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RADIUM CONCENTRATION AND RADON EXHALATION RATE IN WATER OF EUPHRATES RIVER IN THI QAR GOVERNORATE (IRAQ)

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ABSTRACT

Radium concentration C_{Ra} varies from (0.141 - 0.721 Bq/kg) with an average value (0.344 Bq/kg). The radon exhalation rate in terms of area E_A varies from (10.17 - 52.07 mBq/m^2.h) with an average value (24.82 mBq/m^2.h). The radon exhalation rate in terms of mass E_M varies from (1.07 - 5.45 mBq/kg.h) with an average value (2.60 mBq/kg.h). The results are compared with other studies.

KEYWORDS: Radium concentration, radon exhalation rate, Euphrates river, LR-115 type II.

INTRODUCTION

Radium and radon are radioactive elements, they occur from uranium radioactive decay series **[1]**. They emit α–particles, α–particles can be very harmful if exposed internally from inhalation or ingestion because the tissue of sensitive living can be exposed to α–radiation **[2]**. The exposure to α–particles from waterborne radon comes from inhalation or ingestion of radon released from water **[3]**. The solubility of radon in water towering principally when the temperature and concentration of other salts are lowering, to arrive 0.5 l of radon soluble in 1 l of water at 0°c **[4]**.

The measurement of radioactive contamination in water is necessary for the radiation protection and the fact that the water acts as a carrier medium which publishes radioactive pollutants swathes through, especially with the movement of water where there are large amounts of contaminated water, which is raised in nature as being of little radiological effectiveness. On the other hand, the water does not reduce the concentration of radiation as air. That any radioactive contaminants to move great distances without having undergone a lot of mitigation and thereby cause water pollution in areas far from the launch area and can cause a risk when used this water for different purposes, especially the drinking water **[5]**.

The Euphrates in Thi Qar governorate has a length of (180 km), when its enter to the governorate has some branches which have total lengths about (318 km) **[6]**. The Euphrates pass through three regions in Thi Qar governorate which is Al-Nassiriah, Suq Al-Shuyukh, and Chibayish regions as shown in fig. 1. The water of the Euphrates and its branches are used for various purposes in these regions such as a source for drinking water, irrigation in the agricultural area and supply to the public in some areas.

The aim of this study is known as the radium concentration C_{Ra} and radon exhalation rates E_A and E_M in Euphrates river water and it some branches in Thi Qar governorate of Iraq, and has a baseline to the concentration

of elements radioactive in the Euphrates river in this governorate.

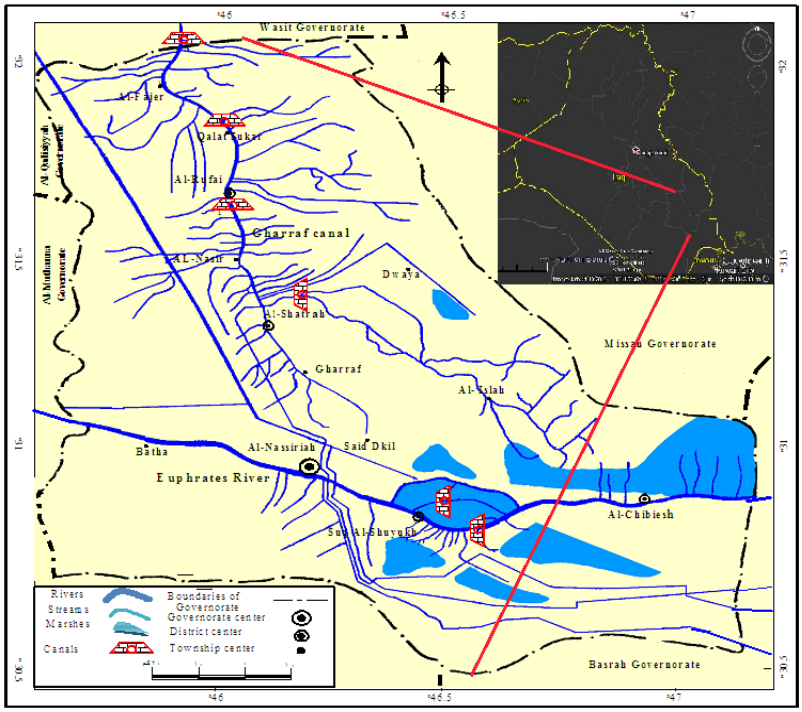

Fig. 1. Distribution of surface water in Thi Qar Governorate.

