4-P. Apart from turbidity, color, and TSS, the parameters are within ideal limits, according to World Health Organization (WHO, 2011) as shown in Figure 2.

Temperature (11.9) ^{o}C, turbidity (2.46) NTU, color (<0.2) Hazen, S^{2-} (0.04) mg l^{-1} and PO_4-P (0.3) mg l^{-1} were registered at the lowest levels in the 0% control (Dukan River), while pH (5.59), EC (13) µS cm^{-1}, TS (22) mg l^{-1}, TDS (17) mg l^{-1} and TSS (5) mg l^{-1} were recorded at the lowest levels in the 100% of WSF (stock solution). However, in 25% of WSF, the lowest value of NH_4-N (0.038) mg l^{-1} was found. The highest values of turbidity (15.7) NTU, color (126.3) Hazen, S^{2-} (0.07) mg l^{-1} and PO_4-P (1) mg l^{-1} were based on 100% of WSF, while the highest values of pH (7.62), EC (233) µS cm^{-1}, TDS (202.5) mg l^{-1} were based on 0% control (Dukan River), TS (262) mg l^{-1} and TSS (72) mg l^{-1} were highest in 25% of WSF, while NH_4-N (0.09) mg l^{-1} and temperature (15.3) ^{o}C were highest in 75% of WSF. The results showed that as the percentage of WSF crude oil contamination increases, the conductivity, pH, total solids, total dissolved solids, and total suspended solid values decrease. This may be due to the water content acting as a bond droplet and a dispersed stage in the continuous crude oil phase. Although the turbidity, color,

NH_4-N, S^{2-}, and PO_4-P values will rise as a result of the pH and sulfur content material (0.60%) of WSF based solely on API properties, it has an effect on nutrient dissolution and transformation in crude oil (WSF), as well as the water quality parameters.

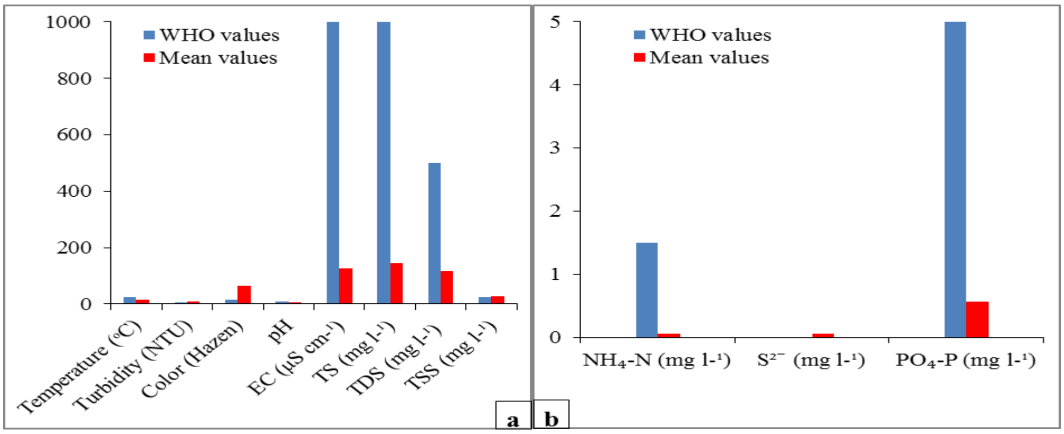

Fig. 2 (a and b) The WHO criteria were used to compare the mean physicochemical characteristics of a Dukan river water sample that had been polluted with crude oil (WSF).

The observed values of the physicochemical characteristics of (Sarchnar spring) water sample 0% control and crude oil's water-soluble fraction that mixed at different percent with water were confirmed in Table 1, with a temperature range of (14.7-16.6) °C for temperature, (<0.01-15.7) NTU for turbidity, (5.5-126.3) Hazen unit for color, (5.59-7.28) for pH, (13-326) µS cm^{-1} for EC, (22-332) mg l^{-1} for TS, (17-282.5) mg l^{-1} for TDS, (5-57) mg l^{-1} for TSS, (0.028-0.07) mg l^{-1} for NH_4-N, (0.04-0.07) mg l^{-1} for S^{2-}, and (0.2-1) mg l^{-1} for PO_4-P. The parameters, with the exception of turbidity, color, and TSS, are within permissible limits according to (WHO) norms, as demonstrated in Figure 3.

