Measurement of ^{222}Rn , ^{226}Ra and ^{238}U Concentrations In Some Fish of Karbala Governorate, Iraq

قياس تراكيز ^{222}Rn ، ^{226}Ra و ^{238}U في الاسماك المتواجدة في محافظة كربلاء (العراق)

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Abstract

In the present work, thirteen samples for local and imported fish collected from Karbala markets to determined radon (^{222}Rn), radium (^{226}Ra) and uranium (^{238}U) concentrations using Solid State Nuclear Track Detector (SSNTD) type CR-39. The results show that the concentration of these nuclides ranged between (8.163-39.746) Bq/m^3, (0.104-0.510)Bq/Kg and (0.082-0.400)ppm with mean values 21.26Bq/m^3, 0.273Bq/Kg and 0.214ppm respectively. These results shown that the concentration of above nuclide were below the permissible limits recommended by ICRP and UNSCEARs therefore it is radiologically safe for human food.

الخلاصة

في العمل الحالي تم جمع ثلاثة عشر عينة من الاسماك المحلية والمستوردة المتواجدة في اسواق محافظة كربلاء لغرض ايجاد تركيز الرادون ^{222}Rn ، الراديوم ^{226}Ra واليورانيوم ^{238}U باستخدام كاشف الاثر النووي للحالة الصلبة نوع CR-39 . اظهرت النتائج بان تراكيز هذه النوى يتراوح بين (39.746-8.163) m^3/Bq ، (0.510-0.104) Kg/Bq و (0.082-0.400) ppm بمعدل 21.26 m^3/Bq ، 0.273 Kg/Bq و 0.214 ppm على الترتيب . كانت تراكيز النوى اعلاه دون الحدود المسموحة والموصى بها من قبل ICRP و UNSCEARs وعليه تعد هذه الاسماك اغذية امنة من هذا الجانب .

Introduction

Radiation is a part of environment which we live in , the sources of natural radiation are cosmic ray particles incident on the atmosphere and the radioactive nuclides in the earth's crust [1]. Most people exposure to receive radiation dose from the components of this environment, the main contribution in this received dose is radon gas. Radon element is a radioactive inert gas and its present in different proportions everywhere [2]. Radon is a daughter of radioactive radium isotope ^{226}Ra (1600 year) which emitted from the natural decay chain of uranium isotope ^{238}U ($4.47\times 10^9 y$) [3]. Radium is a solid radioactive element under ordinary conditions of pressure and temperature, enters into body with food to become concentrated in bones [4]. Uranium is a heavy metal radioactive element, after ingestion of U tends to accumulate in the body, particularly in kidneys, liver, spleen and bones[5]. According to estimates the radon and their progeny contribute about half the average annual effective dose for natural sources [6,7], where the global average for annual effective dose from natural background radiation is (2.4mSv) including (1.4mSv) comes from radon and their progeny [8]. Radon continuously emanates from soil to the atmosphere [9], these radionuclides transferred to the water through interaction with it by erosion and dissolution processes in ground and surface water [10], the uptake of above radioactive substances by fish usually takes place in two ways: penetration of the elements through the gills or skin and ingestion of food or water [11] and migrate from soil to plants and then into human body by food chain [12]. The main methods of exposure to radiation are inhalation and ingestion materials that contain radioactive elements [5,13]. The entry of radioactive substances into body and accumulate in their tissues leads to many diseases, particularly fatal cancers and thus increased mortality rate [14,15]. As its prove that exposure to radon causes lung cancer [16,17], while accumulation of radium leads to bone cancer[4], the risks related to the exposure to U arising from the biochemical toxicity as a heavy metal are considered to be about six orders higher than those from its radioactivity specially for kidneys[5]. There are many researchers who have studied radionuclides concentration in foods, in Iraq [4,12,18,19] and in some countries [15,20-23]. The aim of this work is to measure some radioactive elements radon, radium and uranium concentrations in fish were exist in Karbala governorate using SSNTD technique type CR-39.

