Journal of Pharmaceutical, Chemical and Biological Sciences
ISSN: 2348-7658
Impact Factor (GIF): 0.701
Impact Factor (SJIF): 2.092
September-November 2016; 4(3): 402-415
Published on: 20th November 2016

Original Research Article

N-Alkanes in Soil of West Qurna-2 Oil Field Southern Iraq

Duha S. Karem[1], Hamzah A. Kadhim[1], Hamid T. Al-Saad[2]*

[1]Department of geology / college of Science –Basrah University, Iraq
[2]Faculty of Marine Science, University of Basrah, Basrah, Iraq

***Corresponding Author:** Hamid T. Al-Saad, Faculty of Marine Science, University of Basrah, Basrah, Iraq

Received: 11 October 2016 Revised: 25 October 2016 Accepted: 27 October 2016

ABSTRACT

A study has been carried out to determine the distribution of aliphatic hydrocarbons in surface soils of West Qurna-2 oil field, southern Iraq. Mainly N-alkanes from C13–C36 with bimodal distribution of Low Molecular Weight (C13-C25) with predominance of (C21,C22,C23,C24, C25) which indicate a bacterial activity, and the High Molecular Weight (C26-C36)which predominance of odd carbon number (C29,C30,C31,C32) indicating source of higher plant wax. The higher regional mean concertation of N-Alkanes observed at station 10 (24.240 µg/g) and the lowest at station 1(5.392 µg/g). The results of the present study showed a highest mean concentration of n-alkanes was during winter (17.162µg/g dry weigh) and the lowest during summer (9.808µg/g dry weigh). According to CPI, Pristine/Phytane values and UCM, the source of n-alkanes in the West Qurna-2 oil field was mainly biogenic and anthropogenic, while C17 / Pristane and C18 / Phytane Ratios the source of n-alkanes in soil was indication of weathering and oldness of existing petroleum in soil. There were non-significant correlation between the n-alkanes in soil and each of the soil texture compounds (sand, silt and clay), while there is significant correlation between the n-alkanes in soil and TOC%.

Keyword: N-alkanes, soil; pollution; West Qurna- 2 oil field; southern Iraq

INTRODUCTION

Normal alkanes are open chain saturated hydrocarbons (aliphatic hydrocarbons) single covalent bond is bonded all carbon atoms. They divided into aliphatic and cyclic alkanes (alicyclic) that typically have a carbon number extent from one to around 40 carbons. Saturates usually are the most abundant constituents in crude oils. Normal alkanes generally constitute the major part of saturated hydrocarbons and their distribution patterns are characterized by the predominance of a range of C-numbers depending on the nature of the source material and its microbial or geochemical alteration. Normal alkanes are ubiquitous in sedimentary samples, and often exhibit distributions with an odd C-number predominance, which is lost during the maturation of the organic matter [1].

Organisms produce a great variety of hydrocarbon compounds. Planktonic algal alkanes are dominated by odd-numbered n-alkanes in the low molecular weight region such as n-C_{15} and n-C_{17} [2].

Higher land plant waxes have predominant longer chain (C_{23}-C_{33}) n-alkanes with strong odd/even carbon preference [3]. Bacteria contain n-alkanes ranging from C_{15} to C_{31} with little odd/even carbon preference [4].

Pristane is thought to be derived, from zooplanktonic metabolism of phytol. However, fossil fuels have n-alkane predominance in the low molecular weight region and no odd/even carbon preference [5].

Hydrocarbons in sediments can often reflect their sources. Accordingly, utilizing hydrocarbons as indicators for source matter recognizable proof has been an important and useful tool. In general, in marine sediments show an odd carbon number of n-alkanes predominance in the high molecular region indicating input from land sources [6].

N-Alkane is a kind of hydrocarbons which comprises of odd and even carbon numbers which can be up to 64 carbons with no alkyl branch or alternatives. The "Odd "carbon numbers come fundamentally from the biogenic sources, while "Even" carbon numbers are typically gotten from the anthropogenic sources [7].

Some indices were used by many authors to detected sources of hydrocarbons, these are pristane to phytane ratio (Pr/Ph), heptadecane to pristine ratio (C17/Pr) and the ratio of hydrocarbons with even and odd numbers of carbon atoms, carbon preference index (CPI) [8,9]. West Qurna-2 is one of the largest and important oil fields in Iraq, which located in Basrah city southern Iraq, around 65 km NW of the city of Basrah. The main objective of the present study was to investigate the distribution of N- alkanes in West Qurna-2 oil field.

MATERIAL AND METHODS

Soil samples were collected seasonally during the period from September 2015 to March 2016 at ten stations in West Qurna-2 oil field at Basrah city, samples were warped with aluminum foil then transferred to the laboratory for analysis (Fig.1).