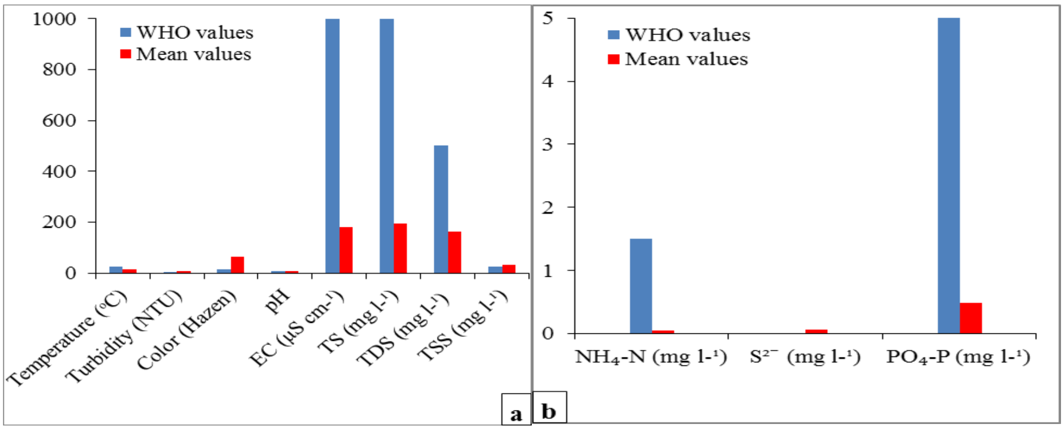

Fig. 3 (a and b) The WHO criteria were used to compare the mean physicochemical characteristics of a Sarchnar spring water sample that had been polluted with crude oil (WSF).

The lowest values of turbidity (<0.01) NTU, color (5.5) Hazen, S^{2-} (0.04) mg l^{-1} and PO_4-P (0.2) mg l^{-1} were recorded in 0% control (Sarchnar spring water). While the lowest values of temperature (4.7) °C, pH (5.59), EC (13) µS cm^{-1}, TS (22) mg l^{-1}, TDS (17) mg l^{-1}, and TSS (5) mg l^{-1} were recorded in 100% of WSF, the lowest value of NH_4-N (0.028) mg l^{-1} was recorded in 25% of WSF. The highest values of turbidity (15.7) NTU, color (126.3) Hazen, S^{2-} (0.07) mg l^{-1} and PO_4-P (1) mg l^{-1} were dependent on 100% of WSF, while the highest values of pH (7.28), EC (326) µS cm^{-1}, temperature (16.6) °C were based on 0% control (Sarchnar spring) water, TS (332) mg l^{-1} and TDS (282.5) mg l^{-1} were maximum in 25% of WSF however TSS (57) mg l^{-1} and NH_4-N (0.07) °C were maximum in 50% and 75% of WSF respectively. Crude oil is made up of several different components. This mixture, which includes polyaromatic hydrocarbons, oxygen, nitrogen, and sulfur-containing materials, plays quite crucial role in water quality parameter variability (Khabakhsh *et al.*, 2014).

CONCLUSION

On the premise of findings, it was concluded that all the physicochemical variables of the crude oil water-soluble fractions (100% WSF) were below the permissible limits for normal drinking water (WHO, 2011) except turbidity and color above permissible limits. Meanwhile, all of the physicochemical variables of the normal drinking water samples obtained from both Dukan River and Sarchnar spring water were consistent with the drinking water standard (WHO, 2011). Therefore, the present study has found that using various percent of crude oil causes the increased values of physicochemical parameters of water samples collected from two sources. Then, the current work has shown that the crude oil (100% WSF) components play important roles in the variability of water quality parameters. In conclusion, many factors, including crude oil content, crude oil volume, and degradation of crude oil, play a role in the impact of crude oil on water quality.

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تحليل مخاطر التلوث بالنفط الخام على جودة مياه الشرب لبعض مصادر المياه العذبة

على باوه شيخ احمد، روزكار عبدالله حسن و نزار ياسين حه مه صالح

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الغرض الرئيسي لهذة الدراسة هو لمعرفة كيفية تأثير الاجزاء القابلة للذوبان في الماء للنفط الخام الخفيف من مصفاة طقطق على المعايير الفيزوكيميائية لمياه الشرب لنهر دوكان ومصادر نبع سرجنار. وفقا للتحاليل الاحصائية اتضح بأنه معايير جودة المياه مثل الاس الهيدروجيني, التوصيل الكهربائي, درجة الحرارة, العكارة, اللون, الاجزاء الصلبة الكلية, الاجزاء الذائبة الكلية, الاجزاء العالقة الكلية, كبريتاد, الامونيوم والفسور جميعها تأثرت بالنفط الخام مقارنة بمعاملة (الكونترول- مصادر المياه) ومعايير جودة مياه الشرب. أظهرت النتائج أن قيم العكارة واللون والأمونيوم والكبريتيد والفوسفور في عينات المياه التي تم معاملتها بنسب مختلفة من الأجزاء النفط الخام القابلة للذوبان في الماء تزداد بسبب التأثيرات العالية للنفط الخام على الخصائص الفيزيائية والكيميائية لمصارد المياه (٪0 الكونترول). وفقًا لنتائجنا ، تم ربط تأثير تلوث النفط الخام على جودة المياه بمجموعة متنوعة من العوامل.

الكلمات المفتاحية: النفط الخام, التلوث, جودة المياه,الاجزاء الذائبة في الماء.