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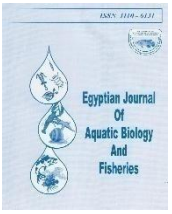

Concentration of Oil and Grease in Al-Rumaytha River Water, Iraq

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ABSTRACT

River water is exposed to many pollutants from direct and indirect sources. The material recovered as a substance soluble in the solvent including other matters extracted by the solvent from an acidified sample and not volatilized during the test is called oil and grease (O&G). The presence of O&G, even the thinnest layer in aquatic ecosystems, does not affect the biotic components but rather exceeds it affecting aquatic life. Water samples were collected monthly for the period from November 2021 to June 2022. In the field, light penetration was measured by the Secchi disc method, with a diameter of 30cm. The results showed that the highest concentration of O&G (2.5 mg/l) was recorded in S2 during February, while the low concentration (0.16 mg/l) was recorded in S3 during December. The results recorded high concentration in winter months, compared to other seasons under study. Light penetration showed that the highest level (37 cm) was recorded in S3 during December, whereas the lowest concentration (18.5 cm) was in S2 during February, with a mean value of 27.52 cm during all study periods. This may be due to the increase and decrease in the concentration of O&G noted during specific months of study, which confirms the occurrence of negative relationships between O&G concentrations and light penetration (r= -0.82, -0.80, -0.44) in the S1, S2, and S3, respectively.

INTRODUCTION

The amount of floatable matter in the waste is a crucial factor to consider when to assess the potential impact of garbage disposal on surface waterways. There are two main categories of floating matter: particulate matter, such as grease balls, and liquid substances that can cover broad surfaces in a thin, highly visible film **(APHA, 2017)**. Each year, 3.5 million tons of petroleum hydrocarbons from anthropogenic and natural sources reach the aquatic environment directly or indirectly **(Maleti *et al*., 2019)**.

According to **APHA (2017)**, oil and grease (O&G) means any material that can be dissolved in the solvent that has been recovered. It also includes chemicals like sulfur compounds, certain organic hues and chlorophyll that were extracted by the solvent from an acidified sample but did not volatilize during the test. The quantity of oil and grease in water is a key indication of its quality and safety (O&G) **(Westerhoff *et al.*, 2018)**.

O&G cause ecology damages for aquatic organisms, such as plants, animals, micro-organisms and as result affect human. O&G may be present in freshwater in a slight concentration

according to the sources of release, Nonetheless, wastewater comprises only about 10% of the total, and its concentration might be anywhere from 10 to 100mg/ l., and in an untreated domestic wastewater, it is always in the range between 50 to 100mg/ l **(Tchobanoglous *et al.*, 2002)**. For its presence in natural water bodies, it depends on what is thrown into the river from anthropogenic wastes.

Oil-water mixes with droplet sizes between 20 and 150; it is classified as dispersed oil mixtures, whereas oil-water combinations with droplet sizes beyond 150 are classified as free oil. Droplets of oil and water smaller than 20 µ are categorized as emulsified oil mixtures, while those with droplet sizes less than 5 µ are referred to as soluble oil mixtures **(Manning & Eric, 1983)**.

Animal fats, vegetable oils and petroleum oils all have comparable physical characteristics, with an ecologically similar impact. In addition to producing unpleasant scents, they alter ecosystems and create products that remain in the environment for a period longer than a year, O&G elements can also have harmful physical impacts on plants and animals by coating them with oil and suffocating them by oxygen depletion **(US EPA, 2022)**. These compounds may cause fish to die by coating their gill surfaces, which prevents them from breathing, drowning of waterfowl due to lack of buoyancy, suffocation of benthic biota, as well as causing unfavorable visual effects on shorelines **(US EPA, 1986)**. Oily and greasy wastewater contains hazardous compounds such phenols, petroleum hydrocarbons and aromatic hydrocarbons that are inhibitors of plant and animal growth as well as mutagenic and carcinogenic to humans. This wastewater is typically disposed of in a water body as its eventual destination **(Alade *et al.*, 2011)**.

