^{226}Ra Concentration and ^{222}RnExhalation Rate in Sediments of Euphrates River andSome ItsBranches in Thi-Qar Governorate -Southern Iraq

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الخلاصة

ان العديد من العناصر المشعة المنبعثة من الرواسب تشارك في الجرعة الاشعاعية الكلية، لذلك فان مراقبة تلوث الرواسب انتشر على مدى واسع لتتبع مصادر التلوث. في هذه الدراسة تم استخدام كواشف الاثر النووي الصلبة SSNTDs LR-115 type II للحصول على قاعدة بيانات حول تركيز ^{226}Ra و معدل انبعاث ^{222}Rn لوحدة المساحة ولوحدة الكتلة في رواسب نهر الفرات وبعض فروعه في محافظة ذي قار. هذه البيانات يمكن ان تستخدم كمرجع للدراسات المستقبلية و لتكملة الخارطة الاشعاعية لجمهورية العراق.

يتراوح تركيز ^{226}Ra في رواسب نهر الفرات وبعض فروعه في محافظة ذي قار بين Bq/kg (2.379-0.742) وبمعدل (Bq/kg 1.498)، بينما يتراوح معدل انبعاث ^{222}Rn لوحدة المساحة بين (200.34-62.52 mBq.m-2.h-1) وبمعدل (126.17 mBq.m-2.h-1)، ويتراوح ايضا معدل انبعاث ^{222}Rn لوحدة الكتلة بين (5.61-17.97 mBq.kg-1.h-1) وبمعدل (11.32 mBq.kg-1.h-1). كان تركيز ^{226}Ra ضمن الحدود الموصى بها طبقا ل OECD. وقد قورنت النتائج مع المعدل العالمي وبعض الدراسات الاخرى.

الكلمات المفتاحية

^{226}Ra ، معدل انبعاث ^{222}Rn ، الرواسب، نهر الفرات

Abstract

Many radionuclides in sediments transference are contributing to global collective doses. Therefore, monitor of the pollution in sediments was used widespread and trace pollution sources. In this study, SSNTDs LR-115 type II are used to provide database about ^{226}Ra concentration and ^{222}Rn exhalation rate in terms of area and mass in sediments of Euphrates river and Its some branches in Thi-Qar governorate. This data can be used as a reference data for future studies and it may be useful for complete radioactivity mapping for Iraq republic.

^{226}Ra concentration in sediments of Euphrates river and its some branches in Thi-Qar governorate varied between (0.742-2.379) Bq/kg with the average value is (1.498) Bq/kg, while the area exhalation rate of ^{222}Rn varied between (62.52-200.34)$mBq.m^{-2}.h^{-1}$ with the average value is (126.17) $mBq.m^{-2}.h^{-1}$, also the mass exhalation rate of ^{222}Rn varied between (5.61-17.97) $mBq.kg^{-1}.h^{-1}$ with the average value is (11.32) $mBq.kg^{-1}.h^{-1}$. ^{226}Ra concentration in this study was included the limit recommended by OECD. Also, The results compared with the average of the world and some other studies

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Keywords

^{226}Ra, ^{222}Rn Exhalation Rate, sediment, Euphrates river, SSNTDs.

1. Introduction

^{226}Raisa radioactive elementexisted in soil, rock, sand, water, animals and plants. ^{226}Rahas entered the human body fromthe soil by vegetarian food, its (like calcium) concentrated in the bones. This led to bombard the bone marrow and mutate tissue.Subsequently, ^{226}Racan causemany health hazardslike anemia, sores, bone cancer and other problems [1].^{226}Rais the parent of ^{222}Rn, after decay ^{226}Ra, ^{222}Rn gas distribution in soil, rock, water and sediments [2].When the atmosphere contains^{222}Rn gas and its decay daughters, the bronchial epithelium received the big part of ionizing radiation, in addition, the extra thoracic airways and the skin may receive good dose, also low dose may receive to the kidney and bone marrow,while ^{222}Rndissolved in drinking water may effect on the stomach [3].Many radionuclides in sediments transferencearecontributing to global collective doses [4].Therefore, monitor of the pollutionin sediments was used widespread and trace pollution sources [5]. Rates of ^{222}Rn exchange from air-water and sediment-water were traced since 1965 by Broecker[6].

The aim of the present work provides database about ^{226}Ra concentration and ^{222}Rn exhalation rate in terms of area and mass in sediments of Euphrates river and Its some branches in Thi-Qar governorate southern Iraq by using SSNTDs LR-115 type II. This data can be used as a reference data for future studies and it may be useful for complete radioactivity mapping for Iraq republic.