MATERIALS AND METHOD

In this work, about 1.5 l of water collected in November from Euphrates river and some different branches in Thi Qar Governorate. The can technique used where 12 g of water samples put in the cylindrical plastic container of 4 cm diameter shown in fig. 2. LR-115 type II SSNTDs was fixed in the mouth from the inside. The cylindrical plastic containers are sealed and left as such three months from November to February, so the detectors can record α–particles. The detectors are etched in (2.5 N) NaOH solution at (60 ±1 ºC) during (2 h). α–particles tracks are counted using an ordinary optical microscope.

The radium concentration C_{Ra} (Bq/kg) and the radon exhalation rate in terms of area E_A (mBq/m^2 h) and mass E_M (mBq/kg h) in water samples were calculated using the equations **[7]**:

$$C_{Ra} = \frac{\rho h A}{K T_e M} \quad \text{.....(1)}$$

$$E_A = \frac{CV\,\lambda}{A[t + 1/\lambda(e^{-\lambda t} - 1)]} \quad \text{.....(2)}$$

$$E_M = \frac{CV\,\lambda}{M\,[t + 1/\lambda(e^{-\lambda t} - 1)]} \quad \text{.....(3)}$$

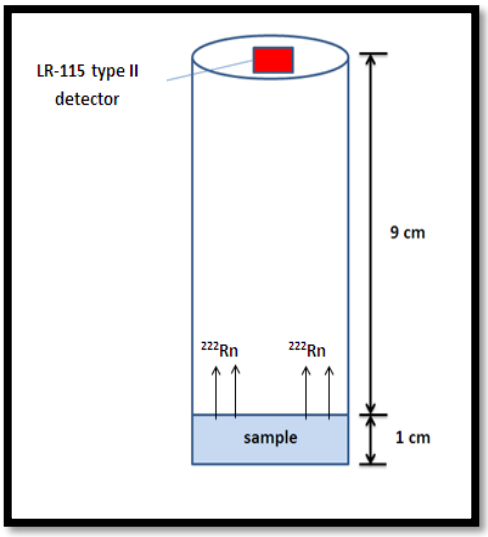

Fig. 2. Arrangement of LR-115 type II film and a water sample in cylindrical plastic container.

Where ρ (tracks/cm^2) is the recorded track density, h (m) is the distance from the detector to the top of the water sample, A (m^2) is the area of cross-section of the container, T_e (d) is the time of effective exposure, M (kg) is the sample mass, C (Bq m^{-3} h) is the exposure of integrated radon, V (m^3) is the volume of air in the container, λ (h^{-1}) is the radon constant decay constant and t (h) is the collection time exposure.

The calibration factor is calculated by the equation (4) **[8]**:

$$K = \frac{1}{4} a \cos\theta_c \left(2 - \frac{a_1}{a} - \frac{a}{a_\circ}\right) \ldots\ldots\ldots (4) \quad \text{If } (a_1 \le a \le a_\circ)$$

Where a is the radius of the cylindrical plastic container, $a_\circ = R_\circ \cos\theta_c$, $a_1 = R_1 \cos\theta_c$, ($\theta_c = 40^\circ$) is the critical angle., $R_\circ = R - R_{min}$ and $R_1 = R - R_{max}$.

(R=3.90 cm) is the range of α–particle which emitted from radon in air, R_{max}= 3.44 cm and R_{min} = 0.80 cm **[9]**. Therefore, the calibration factor is (K = 0.0324 tracks.cm^{-2}.day^{-1}/ Bq.m^{-3}) which compared with **[10, 11]**.

RESULTS AND DISCUSSION

The results for radium concentration and radon exhalation rate in water samples belonging to Euphrates river and some its branches in three regions (ten districts) are presented in table 1. It's useful to show that Maa Al-Chibayish branch is coming from Gharraf canal and not Euphrates river, when it arrives to Al-Fuhud, Al-Manar and Chibayish charge some branches from Euphrates river is flowing in it. Where water of Euphrates river more salty than water of Gharraf canal.

For total samples, the radium concentration varies from (0.141 - 0.721 Bq/kg) with an average value (0.344 Bq/kg). The radon exhalation rate in terms of area varies from (10.17 - 52.07 mBq/m^2.h) with an average value (24.82 mBq/m^2.h). The radon exhalation rate in terms of mass varies from (1.07 - 5.45 mBq/kg.h) with an average value (2.60 mBq/kg.h). The results in this study are closed from each other in many samples because of the similarity in the formation of soil and sediments in these regions.

Table 1. Radium concentration C_{Ra} and radon exhalation rate in term of area E_A and mass E_M in water from Euphrates river and Its some branches of Thi Qar governorate.