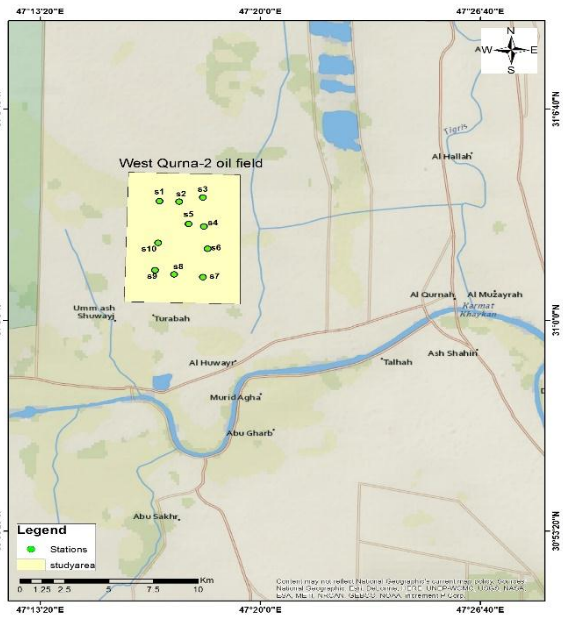

Fig. 1: The study area

The procedure which described by [10,11] was used to extracted the Hydrocarbons from soil. Twenty five grams of soil were soxhlet extracted for 24 hours with 250 ml Methanol: Benzen (1:1). Elemental sulfur was removed from the extracts using activated elemental copper in order to avoid sulfur interferences when using gas chromatography. The extracts were then fractionated into aliphatic and aromatic hydrocarbons by chromatography column. The column was prepared by slurry packing 10 g of silica (100-200 mesh), followed by 10 g of alumina (100-200 mesh) (silica-gel and alumina were activated at 200° C for 4 hours and then partially deactivated with 5 % water) and finally 1 g of anhydrous sodium sulphate was added to the surface to avoid disturbance of the top layer when pouring the solvent. The extract was then applied to the head of the column and eluted with 25 ml n-hexane to obtain on the aliphatic. The aliphatic fractions were concentrated on a rotary evaporator, transferred to a vial, and the volume was adjusted to 1 ml exactly using a stream of N_2. An aliquot of 1 µl of extract of aliphatic hydrocarbons was subjected to analysis by an allegiant capillary gas chromatography with flam ionization detector (FID). Column (model Agilent 19091J-101HP-5 5% phenyl Methyl silicone with dimensions (50 m. *200µm *0.33 µm) was used for aliphatic separation, while the fused silica capillary column (100 m x 250 µm x 0. 5µm) used was a wall coated open tubular (methyl silicone) (Agilent US2463233H DB-petrp), with helium as gas carrier at flow rate of 1.5 ml/minute.

The detector and injector temperatures used were 300 °C and 320 °C, respectively. For aliphatic analysis, condition temperature of column was held at 35 °C for 13 minute then rate 5 °C /minute to 280°C for 50min. The individual of aliphatic were identified based on the retention time of an authentic mixed standard procured from Supelco, USA. The concentrations of aliphatic compounds were calculated based on the standard calibration curve of corresponding standard compounds. 80 % to 92 % are the range of recovery assays for standards compounds. Standard deviation for the method was less than 10 % based on replicate analysis. Great care was taken to avoid contamination of the samples throughout the analytical procedure. All solvents were distilled twice before use; glassware was rinsed with distilled water and heated in an oven at 250 °C for 24 hours. However, procedural blanks consisting of all reagents and glassware used during the analysis were periodically determined which had shown no detectable interference.

RESULTS AND DISCUSSION

The carbon chains length of n-alkanes in soil samples were recorded from C13 - C36. Numbers of other hydrocarbons compounds were present in the aliphatic fraction, including pristine and phytane. The seasonal values of n-alkanes in soil at the studied stations were represented in Tables (1-4).

The total concentrations of N-alkanes in soil samples at ten stations were range as following: Station 1 from 4.999 µg/g during summer to 6.185 µg/g during winter, station 2 from 6.230 µg/g during winter to 9.580 µg/g during spring, station 3 from 7.760 µg/g during summer to 11.424 µg/g during winter, station 4 from 7.934 µg/g during summer to 12.020 µg/g during spring, station 5 from 8.372 µg/g during summer to 16.837 µg/g during winter, station 6 from 8.192 µg/g during summer to 12.997 µg/g during winter, station 7 from 11.565 µg/g during summer to 18.100 µg/g during winter, station 8 from 12.297 µg/g during summer to 22.108 µg/g during winter, station 9 from 14.836 µg/g during summer to 22.444 µg/g during winter and station 10 from 15.173 µg/g during summer to 43.324µg/g during winter Tables (1-4). The highest of total n-alkanes mean concentrations in soil (24.240 µg/g dry weight) was recorded at station 10, while the lowest mean concentrations (5.392µg/g) was recorded at station 1 (Table 5) (Fig. 2).

Table 1: Regional Concentrations of n-alkanes (µg/g) dry weigh in soil samples of West Qurna-2 oil field during Summer season 2015