2. Area of study

Length of Euphrates river within Thi-Qar governorate is (180 km), about (15.5%) of the total length of the river within Iraq, and the total lengths of branches in the governorate about (318 km) [7]. Euphrates river and its some branches pass through three regions consist of some of the districts like batha, Al-Nassiriah, Fudaliyah, Suq Al-Shuyukh, Aekakh, Garmat Bani Sa'aeed, Tar, Al-Fuhud, Al-Manar and Chibayish in Thi-Qar governorate as shown in Fig.(1). Approximately, the population of these districts was (968,921) people obtained by CSO [8]. WhereEuphrates river and its branches extend along the west, middle and east of Thi-Qar governorate.

3. Materials and Method

After collecting the sediment samples from the Euphrates river and Its some branches in different places in Thi-Qar governorate. The samples driedin an oven to remove moisture, then crashed and milled into a powder (14g). After that its placed at the bottom of a closed-cylindrical plastic canof diameter (4)cm as shown in Fig.(2). LR-115 type II was fixed in the mouth of the can from inside. The tracks of alpha particles recorded on the detector from ^{222}Rn decay. The detectors, fixedforthree months, thenit's removed and developed in a (NaOH)

solution of (2.5 N at 60 ±1 °C during 2 h). An ordinary microscope at a magnification of (400×) uses to number alpha (α) tracks in LR-115 type IIdetectors.

To evaluate the ^{226}Ra concentration in sediments was calculated using equation (1) [1]:

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

Where(tracks.cm^{-2}) is the track density due to ^{222}Rn,h (m) is the distance between the SSNTDs and the top of the sediment sample, A (m^2) is the surface area of the sediment sample, M (kg) is the mass of the sediment sample and T_e (d) is the effective exposure timedetermined by the equation (2):

T_e = t-1 / (1-) (2)

While the calibration factordetermined by theequation (3) If ($a_1 \leq a \leq a_\circ$) [9]:

$$K = \frac{1}{4} a \cos\theta_c \left(2 - \frac{a_1}{a} - \frac{a}{a_\circ}\right) \quad (3)$$

Where θ_c equal (40°) is the critical angle, a is the radius of the can, $a_\circ$ and $a_1$determined by the equations (4):

$$a_\circ = R_\circ \cos\theta_c, R_\circ = R - R_{min}, a_1 = R_1 \cos\theta_c \text{ and } R_1 = R - R_{max} \quad (4)$$

Where R equal (3.90 cm) is the alpha range of ^{222}Rn in air, R_{max}equal (3.44 cm)and R_{min} equal (0.80 cm)are the alpha (α) particle ranges in the air volume which match to the upper (E_{max}) and lower (E_{min}) energy limits respectively[10].Consequently,K=0.032 tracks. cm^{-2}.day^{-1} per Bq.m^{-3},where this calibration factor compared with [11, 12].

The ^{222}Rn exhalation rate in terms of area(E_A) and mass(E_M)from the sediments determined according to the following equations (5) and (6)[13]:

$$E_A = CV\lambda / A[t + 1/\lambda(e^{-\lambda t} - 1)] \quad (5)$$

$$E_M = CV\lambda / M[t + 1/\lambda(e^{-\lambda t} - 1)] \quad (6)$$

Where C (Bq.m^{-3}.h) is the integrated ^{222}Rn exposure from sediments, V (m^3) is the Volume of air in can, λ (h^{-1}) is the decay constant of ^{222}Rn, and t(h) is theaccumulation time exposure.

4. Results and Discussion

^{226}Ra concentration and^{222}Rnexhalation rate in terms of area and mass in the samples have been measured from Euphrates river and Its some branches in various places atThi-Qar governorate. The obtained results are summarized in Table (1), with the maximum, minimum and average valuesof thetotal.Point out that showed that Maa Al-Chibayish (samples no. 19) is branch from Gharraf canal and not Euphrates river, but some branches from Euphrates river is flowing in it.

Table(1)^{226}Ra concentration and ^{222}Rn exhalation rate in sediments of Euphrates river and its some branches in Thi-Qar governorate.