The region	*The district*	*Name of the station*	C_{Ra} *Bq/kg*	E_A *mBq/m².h*	E_M *mBq/kg.h*
Al-Nassiriah	Batha	Euphrates (1)	0.433	31.24	3.27
	Al-Nassiriah	Almsaffar	0.144	10.41	1.09
		Alsaah	0.433	31.24	3.27
		Almohia	0.721	52.07	5.45
	Maximum		0.721	52.07	5.45
	Minimum		0.144	10.41	1.09
	Average		0.433	31.24	3.27
Suq Al-Shuyukh	Suq Al-Shuyukh	Euphrates (2)	0.282	20.35	2.13
	Garmat Bani Sa'aeed	Algarmashiyah	0.428	30.88	3.23
		Am nakhala	0.423	30.52	3.19
	Tar	Alhaffar	0.282	20.35	2.13
		Kheoah	0.141	10.17	1.07
	Aekakh	Abu Sha'atha	0.143	10.29	1.08
		Alrufia'a	0.143	10.29	1.08
		Garmat Hassan	0.352	25.43	2.66
	Fudaliyah	Am Hilan	0.282	20.35	2.13
		Fadhliyah	0.564	40.69	4.26
	Maximum		0.564	40.69	4.26
	Minimum		0.141	10.17	1.07
	Average		0.304	21.93	2.30
Chibayish	Al-Fuhud	Barbid	0.649	46.86	4.91
		Alla'aiossayyah	0.289	20.83	2.18
		Maa Al-Chibiesh	0.361	26.04	2.73
	Al-Manar	Hanbat	0.433	31.24	3.27
		Tina	0.289	20.83	2.18
	Chibayish	Abu Sobat	0.144	10.41	1.09
		Euphrates (3)	0.289	20.83	2.18
	Maximum		0.649	46.86	4.91
	Minimum		0.144	10.41	1.09
	Average		0.351	25.29	2.65
Total	Maximum		0.721	52.07	5.45
	Minimum		0.141	10.17	1.07
	Average		0.344	24.82	2.60

Figs. 3 and 4 show the graphs between radium concentration and radon exhalation rate in Euphrates river water. Where the radon exhalation rate generally tends increases with enhanced radium concentration, they have a positive correlation.

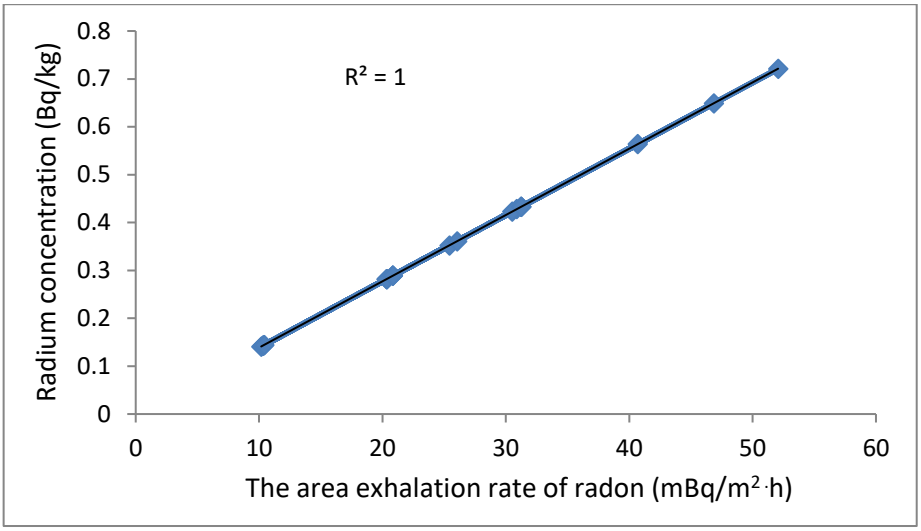

Fig. 3 the graph between the area exhalation rate of radon E_A and radium concentration C_{Ra} in water samples