In addition, The presence of even a thin coating of these elements has a negative impact on aquatic life because it reduces light penetration and the exchange of oxygen between the air and the water; however, it has no effect on the biotic components of the ecosystem. Thus, the effect on photosynthesis and other biological processes depend on both important factors. There are some environmental factors drive phytoplankton primary productivity, where light penetration and dissolved oxygen are notably the most important factors, especially in the dry season **(Hassan *et al.*, 2023)**.

Al-Rumaytha River in Al-Muthanna province has not received many environmental studies to determine the pollutants in its waters including petroleum hydrocarbon pollution, which includes oil and grease and others. That is why the objective of this research was focused on determining the concentration of O&G in the surface water of Al-Rumaytha River and assessing its relationship with light penetration since they have a significant impact on the biotic and non-biotic components of the river water.

MATERIALS AND METHODS

Around 25 kilometers north of Samawa City lies Al-Rumaytha City, where the Al-Rumaytha River, a tributary of the Euphrates flows. Samawa City is about 270 kilometers southeast of Baghdad, the capital of Iraq **(Al-Fanharawi, 2016)**.

Three sites were selected on Al-Rumaytha River; S1 is the one closest to the river entrance and is characterized by its proximity to agricultural use. The second location (S2) is in the center of Rumaytha City, and it is characterized by the presence of waste flow from the markets and stores, sewage drainage pipes, fishing activity in addition to the lack of grass and trees on both river banks. South of the city center is where you'll find the third site, or S3 (Fig. 1).

Each month (two replicates) from November 2021 to June 2022, samples of subsurface water were taken from the research locations. One liter-capacity glass vials were cleaned with solvent and used to collect samples monthly from each location. Each location and metric had two samples taken for statistical confirmation.

The O&G concentration in water samples was determined using gravimetric methods **(APHA, 2017)**, the weight measured using a 4-decimal place microbalance (highly sensitive balance). The method's underlying premise is based on the gravitational separation of particles, with densities lower than the surrounding water. Surface-collected particles were isolated by filtration and oven dried at a temperature ranging between 103– 105°C; the concentrations of O&G were calculated in milligrams per milliliter.

The amount of light that penetrated a disc with a 30-cm diameter was measured using the Secchi technique. Statistical analysis was performed using SPSS. V.20. Less significant difference (LSD) and analysis of variance (ANOVA) was used to explain the differences between means at $P \leq 0.05$, standard deviation, minimum and maximum. Correlation coefficient analysis at $P \leq 0.05$ and $P \leq 0.01$ was used to evaluate water pollution parameters **(Gerry & Michael, 2002)**.