No.	*The region*	*The district*	*The name of the station*	C_{Ra} *Bq/kg*	E_A *mBq.m^{-2}.h*	E_M *mBq.kg^{-1}.h*
1	Al-Nassiriah	Batha	(Euphrates (1	0.877	73.81	6.62
2		Al-Nassiriah	Almsaffar	1.753	147.61	13.24
3			Alsaah	1.502	126.53	11.35
4			Almohia	2.379	200.34	17.97
5	Suq Al-Shuyukh	Suq Al-Shuyukh	Euphrates (2)	1.712	144.20	12.94
6		Garmat Bani Sa'aeed	Garmat Bani Sa'aeed	0.978	82.40	7.39
7			Agarmashiyah	1.979	166.74	14.96
8			Am nakhala	0.856	72.11	6.47
9		Tar	Alhaffar	1.345	113.30	10.16
10			Kheoah	2.324	195.71	17.56
11			Abu Ouane	2.079	175.10	15.71
12		Aekakh	Abu Sha'atha	1.361	114.62	10.28
13			Al rufia'a	0.742	62.52	5.61
14			Garmat Hassan	1.345	113.30	10.16
15		Fudaliyah	Am Hilan	0.856	72.11	6.47
16			Al Fadhliyah	1.345	113.30	10.16
17	Chibayish	Al-Fuhud	Barbid	2.379	200.34	17.97
18			Alla'aiossayyah	1.252	105.45	9.46
19			Maa Al-Chibayish	1.878	158.16	14.19
20		Al-Manar	Hanbat	1.502	126.53	11.35
21			Tina	1.252	105.45	9.46
22		Chibayish	Euphrates (3)	1.377	115.98	10.41
23			Abu nersi	1.502	126.53	11.35
24			AbuSobat	1.377	115.98	10.41
Total		Maximum		2.379	200.34	17.97
		Minimum		0.742	62.52	5.61
		Average		1.498	126.17	11.32
		Standard Deviation		0.482	40.61	3.64

^{226}Ra concentration in sediments of Euphrates river and some branches in Thi-Qar governorate varied between (0.742-2.379Bq/kg) with the average value is (1.498) Bq/kg, while the area exhalation rate of ^{222}Rn variedbetween (62.52-200.34) mBq.m^{-2}.h^{-1} with the average value is (126.17) mBq.m^{-2}.h^{-1}, also the mass exhalation rate of ^{222}Rn varied between (5.61-17.97) mBq.kg^{-1}.h^{-1} with the average value is (11.32) mBq.kg^{-1}.h^{-1}.

^{222}Rn exhalation rate varies from one station to another, the variation in these stations may be due to the differences in ^{226}Ra concentration and porosity of the sediments.The relation between ^{226}Ra concentration and the area exhalation rate of ^{222}Rn, and also the relation between ^{226}Ra concentration and the mass exhalation rate of ^{222}Rn are leaner one, where (R^2=1) is the squire of the correlation coefficient, these obtained in Figures (3 and 4).It is worth mentioning that the concentration of ^{226}Ra in this study was include the recommended safe (370 Bq/kg) according to OECD [14].

Whencomparing the results which obtained from sediments of Euphrates river and its branches with other studies, Obviously, these results are closed from results[15], [16] and [31] from Iraq,but itis lower than other studies especiallythe average of the world by [4], as shown in the Table(2).

Table(2): comparison of our sediments with other areas of the world

Location	C_{Ra} *(Bq/kg)*	E_A *(mBq.m^{-2}.h^{-1})*	E_M *(mBq.kg^{-1}.h^{-1})*	*Reference*
Average (Range)				
^{226}Ra concentration				
Baltic sea, Southern Baltic	(3.6-47)			[17]
China	50			[18]
Dutch	Not detected			[19]
Abano Terme, Italy	Not detected			[20]
Aegean region, Turkey	Not detected			[21]
Cauvery river,India	5.6			[22]
Vistula river, Poland	(205-415)			[23]
Danube river, Serbia	31			[24]
Cauvery river, India	84.89			[25]
Nile river, Egypt	(7-188)			[26]
Al- Hindiyah, Iraq	1.420			[16]