Carbon number	staion1	2	3	4	5	6	7	8	9	10
N-C13	0.003	0.006	0.007	0.032	0.010	0.053	0.045	0.045	0.054	0.021
N-C14	0.008	0.009	0.046	0.044	0.059	0.061	0.062	0.056	0.097	0.038
N-C15	0.032	0.035	0.071	0.088	0.092	0.088	0.091	0.102	0.131	0.048
N-C16	0.048	0.067	0.092	0.121	0.131	0.121	0.142	0.153	0.175	0.085
N-C17	0.055	0.068	0.149	0.106	0.108	0.148	0.235	0.225	0.155	0.116
N-C18	0.024	0.035	0.059	0.042	0.055	0.063	0.101	0.095	0.061	0.078
N-C19	0.053	0.157	0.172	0.099	0.164	0.173	0.427	0.301	0.167	0.297
N-C20	0.051	0.126	0.159	0.106	0.184	0.156	0.259	0.283	0.199	0.273
N-C21	0.106	0.361	0.334	0.248	0.493	0.371	0.841	0.727	0.587	0.695
N-C22	0.138	0.387	0.456	0.310	0.556	0.386	0.768	0.868	0.732	0.894
N-C23	0.123	0.385	0.361	0.314	0.562	0.411	0.871	0.873	0.893	0.848
N-C24	0.919	0.274	0.456	0.478	0.408	0.461	1.146	1.019	0.845	0.926
N-C25	0.151	0.317	0.423	0.401	0.491	0.392	0.583	0.841	0.706	1.091
N-C26	0.134	0.263	0.205	0.288	0.406	0.275	0.491	0.451	0.828	0.886
N-C27	0.156	0.353	0.395	0.353	0.446	0.331	0.691	0.887	1.028	1.024
N-C28	0.266	0.399	0.401	0.502	0.569	0.378	0.738	0.725	1.309	1.233
N-C29	0.338	0.367	0.473	0.638	0.565	0.666	0.481	0.634	0.999	1.029
N-C30	0.756	1.097	1.027	1.277	0.974	0.996	1.478	1.542	1.994	2.121
N-C31	0.541	0.931	1.209	1.145	1.238	1.342	0.743	1.119	0.464	1.262
N-C32	0.448	0.515	0.541	0.479	0.379	0.478	0.593	0.702	0.754	0.888
N-C33	0.312	0.388	0.215	0.341	0.146	0.484	0.361	0.399	0.631	0.561
N-C34	0.127	0.158	0.255	0.259	0.112	0.141	0.301	0.114	1.018	0.661
N-C35	0.112	0.132	0.122	0.132	0.101	0.116	0.061	0.073	0.572	0.089
N-C36	0.098	0.123	0.132	0.131	0.123	0.101	0.056	0.063	0.437	0.009
Total	**4.999**	**6.953**	**7.760**	**7.934**	**8.372**	**8.192**	**11.565**	**12.297**	**14.836**	**15.173**
odd	1.982	3.500	3.931	3.897	4.416	4.575	5.430	6.226	6.387	7.081
even	3.017	3.453	3.829	4.037	3.956	3.617	6.135	6.071	8.449	8.092
CPI	0.656	1.013	1.026	0.965	1.116	1.264	0.885	1.025	0.755	0.875
Pristane	0.011	0.017	0.067	0.074	0.027	0.028	0.211	0.139	0.122	0.031
Phytane	0.004	0.026	0.045	0.017	0.043	0.025	0.067	0.087	0.047	0.032
Pristane /phytane	2.750	0.653	1.488	4.352	0.627	1.120	3.149	1.597	2.595	0.968
C17/pristane	5.000	4.000	2.223	1.432	4.000	5.285	1.113	1.618	1.270	3.741
C18/phytane	6.000	1.346	1.311	2.470	1.279	2.520	1.507	1.091	1.297	2.437

Table 2: Regional Concentrations of n-alkanes (µg/g) dry weigh in soil samples of West Qurna-2 oil field during Autumn season 2015

Carbon number	station1	2	3	4	5	6	7	8	9	10
N-C13	0.080	0.020	0.040	0.052	0.037	0.182	0.048	0.110	0.027	0.095
N-C14	0.010	0.024	0.020	0.108	0.037	0.189	0.036	0.100	0.017	0.120
N-C15	0.025	0.041	0.024	0.216	0.043	0.203	0.016	0.130	0.034	0.145
N-C16	0.053	0.070	0.048	0.424	0.049	0.252	0.044	0.140	0.062	0.245
N-C17	0.058	0.068	0.032	0.400	0.062	0.112	0.036	0.120	0.074	0.230
N-C18	0.020	0.032	0.060	0.128	0.055	0.218	0.060	0.240	0.050	0.100
N-C19	0.041	0.064	0.196	0.048	0.111	0.105	0.216	0.320	0.154	0.070
N-C20	0.044	0.062	0.248	0.144	0.167	0.147	0.200	0.430	0.197	0.205
N-C21	0.089	0.117	0.252	0.368	0.037	0.315	0.400	0.420	0.566	0.395
N-C22	0.133	0.129	0.344	0.336	0.074	0.287	0.240	0.440	0.542	0.495
N-C23	0.117	0.089	0.252	0.260	0.204	0.182	0.260	0.450	0.584	0.355
N-C24	0.154	0.127	0.292	0.300	0.241	0.364	0.220	0.380	0.573	0.620
N-C25	0.170	0.126	0.268	0.344	0.074	0.357	0.212	0.420	0.832	0.485
N-C26	0.153	0.123	0.168	0.180	0.192	0.245	0.144	0.400	0.533	0.400
N-C27	0.355	0.380	0.416	0.276	0.427	0.308	0.504	0.520	0.911	0.865
N-C28	0.201	0.250	0.504	0.328	0.427	0.322	0.224	0.400	1.133	0.670
N-C29	0.816	0.783	2.196	0.956	1.909	1.764	1.764	1.290	1.633	2.260
N-C30	1.001	0.415	1.468	1.328	1.829	0.742	4.708	0.950	1.154	2.670
N-C31	0.799	1.695	0.620	0.916	1.494	0.770	0.964	1.240	2.521	2.675
N-C32	0.347	0.467	0.496	0.272	0.297	0.154	0.780	0.600	1.537	0.760
N-C33	0.187	0.992	0.228	0.180	0.316	0.231	0.360	1.220	0.434	0.515
N-C34	0.150	0.251	0.100	0.264	0.880	0.308	0.408	1.210	0.845	0.510
N-C35	0.116	0.082	0.092	0.256	0.006	0.175	0.240	0.620	0.208	0.310
N-C36	0.046	0.041	0.084	0.596	0.005	0.847	0.120	0.720	0.231	0.320
Total	**5.165**	**6.448**	**8.448**	**8.680**	**8.982**	**8.779**	**12.204**	**12.870**	**14.852**	**15.515**
odd	2.853	4.457	4.616	4.272	4.724	4.704	5.000	6.860	7.978	8.400
even	2.312	1.991	3.832	4.408	4.258	4.075	7.184	6.01	6.874	7.115
CPI	1.233	2.238	1.204	0.969	1.109	1.154	0.698	1.141	1.160	1.180
Pristane	0.052	0.032	0.011	0.192	0.035	0.035	0.063	0.093	0.051	0.118
Phytane	0.018	0.019	0.029	0.042	0.013	0.068	0.016	0.084	0.021	0.034
Pristane /phytane	2.888	1.684	0.379	4.571	2.692	0.514	3.937	1.107	2.428	3.470
C17/pristane	1.115	2.125	2.909	2.083	1.771	3.200	0.571	1.290	1.450	1.949
C18/phytane	1.111	1.684	2.068	3.047	4.292	3.211	3.750	2.857	2.380	2.941