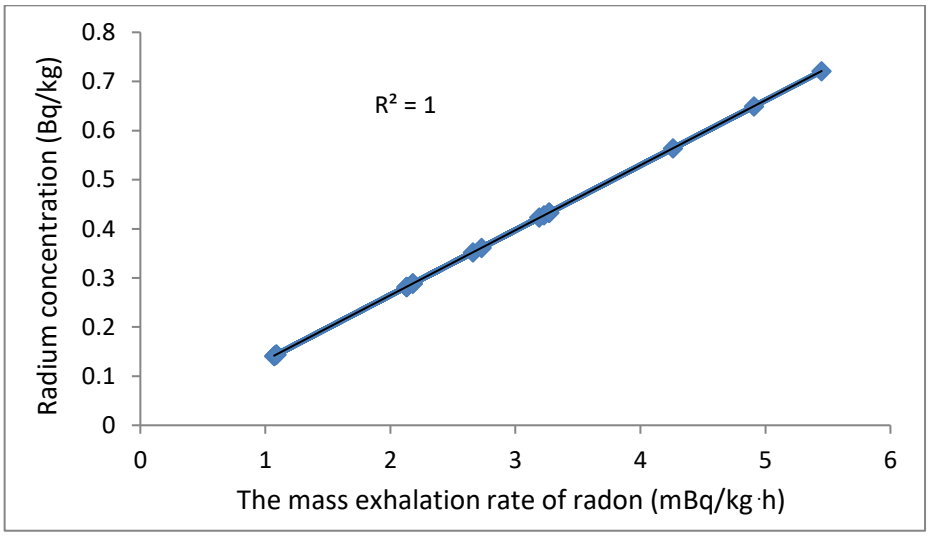

Fig. 4 the graph between the mass exhalation rate of radon E_M and radium concentration C_{Ra} in water samples

The radium concentration and radon exhalation rate in this study compare with other studies (where 1kg of water is slightly less than 1l) in table 2. The radium concentration in Shatt-Alarab river, Basrah, Iraq **[12]**, Cauvery river, India **[13]**, Nile river, Fayoum depression, Egypt **[14]**,Surface water and Seawater, Southeastern Australia **[15]**, river water, Sudan **[16]** and Water from different thermal power plants, northern India **[17]** was greater than the results in this study, while the radium concentration in water in River water, Turkey **[18]** and in Tap water, Al-Hindiyah, Karbala, Iraq **[19]** was closed from the results in this study. The radon exhalation rate in terms area and mass of water of the Euphrates river in Thi Qar Governorate was less than the radon exhalation rate in terms of area and mass in water from different thermal power plants, northern India **[17]** and the radon exhalation rate in term of area in tap water in Wassit Governorate, Iraq **[20]**.

Table 2 Concentration of Radium (Ra) and radon exhalation rate (E_A and E_M) in water in several countries

	Ra	E_A	E_M	References
	(Range) average			
Shatt-Alarab river, Basrah, Iraq	(3.030-13.820) 5.643 Bq/l			**[12]**
Cauvery river, India	(0.82-1.06) mBq/l			**[13]**
Nile river, Fayoum depression, Egypt	(3.99-6.85) 4.86 Bq/kg			**[14]**
River water, Turkey	0.126 Bq/l	191.7 mBq/m^2 h		**[18]**
Surface water Seawater , Southeastern Australia	(0.63-3.00)mBq/l 1.30 mBq/l			**[15]**
Tap water, Al-Hindiyah, Karbala, Iraq	(0.154-0.713) 0.418 Bq/kg			**[19]**
River water, Sudan	14.13 Bq/l			**[16]**
Tap water, Wassit, Iraq		650 mBq/m^2 h		**[20]**
Water from different thermal power plants, northern India	1.11-3.11 Bq/l	245.21-690.24 mBq/m^2.h	8.95-25.08 mBq/kg.h	**[17]**
Euphrates river, Thi Qar, Iraq	(0.141 - 0.721) 0.344 Bq/kg	(10.17 - 52.07) 24.82 mBq/m^2 h	(1.07 - 5.45) 2.60 mBq/kg.h	This study

CONCLUSION

Radium concentration and radon exhalation rate in terms of area and mass were carried out in the water of the Euphrates river and it some branches in Thi Qar governorate by using LR-115 type II. These results may consider low when compared with other studies in the table 2. This study represents a qualitative addition to the studies in the field of detection of radiation contaminants to obtain a database for future studies and detect the potential risks.

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تركيز الراديوم ومعدل انبعاث الرادون في مياه نهر الفرات في محافظة ذي قار

الخلاصة

يتراوح تركيز الراديوم بين (0.141 – 0.721 Bq/kg) وبمعدل (0.344Bq/kg). ويتراوح معدل انبعاث الرادون لوحدة المساحة بين (10.17 – 52.07 mBq/m^2.h) وبمعدل (24.82 mBq/m^2.h). ويتراوح معدل انبعاث الرادون لوحدة الكتلة بين (1.07 – 5.45 mBq/kg.h) وبمعدل (2.60 mBq/kg.h). وقد قورنت النتائج مع بعض الدراسات الاخرى.