^{222}Rn exhalation rate				
White Oak river, USA		(2041200-4536000)		[6]
Basrah, Iraq		(20-340)		[15]
Azad Kashmir, Pakistan		(193-308)		[27]
^{226}Raconcentration and ^{222}Rn exhalation rate				
The average of the world	35	57600		[4]
Bahawalpur, Pakistan	(28-36.5)	(1560-3330)		[28]
Bulandshahr, India	14.1	600.74	23.1	[29]
Benghazi, Libyan	(1.5-23.0)	216.5	8.2	[13]
Northern Rajasthan, India	12.45(6.88-19.31)	495.32(273.80-768.04)	14.96(8.27-23.19)	[30]
Khor-Abdulla, Arabian Gulf, Basrah, Iraq	0.910(0.235-1.814)	267(69-531)	6.87(1.77-13.70)	[31]
Kassala town, Sudan	16.3(3.9-34.2)	3500(840-7350)	70(17-148)	[32]
Euphrates river, Thi-Qar, Iraq	1.498(0.742-2.379)	126.17(62.52-200.34)	11.32(5.61-17.97)	This study

5. Conclusion

Measurements of gross ^{226}Ra concentration and ^{222}Rn exhalation rate in terms of area and mass of sediments collected from Euphrates river and its some branches in Thi-Qar governorate southern Iraq were performed using SSNTDs LR-115 type II technique. The observed values of ^{226}Ra concentration in sediment samples in the present study are less than the recommended safe according to OECD. ^{226}Ra concentration and ^{222}Rn exhalation rate are much lower than the average of the world. The relation between ^{222}Rn exhalation rate in terms of area and mass to ^{226}Ra concentration obtained in figures (3 and 4) are leaner one, sofrom ^{226}Ra concentration may give a good estimate about ^{222}Rn exhalation rate and inversion. Thereby it is concluded that sediments of Euphrates river and Its some branches in Thi-Qar governorate are radiologically safe.