Table 3: Regional Concentrations of n-alkanes (µg/g) dry weigh in soil samples of West Qurna-2 oil field during Winter season 2015

Carbon number	Station1	2	3	4	5	6	7	8	9	10
N-C13	0.007	0.189	0.017	0.007	0.075	0.016	0.185	0.075	0.074	0.041
N-C14	0.012	0.201	0.035	0.009	0.082	0.024	0.232	0.093	0.085	0.045
N-C15	0.018	0.207	0.087	0.027	0.169	0.041	0.647	0.185	0.170	0.120
N-C16	0.025	0.049	0.052	0.096	0.169	0.102	0.107	0.217	0.211	0.240
N-C17	0.051	0.065	0.175	0.054	0.367	0.205	0.358	0.360	0.225	0.688
N-C18	0.084	0.076	0.099	0.090	0.160	0.113	0.101	0.168	0.096	0.057
N-C19	0.188	0.079	0.458	0.17	0.261	0.196	0.622	0.266	0.207	0.324
N-C20	0.141	0.132	0.152	0.159	0.405	0.118	0.827	0.255	0.33	0.257
N-C21	0.309	0.286	2.497	0.385	1.228	0.241	3.533	0.268	0.57	0.744
N-C22	0.436	0.435	0.572	0.709	0.702	0.866	0.716	1.131	0.320	1.069
N-C23	0.431	0.441	0.649	0.789	0.609	0.732	0.738	0.985	0.730	1.095
N-C24	0.533	0.615	0.938	1.012	0.957	1.278	0.792	0.229	0.907	1.622
N-C25	0.493	0.435	0.760	0.884	0.779	1.091	0.685	1.032	1.037	1.616
N-C26	0.220	0.237	0.437	0.454	0.568	0.641	0.341	0.741	0.554	1.068
N-C27	0.316	0.293	0.458	0.748	0.997	0.988	0.497	1.495	1.193	2.598
N-C28	0.163	0.166	0.249	0.326	0.49	0.629	0.358	1.158	1.040	1.840
N-C29	0.693	0.522	0.839	0.209	2.02	0.299	1.343	2.319	3.779	6.511
N-C30	0.449	0.564	1.658	2.801	1.988	2.057	1.385	3.86	4.577	7.68
N-C31	0.882	0.32	0.472	1.276	3.038	1.245	0.559	3.412	3.375	10.363
N-C32	0.176	0.297	0.201	0.203	0.405	0.362	0.223	1.01	0.226	2.497
N-C33	0.198	0.282	0.166	0.267	0.35	0.518	0.178	0.61	0.391	1.389
N-C34	0.145	0.153	0.182	0.321	0.484	0.429	0.198	0.409	0.439	0.674
N-C35	0.112	0.095	0.145	0.283	0.235	0.228	1.933	0.585	0.852	0.335
N-C36	0.103	0.091	0.126	0.699	0.299	0.578	1.542	1.245	1.056	0.451
Total	**6.185**	**6.23**	**11.424**	**11.978**	**16.837**	**12.997**	**18.100**	**22.108**	**22.444**	**43.324**
Odd	3.698	3.214	6.723	5.099	10.128	5.8	11.278	11.592	12.603	25.824
Even	2.487	3.016	4.701	6.879	6.709	7.197	6.822	10.516	9.841	17.50
CPI	1.486	1.065	1.430	0.741	1.509	0.805	1.653	1.102	1.280	1.475
Pristane	0.049	0.033	0.098	0.049	0.123	0.102	0.105	0.098	0.091	0.165
Phytane	0.042	0.061	0.091	0.078	0.153	0.108	0.093	0.134	0.083	0.047
Pristane /phytane	1.166	0.540	1.076	0.628	0.803	0.944	1.129	0.731	1.096	3.510
C17/pristane	1.040	1.969	1.785	1.102	2.983	2.009	3.409	3.673	2.472	4.169
C18/phytane	2	1.245	1.087	1.153	1.045	1.046	1.086	1.253	1.156	1.212

Table 4: Regional Concentrations of n-alkanes (µg/g) dry weigh in soil samples of West Qurna-2 oil field during spring season 2016