Materials and Method

In March 2016, thirteen fish samples have been obtained from local markets of Karbala governorate located about 100Km southwest of Baghdad (the capital of Iraq) at $32^{\circ}9' - 32^{\circ}50'$N latitudes and $43^{\circ}9' - 44^{\circ}18'$E longitudes. The sources of local fish samples is Euphrates river, Alrazaz lake, drainage of irrigation water and artificial lakes. Either, imported they are frozen marine fish as shown in table (1). Fish samples were peeling and made ashes by oven at $(270^{\circ}C)$ for (4 hours) [19]. (7gm) of each sample were stored at (22 days) in closed test tube (cylindrical container) to equilibrium between ^{226}Ra and its decay products [24]. To estimate number of alpha particles emitted from radon in samples was used SSNTD, CR-39 with dimensions (1×1)cm^2. The distance between sample and detector is (6.5cm), this technique as shown in figure (1). The test tubes were closed for (60 days) from 13/4/2016 to 13/6/2016. During this time alpha particles strike the detector. After this irradiation time the SSNTD were removed and chemically etched in (6.25N) of NaOH solution at $(70^{\circ}C)$ for (7h) [19]. Then the alpha tracks is determined in each detector using an optical microscope with magnification 400x.

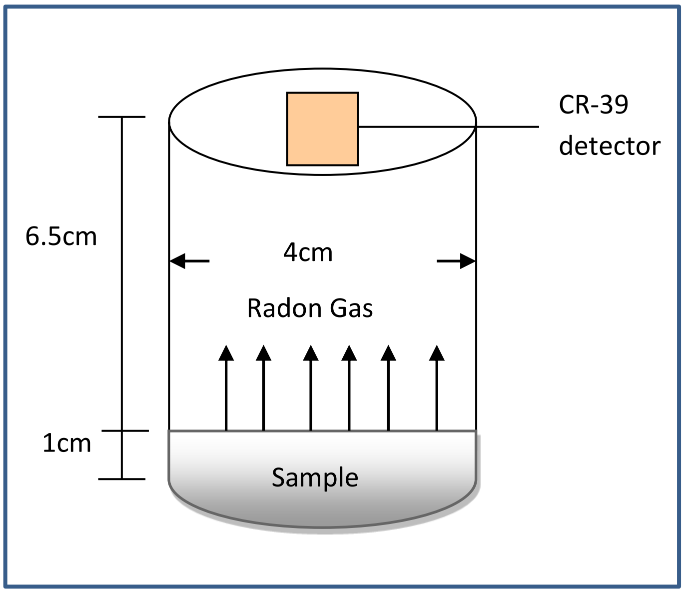

Figure 1. test tube technique in present study

The ^{222}Rn concentration $C(Bq/m^3)$ within test tube air is estimated by the following equation [25]:

$\rho = K.C.T$ (1)

Where, $\rho(\frac{Trac}{cm^2})$ the density of tracks, T :exposure time (60 day) and K: ^{222}Rn gas diffusion constant , which is equal to 4.8584× $10^{-2}[\frac{Trac/cm^2.day}{Bq/m^3}]$ [18].

The radon activity concentration $C_{Rn}(Bq/m^3)$ in the fish samples was determined by [26]:

$C_{Rn} = \frac{C.\lambda_{Rn}.h.T}{l}$ (2)

Where, λ_{Rn}: decay constant for ^{222}Rn which is equal to $(7.554 \times 10^{-3}\ hr^{-1})$, h: distance between sample surface and detector (6.5 cm) and l is depth of powder (1cm).

The activity of ^{22}Rn, (A_{Rn}) in fish samples will be calculated in (Bq) from the relation [18]:

$A_{Rn} = C_{Rn}V$ (3)

Where V (m^3) is volume of the sample in test tube. The number of radon atom N_{Rn} was calculated by [27]:

$A_{Rn} = \lambda_{Rn}N_{Rn}$ (4)

The radium concentration C_{Ra} (Bq/Kg) in sample has been calculated according to the following relation [11]:

$C_{Ra} = \frac{\rho h A}{KT_{ef}m}$ (5)

Where A(m^2) is the cross section area of the test tube, m is the mass of sample (7gm) and T_{ef}(hr) is the effective exposure time can calculated from [25]:

$T_{ef} = T - \frac{1}{\lambda_{Rn}}(1 - e^{-\lambda_{Rn}T})$ (6)

To estimate numbers of uranium atoms N_U in sample using the law of radiation equilibrium [18]:

$\lambda_U N_U = \lambda_{Rn}N_{Rn}$ (7)

λ_U is uranium decay constant $(4.98 \times 10^{-18}S^{-1})$.