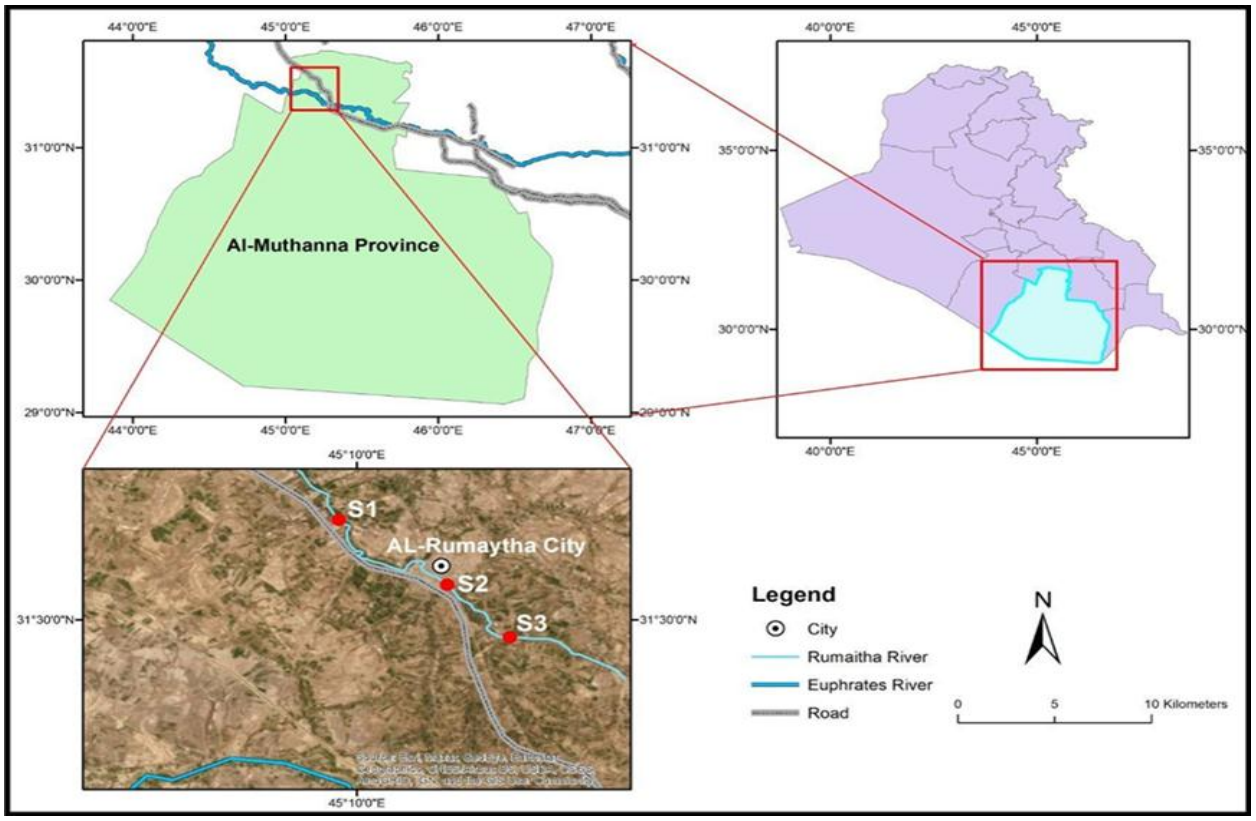

Fig. 1. A map for Al- Rumaytha River showing study sites

RESULTS AND DISCUSSION

Oil and grease concentration

The O&G in water can cause surface films and shoreline deposits, leading to environmental degradation, and can induce human health risks when discharged to the surface or into the ground water **(Pisal, 2010)**. The presence of even very low concentrations of O&G in raw water sources is undesirable due to the complications produced in the treatment processes such as coagulation and sedimentation **(Manivasakam, 2011)**. The presence of O&G in the river water leads to the formation of oil layer, which causes significant problem to biota and abiotic factors such as the reduction of light penetration.

The results of current study showed that the highest concentration (2.5 mg/l) was recorded in S2 during February month, while the lowest (0.16 mg/l) was in S3 during December. These results agree with those of **Fadzil *et al.* (2017)**. In general, the results recorded high concentration in winter months, compared to the remaining study seasons (Fig. 2). This may return to the use of the hydrocarbon compounds at homes, in shops and villages for heating and cooking purposes, and it may be released with sewage water reaching river water. Lower concentration in hot months may be attributed to the increase in the evaporation processes and decrease of activities, which coincides with a study on the Nile River **(Moursy, 1983)** and a study on Bujagali reservoir **(Wanda *et al.*, 2021)**.

The high mean value of O&G concentration during the study period recoded in S2 (0.99 mg/l; table,1) may be attributed to the increased anthropogenic activities noted in this site, such as oil replacement and car wash stations, boat traffic and city center wastes and sewage.