Carbon number	Station1	2	3	4	5	6	7	8	9	10
N-C13	0.020	0.005	0.050	0.040	0.010	0.007	0.025	0.030	0.070	0.015
N-C14	0.025	0.010	0.060	0.150	0.015	0.017	0.075	0.020	0.175	0.030
N-C15	0.035	0.015	0.340	0.160	0.020	0.010	0.070	0.102	0.330	0.115
N-C16	0.030	0.035	0.660	0.390	0.030	0.012	0.245	0.287	0.505	0.040
N-C17	0.035	0.065	0.630	0.410	0.065	0.047	0.390	0.255	0.590	0.210
N-C18	0.085	0.075	0.220	0.170	0.105	0.062	0.200	0.130	0.210	0.125
N-C19	0.035	0.205	0.200	0.110	0.090	0.057	0.580	0.265	0.555	0.220
N-C20	0.040	0.265	0.290	0.130	0.170	0.090	0.445	0.307	0.505	0.225
N-C21	0.045	0.215	0.270	0.120	0.360	0.190	0.545	0.730	1.560	0.460
N-C22	0.130	0.350	0.620	0.150	0.545	0.322	0.975	0.912	0.300	0.685
N-C23	0.220	0.335	0.520	0.140	0.525	0.325	0.780	0.872	1.070	0.640
N-C24	0.445	0.480	0.930	0.920	0.915	0.510	0.780	1.085	1.245	3.440
N-C25	0.225	0.485	0.640	0.570	0.760	0.487	0.755	0.892	0.985	0.775
N-C26	0.230	0.270	0.430	0.360	0.485	0.375	0.275	0.950	0.625	0.670
N-C27	0.215	0.390	0.500	0.480	0.745	0.700	0.695	1.167	0.890	0.665
N-C28	0.175	0.340	0.250	0.550	0.660	0.552	0.785	1.105	0.420	1.410
N-C29	0.765	0.870	0.720	2.250	1.985	1.647	1.235	2.247	1.525	2.405
N-C30	0.750	1.620	0.740	3.040	2.590	1.910	1.845	2.155	1.390	3.030
N-C31	0.535	0.970	0.880	0.910	1.580	2.800	2.290	2.695	3.820	3.885
N-C32	0.455	0.340	0.850	0.210	0.365	1.422	0.885	0.705	1.495	1.875
N-C33	0.305	0.210	0.520	0.190	0.425	0.445	0.475	0.457	0.630	0.425
N-C34	0.170	0.145	0.260	0.200	0.540	0.222	0.680	0.265	1.115	0.540
N-C35	0.175	1.710	0.240	0.180	0.310	0.265	0.375	0.182	0.385	0.325
N-C36	0.075	0.175	0.130	0.190	0.180	0.162	0.475	1.900	0.805	0.740
Total	**5.220**	**9.580**	**10.950**	**12.020**	**13.475**	**12.636**	**15.880**	**19.715**	**21.200**	**22.950**
odd	2.610	5.475	5.510	5.560	6.875	6.980	8.215	9.894	12.410	10.140
even	2.610	4.105	5.440	6.460	6.600	5.656	7.665	9.821	8.790	12.810
CPI	1.000	1.333	1.012	0.860	1.041	1.234	1.071	1.007	1.411	0.791
Pristane	0.007	0.013	0.126	0.164	0.013	0.009	0.078	0.076	0.177	0.084
Phytane	0.051	0.022	0.110	0.068	0.031	0.024	0.060	0.091	0.030	0.062
Pristane /phytane	0.137	0.590	1.145	2.411	0.419	0.375	1.300	0.835	5.900	1.354
C17/pristane	5.000	5.000	5.000	1.036	5.000	5.222	5.000	3.355	3.333	2.500
C18/phytane	1.666	3.409	2.000	2.500	3.387	2.583	3.333	1.428	7.000	2.016

Table 5: Seasonal variations of N-Alkanes (µg/g) with mean in West Qurna2 oil field

Stations	Summer	Autumn	Winter	Spring	R. Mean	±SD
1	4.999	5.165	6.185	5.220	5.392	0.536
2	6.953	6.448	6.230	9.580	7.302	1.548
3	7.760	8.448	11.424	10.950	9.645	1.812
4	7.934	8.680	11.978	12.020	10.153	2.153
5	8.372	8.982	16.837	13.475	11.916	3.992
6	8.192	8.779	12.997	12.636	10.651	2.516
7	11.565	12.204	18.100	15.880	14.437	3.094
8	12.297	12.870	22.108	19.715	16.747	4.911
9	14.836	14.852	22.444	21.200	18.333	4.060
10	15.173	15.515	43.324	22.950	24.240	13.218
S. Mean	9.808	10.194	17.162	14.362	-	-

R. Mean= regional mean, S. Mean= seasonal mean.

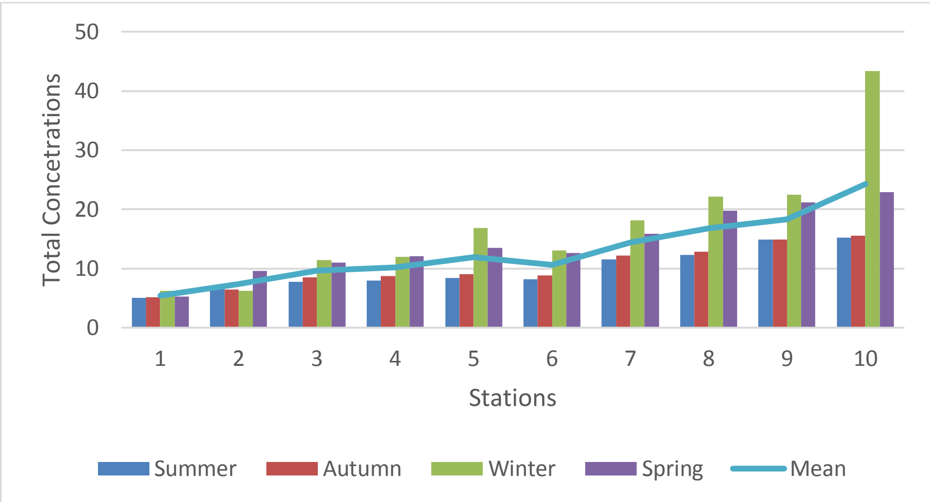

Fig 2: Seasonal and mean concentrations of n-alkane at West Qurna 2-oil field.