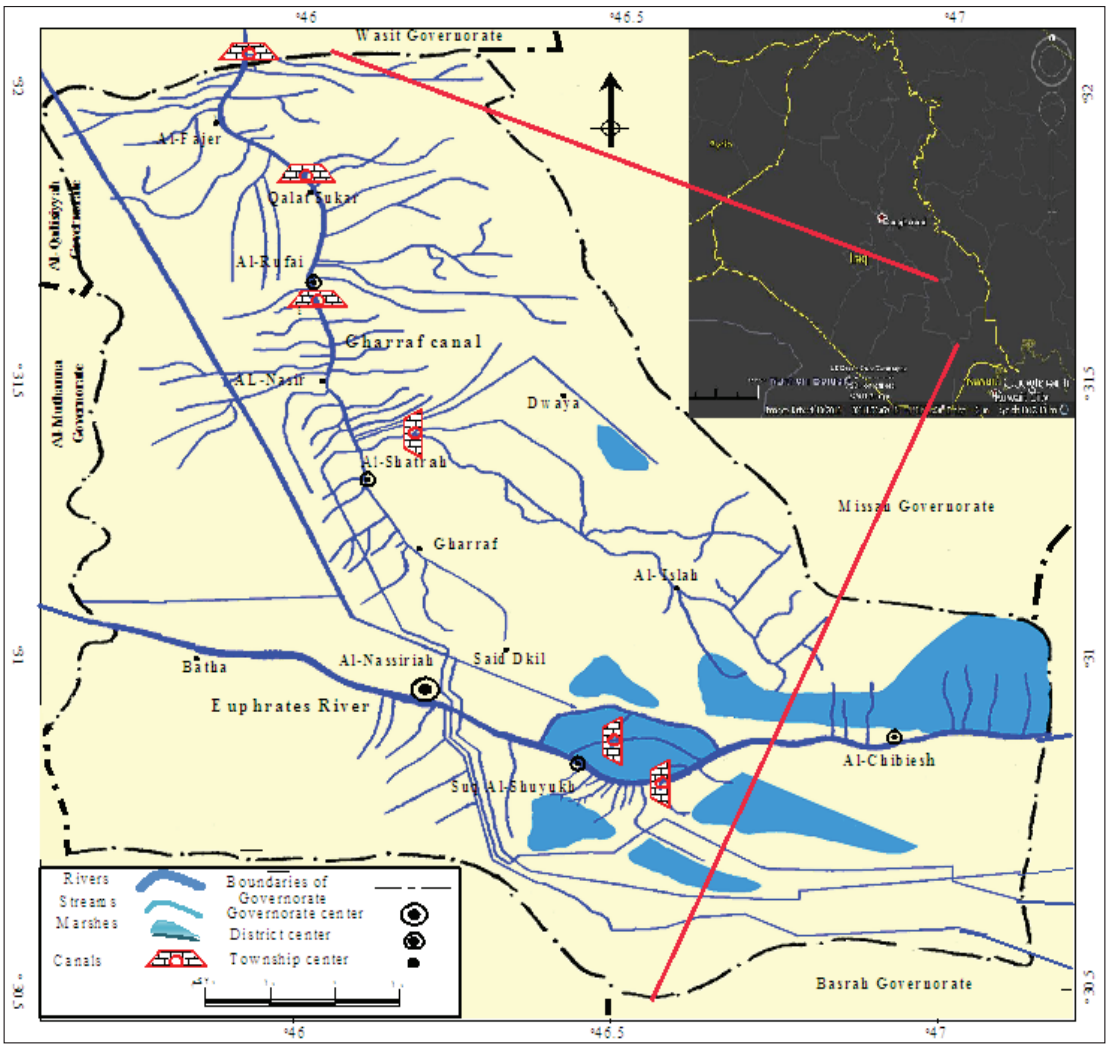

Fig.(1): surface water resources in Thi-Qar governorate including Euphrates river and its branches.

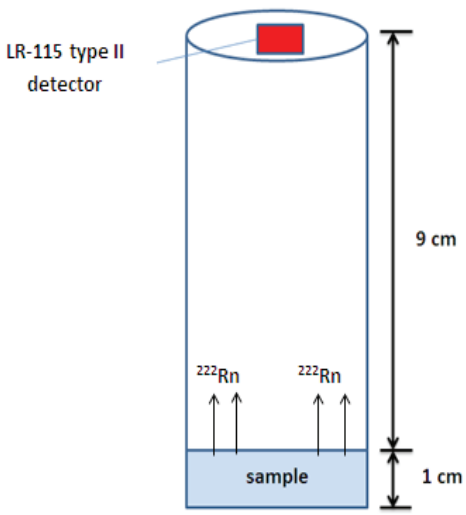

Fig.(2): shown of (LR-115 type II) film and a sediment sample in a closed cylindrical plastic can.