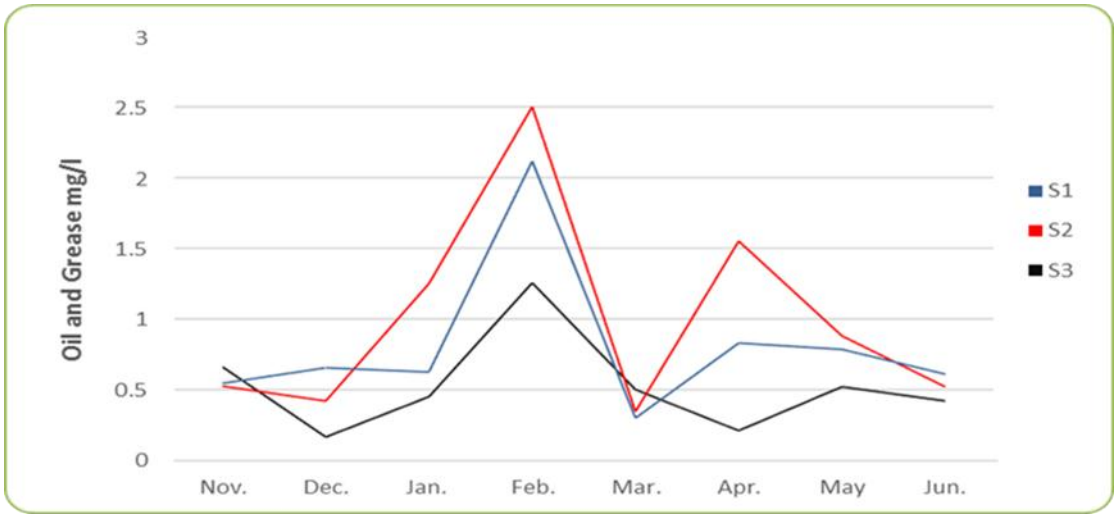

Fig. 2. Monthly variations of O&G concentration at the study sites along Al-Rumaytha River

Table 1. Monthly variations of O&G concentration (with mean and replications) at the study sites along Al-Rumaytha River

Months	Oil and Grease mg/l				Mean
	Sites / Replications	S1	S2	S3	
Nov.	R1	0.47	0.52	0.69	0.56
	R2	0.62	0.53	0.63	0.59
Mean		0.545	0.525	0.66	0.57
Dec.	R1	0.64	0.41	0.16	0.40
	R2	0.67	0.43	0.17	0.42
Mean		0.655	0.42	0.165	0.41
Jan.	R1	0.65	1.3	0.5	0.81
	R2	0.6	1.2	0.4	0.73
Mean		0.625	1.25	0.45	0.77
Feb.	R1	1.92	1.76	1.44	1.70
	R2	2.31	3.24	1.07	2.2
Mean		2.115	2.5	1.255	1.95
Mar.	R1	0.4	0.34	0.4	0.38
	R2	0.2	0.35	0.6	0.38
Mean		0.3	0.345	0.5	0.38
Apr.	R1	0.86	1.6	0.22	0.89
	R2	0.8	1.5	0.2	0.83
Mean		0.83	1.55	0.21	0.86
May	R1	0.78	0.89	0.55	0.74
	R2	0.79	0.87	0.49	0.71
Mean		0.785	0.88	0.52	0.72
Jun.	R1	0.62	0.56	0.44	0.54
	R2	0.6	0.48	0.4	0.49
Mean		0.61	0.52	0.42	0.51
Total mean		0.80	0.99	0.52	0.77

Despite of the variations noted among sites (Table 1), there were no significant spatial differences in the O&G concentration between the different sites ($P > 0.05$). Nevertheless, significant differences were noted between the months at study sites.

Olufemi *et al*. (2011) postulated that, the concentration of O&G in Ubeji River was high (209.3 mg/l), compared to the concentration in sediment because the O&G do not mix with river water, and most of them settle at the bottom of the river. The higher values of O&G recorded in heavy rainy months (winter months) are influenced by the runoffs from land in the Euphrates River **(khan, 2018)**.

Measurement of water quality that rely on the amount of light seen through a body of water are known as transparency and the Secchi disk depth. In general, the quality of water in bodies with high transparency levels is recorded as high **(UNEP GEMS, 2008)**. Even a thin coating may block some sunlight rays from reaching the water's surface, which subsequently has a negative impact on the water's quality. This can be achieved even with trace amounts of O&G in the water.

The results of light penetration in the current study showed that the highest level (37 cm) was recorded in S3 during December, and the lowest concentration (18.5 cm) was in S2 during February, as shown in Fig. (3). Hence, the average light penetration level was at its highest in S3 (at 29.75 cm) and lowest in S2 (25.75 cm). Table (2) shows that the mean value for the whole research period was 27.52cm, which is unquestionably attributable to the observed increases and decreases in O&G concentration in various months.

This confirms the occurrence of a negative relationships between O&G concentration and light penetration (r= -0.82, -0.80, -0.44) in the S1, S2, and S3 respectively. In addition, during all the study period, the relationship between O&G concentration and light penetration was negative (r= -0.75).