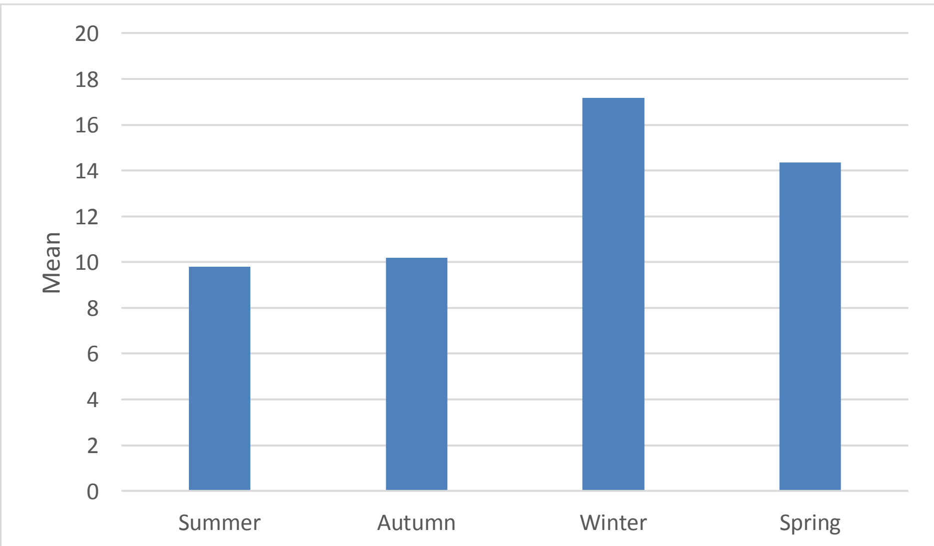

Fig 3: Seasonal Variations of N-alkanes at West Qurna 2-oil field.

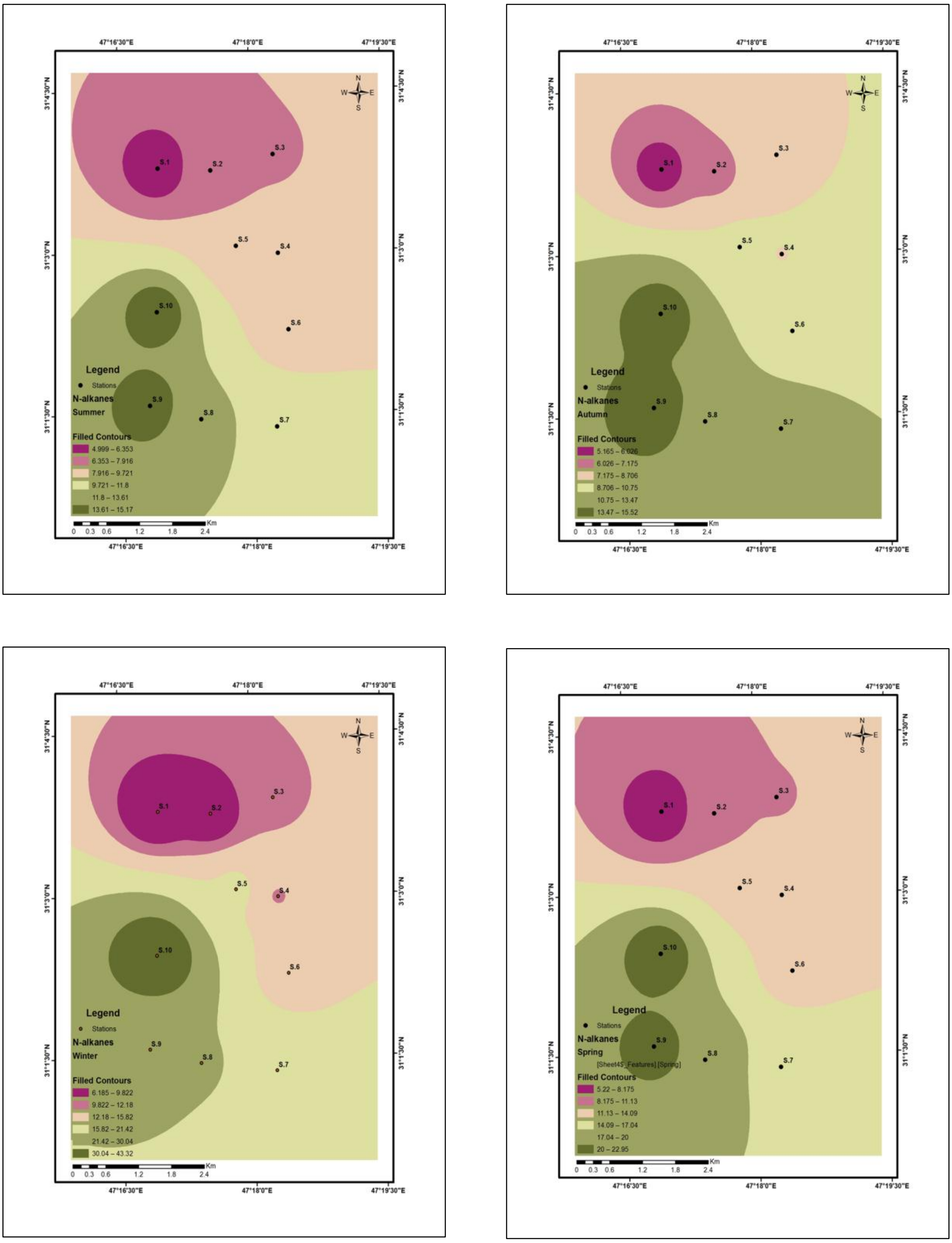

Fig. 4: GIS map showing N-alkanes distribution in soil at West Qurna 2-oil field for different seasons

Seasonal variations of N-alkanes were observed during this study. The highest concentrations were observed during winter season while lower concentration observed during summer season (Fig. 3). Based on our data, the GIS maps were represent the concentrations of N-alkanes measured during different seasons (Fig.4).