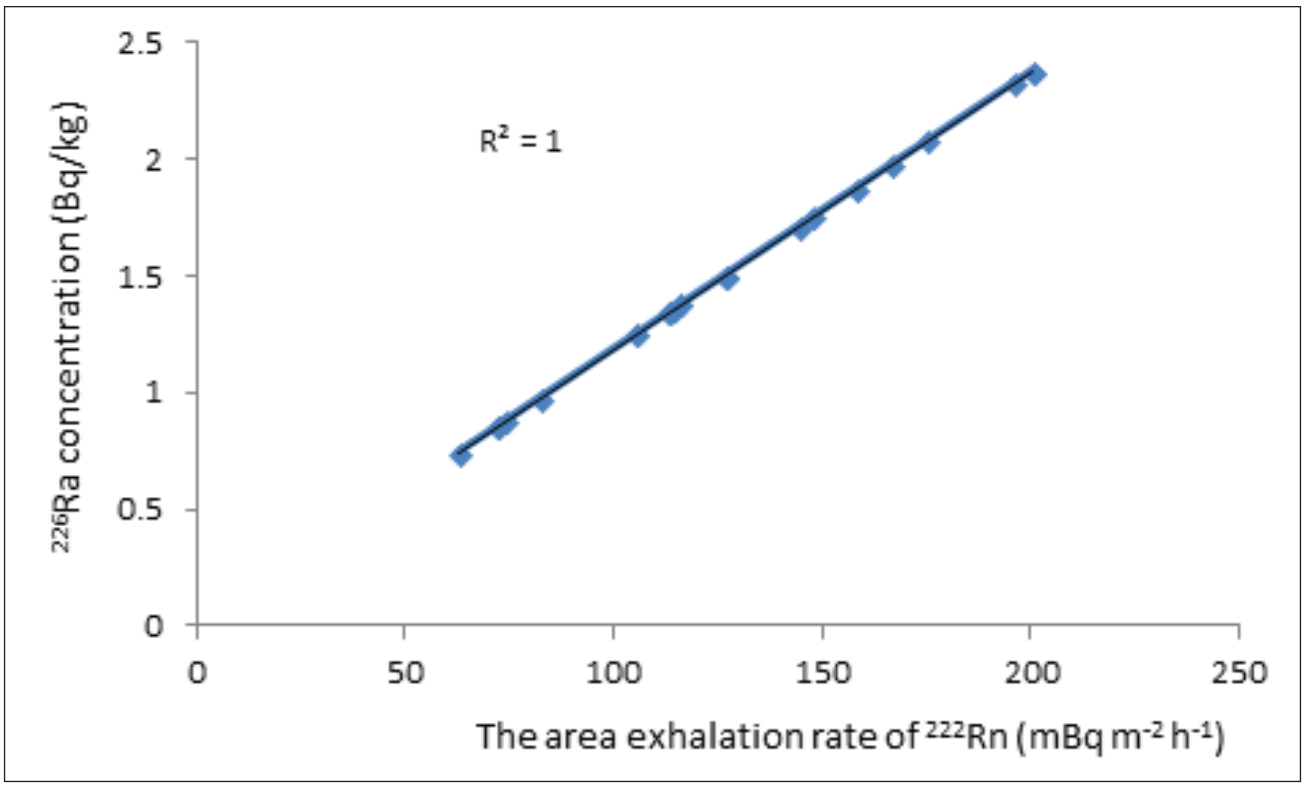

Fig.(3): show the relation between the area exhalation rate of 222Rn and 226Ra concentration

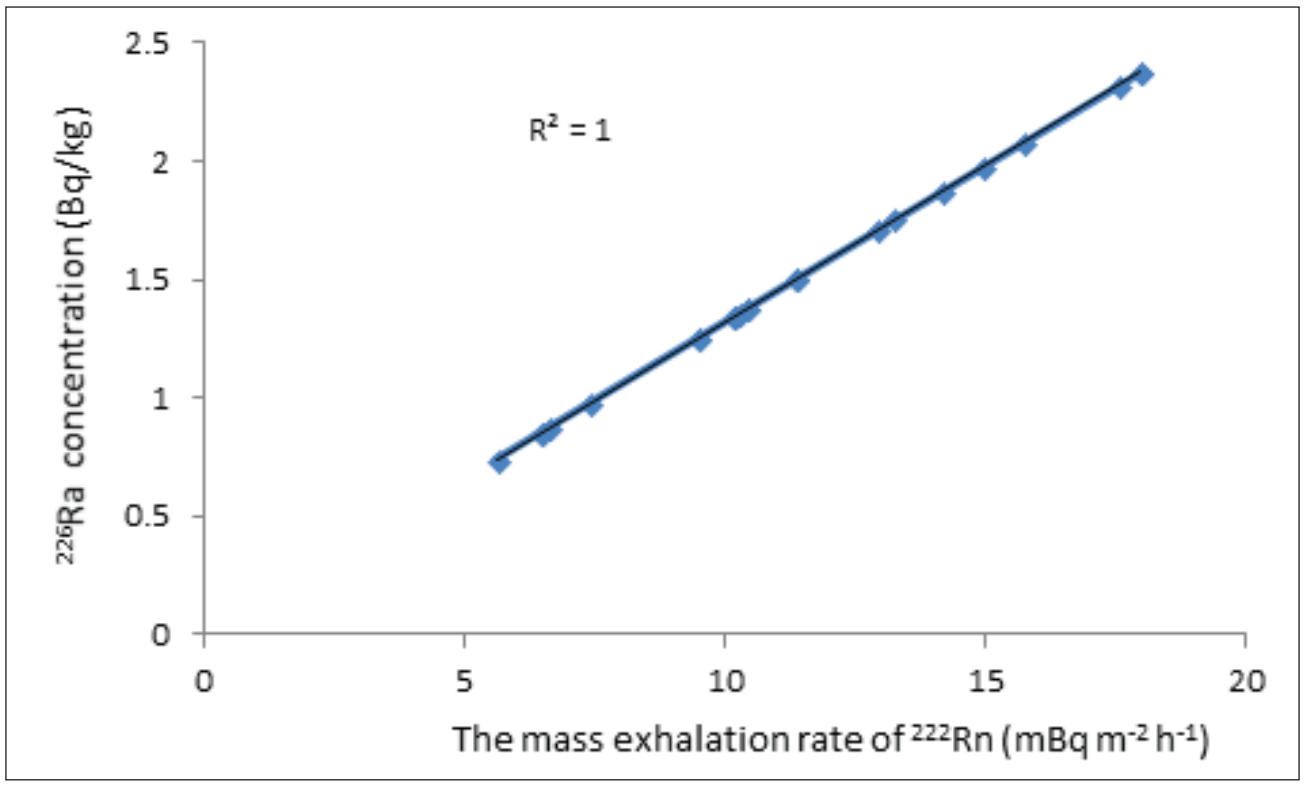

Fig.(4): show the relation between the mass exhalation rate of 222Rn and 226Ra concentration.

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