Lower level of light penetration recoded in this study in S2 may be due to draining the city wastes into the river, absence of aquatic plants, fishing activity and decrease water temperature that reduced the activity of decomposers. In addition, the highest concentrations of O&G were recorded at this site. Oil pollution came from the Abadan oil refinery was the cause of the recorded low level of light penetration in Shatt Al-Arab River, in addition to the narrow section of the river with the increase in ship activities **(Adlan & Al-Abbawy, 2022)**.

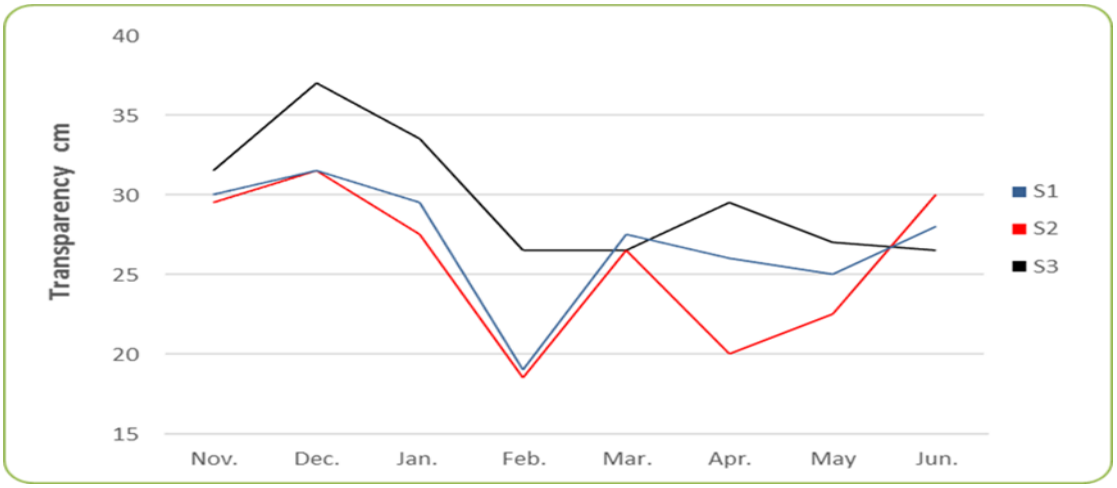

Fig. 3. Monthly variations of light penetration at the study sites along Al-Rumaytha River

Table 2. Monthly variations of light penetration level (with mean and replications) at the study sites along Al-Rumaytha River

Months	Light penetration cm				Mean
	Sites / Replications	S1	S2	S3	
Nov.	R1	30	30	31	30.33
	R2	30	29	32	30.33
Mean		30	29.5	31.5	30.33
Dec.	R1	32	31	36	33
	R2	31	32	38	33.66
Mean		31.5	31.5	37	33.33
Jan.	R1	30	27	33	30
	R2	29	28	34	30.33
Mean		29.5	27.5	33.5	30.16
Feb.	R1	19	20	28	22.33
	R2	19	17	25	20.33
Mean		19	18.5	26.5	21.33
Mar.	R1	28	25	28	27
	R2	27	28	25	26.66
Mean		27.5	26.5	26.5	26.83
Apr.	R1	25	20	29	24.66
	R2	27	20	30	25.66
Mean		26	20	29.5	25.16
May	R1	26	22	27	25
	R2	24	23	27	24.66
Mean		25	22.5	27	24.83
Jun.	R1	29	30	27	28.66
	R2	27	30	26	27.66
Mean		28	30	26.5	28.16
Total mean		27.06	25.75	29.75	27.52

CONCLUSION

To conclude, based on the findings of this research, the Rumaytha River is exposed to different concentrations of oil pollutants. The main reasons for recording the highest values of O&G concentration in the city center (S2) are owing to the anthropogenic activities noted such as oil replacement and car wash stations, boat traffic and city center wastes and sewage, and this in turn reduced the light penetration through the water column. As a result, this will affect the primary productivity and the homeostasis of the aquatic ecosystem. Therefore, we recommend studying these effects on organisms and other water quality characteristics.

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