The chromatograms of aliphatic hydrocarbons (Fig 5) from the different stations showed that aliphatic hydrocarbons comprised of a series of solved compounds, mainly n-alkanes from C13 –C36 with bimodal distribution first the Low Molecular Weight (C13-C25) with predominance of (C21,C22, C23,C24,C25) which indicate a bacterial activity, and second the High Molecular Weight (C26-C36)which predominance of odd carbon number (C29,C30,C31,C32) indicating source of higher plant wax (Fig 4.1). The same result was obtain by [12] found that C17 , C18 and C19 were originated from algae and bacteria ,whereas [13] pointed that sedimentary aliphatic hydrocarbons consisted of C12 to C33 and [14] found that the high values of odd carbon number chains of C17 in sediments was a result of the presence sulfuric reducer bacteria (*Desulfovibrio desulforicans*) in the sediments, while the C19 indicating the algal origin . [15, 16, 17] pointed that the high values of C25, C27, and C29 in sediments indicating decomposition of the higher plant tissues.

Biogenic sources of hydrocarbons were indicated by the dominance of the odd carbon n-alkanes, C15, C17, and C19 which are usually found in algae, C20 to C28 model n-alkanes without carbon number preference, maximizing around C23 which may be combined by bacterial activity [18], and C25 to C32 odd carbon number n-alkanes which are synthesized by higher plants [11].

The results of regional N- alkanes at the present study showed a highest concentration of n-alkanes was observed in winter at station 10 (43.324 µg/g dry weigh) and a lowest in summer at station 1 (4.999 µg/g dry weigh), while the higher mean concertation of N-Alkanes in station 10 (24.240 µg/g) and the lowest in station 1(5.392 µg/g) (Table 5).

They gradually increased starting from station 1 until station 5, and then significantly decreased at station 6 and then increased to station 10. The fluctuation in concentrations of N-alkanes in stations is due to distance from the flame of the flare which near to the stations 8,9,10 and far to the stations 1,2,3,4,5,6,7 (Fig 3.6).

Basrah city effected by oil pollution from many sources such as: Association with discharges of petroleum wastes. The largest oil refineries, gas production plant and add to these stations represented the sites of crude oil extraction and production (oilfields) also Basrah city received petroleum wastes from gasoline stations, leakages from tanks or tanker trucks and dump of waste petroleum by-products on soils, transportation and industries activities electrical generating plants and units, houses and workshops activities [17].

Generally the total concentrations of n-alkanes in soil during winter were more than summer, The results of the present study showed a highest mean concentration of n-alkanes was during winter (17.162µg/g dry weigh) and the lowest during summer (9.808µg/g dry weigh), while spring was (14.362µg/g) and autumn (10.194µg/g), the seasonal concentration arrange as following: winter >spring>autumn>summer (Table 5) and (Fig 3). This is due to fluctuation in temperature which plays important role in evaporation processes of these compounds and biodegradation processes which occur by the bacteria and fungi.

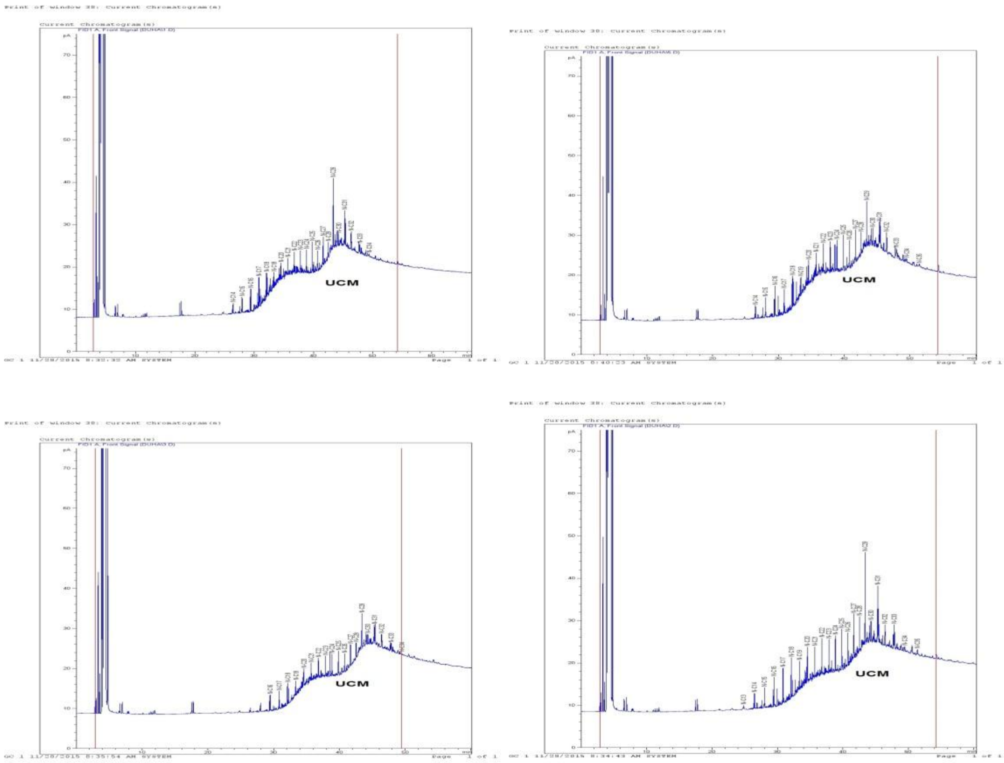

Fig. 5: A repersentive Chromatograms of N-alkanes in soil samples of the studied stations during different seasons

Although hydrocarbon compounds biodegrade over an extensive variety of temperatures, the rate of biodegradation for the most part decreases with decreasing temperature [19, 20, 21, 22]. [17] showed that the total n-alkanes concentrations in surficial soils of Basrah city were higher in winter and autumn than that recorded for spring and summer so that the result was in agreement with him.

[23] Found that temperature is the most important variables limited the rates of hydrocarbons microbial degradation in the winter. Also the weather impacted the activities of the microorganisms in the soils causes degradation in the hydrocarbons. The highest rates of hydrocarbons biodegradation causing by the high temperature. So that hydrocarbons biodegradation is rapid during the warmer months while during the colder month the biodegradation process is less efficient. Therefore, biodegradation was the most effective in the spring and summer seasons of Basrah city soils.

There were non-significant correlation between the n-alkanes in soil and each of the soil texture compounds (sand, silt and clay). This result was in agreement with [12, 16, 17] who found non-significant correlation between the n-alkanes in sediments and each of the sediments texture compounds (sand , silt and clay) .while there is significant correlation between the n-alkanes in soil and TOC% ($r=0.754$, $p\geq 0.01$) that was agreement with [24] who found a significant correlation between the n-alkanes in sediments and TOC% (Table 6).

The CPI values ranged from 0.656 at station1 during summer to 2.238 at station2 during autumn. CPI value more than one indicates that n-alkanes were biogenic in origin from algae, bacterial activity, and wax of vascular higher plant leaves [25]. Pristane / phytane ratio ranged from (0.137) at station 1 in Spring to (4.571) at station 4 in Autumn. According to the ratio values, the source of n-alkanes in soil was biogenic and anthropogenic. C17 / pri ratio ranged from (0.571) at station 7 in autumn to (5.222) at station 6 in spring. According to the ratio values, the source of n-alkanes in soil was indication of weathering and oldness of existing petroleum in soil. C18 / phy ratio ranged from (1.087) at station 3 in winter to (7.000) at station 9 in spring. According to the ratio values, the source of n-alkanes in soil was indication of weathering and oldness of existing petroleum in soil.

Table 6: Seasonal variation of TOC% and Grain size in West Qurna2 oil field

Station	TOC%				Grain size			
	Summer	Autumn	Winter	Spring	Clay%	Silt%	Sand%	Clay%
1	0.256	0.558	1.116	1.118	2	70	28	2
2	0.358	0.651	1.162	1.162	1	41	58	1
3	0.461	1.023	1.441	1.213	3	68	29	3
4	0.666	1.038	1.581	1.415	1	47	52	1
5	0.923	1.829	1.813	1.668	1	76	23	1
6	0.82	1.162	1.674	1.649	2	32	66	2
7	0.974	1.953	1.891	1.668	1	42	57	1
8	1.025	2.046	2.000	1.800	1	56	43	1
9	1.179	2.093	2.418	1.876	1	39	60	1
10	1.282	2.511	2.511	2.445	2	73	25	2

Table (7): Comparison between the levels of n-alkanes (μg/g dry weight) in soil for the present study with the other previously studies

Studied Areas	n-alkane(μg/g)	References
Shatt Al-Arab River &NW Arabian Gulf	6.97-55.67	Al-Saad (1995)[26]
Shatt Al-Arab River &NW Arabian Gulf	3.470 – 18.952	Al-Khatib (1998)[12]
Al-Howaiza Marsh	3.43 – 42.38	Al-Khatib (2008)[15]
Al-Hammar Marsh	6.53 - 31.46	Talal (2008)[27]
Shatt Al-Arab River	4.76 – 10.09	Al-Hejuje (2014)[16]
Shatt Al-Arab River	8.243-0.244	Al–Mahana (2015)[24]
West Qurna-2 Oil field	**4.999-43.324**	**The present work**

Unresolved Complex Mixture (UCM)

Few of chromatograms of the samples analyzed (Fig 5) showed a measurable unresolved envelop (hump) that referred mainly to petroleum pollution which has unresolved complex mixture (UCM) resistance to weathering and decomposed by microorganisms. The UCM in these soil could originate from number of possible source. The UCM compound of petrolum is resistance to weathering and bacterial breakdown and thus its presence has frequently been taken as evidence of petroleum pollution [30,26]. The present of UCM in soil suggest that low-level, petroleum hydrocarbon source exist in this area, and this probably due to deposited hydrocarbons from the air or from mobile source. UCM could synthesized by some bacteria and algae, the UCM is concentrated in West Qurna-2 oil field environment is due to biogenic and anthropogenic sources.

If we compared our data of N-alkanes with previous studies on the area during the last two decades (Table 7), we found that it is located within the ranges of the previous studies.

CONFLICT OF INTEREST STATEMENT

Authors declare that they have no conflict of interest.

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Cite this article as:
Duha S. Karem, Hamzah A. Kadhim, Hamid T. Al-Saad. N-Alkanes in Soil of West Qurna-2 Oil Field Southern Iraq. J Pharm Chem Biol Sci 2016; 4(3): 402-415.