The weight of uranium in fish samples W_U(gm) can calculate from the formula [27]:

$W_U = \frac{N_U W_{mol}}{N_A}$ (8)

Where W_{mol} is uranium molecular weight and N_A is Avogadro number.

Uranium concentration C_U in part per million unit (ppm) calculated with the relation [18]:

$C_U = \frac{W_U}{m}$ (9)

Results and discussion

The results for radionuclides concentrations: ^{222}Rn, ^{226}Ra and ^{238}U for fish samples collected from Karbala markets inserted in Table (1). The highest concentration for these radionuclides were found in sample number (9), Khishni, (from drainage of irrigation water) 39.746Bq/m^3, 0.510Bq/Kg and 0.400ppm respectively and the lowest for these radionuclides with sample number (6), Carp (from artificial lake) 8.163Bq/m^3, 0.104Bq/Kg and 0.082ppm respectively. The average value for above nuclides concentrations were 21.255Bq/m^3, 0.272Bq/Kg and 0.213ppm respectively. The figures (2-4) illustrate distribution of these nuclides on the samples. The highest value of radionuclides concentration in sample (9) because the environment of this sample, drainage of irrigation water is infiltration through agriculture soil where interacted with much amount of soil and this soil content phosphate fertilizers which distinguish is contain a high amount of ^{238}U and ^{232}Th. These results for ^{222}Rn , ^{226}Ra and ^{238}U content in fish samples were below the allowed limit recommended by (ICRP,1987) [28], (UNSCEAR,2008) [1] and (UNSCEAR,1993) [29]. These results have revealed the fish were safety from a health hazard point of view. By comparing the result for current work with results of Salman and Al-Khalifa [19] observed that increase of average radon activity concentration about doubled. Perhaps, this increase is due to the difference of the study samples environment. Figure (5) shows the distribution of radon activity concentration for present work and its average from results of reference [19].

Conclusions

The results shown that the highest concentrations of ^{222}Rn, ^{226}Ra and ^{238}U nuclides in selected samples was found in sample number (9), Khishni and the lower concentration was in sample number (6), Carp from artificial lake. These results were within permissible levels recommended by $ICRP$ (1987) and UNSCEARs. Hence it could be concluded that fish is a safe for human consumption point of view.

Table -1. Fish samples name and sources there and radon, Radium and Uranium concentrations

	No.	Common name	Scientific name of fish	Source of fish	$\rho(\frac{Trac}{cm^2})$	$C(\frac{Bq}{m^3})$	$C_{Rn}(\frac{Bq}{m^3})$	$C_{Ra}(\frac{Bq}{Kg})$	$C_U(ppm)$
Fresh local	1	Carp	*Cyprinus carpio*	Euphrates River	70.800	24.287	1717.282	0.312	0.244
	2	Bunni	*Barbus sharpeyi*		72.525	24.879	1759.122	0.319	0.250
	3	Shabbout	*Barbus grypus*		90.759	31.135	220.395	0.400	0.313
	4	Himri	*Barbus luteus*		73.810	25.320	1790.290	0.325	0.255
	5	Gattan	*Barbus xanthopterus*		60.667	20.812	1471.520	0.267	0.209
	6	Lake Carp	*Cyprinus carpio*	Artificial lake	23.796	8.163	577.181	0.104	0.082
	7	Silver Carp	*Hypophthalmichthys molitrix*		34.594	11.867	839.091	0.153	0.119
	8	AlRazaza Shanag	*Acanthopagrus latus*	AlRazaza lake	38.217	13.110	926.968	0.168	0.132
	9	Khishni	*Liza abu*	drainage of irrigation water	115.862	39.746	2810.302	0.510	0.400
Frozen imported	10	Sea Carp	*Cyprinus carpio*	Myanmar	36.318	12.458	880.907	0.160	0.125
	11	Sea Shanag	*Acanthopagrus latus*	Vietnam	52.624	18.053	1276.425	0.232	0.182
	12	Zubady	*Pampus argenteus*	Myanmar	63.641	21.832	1543.637	0.280	0.219
	13	Tuna	*Thynnus alaionga*	-	71.867	24.654	1743.162	0.316	0.248
Max						39.746	2810.302	0.510	0.400
Min						8.163	577.181	0.104	0.082
Mean						21.255	1502.868	0.272	0.213
Standard deviation						8.679	613.679	0.111	0.087

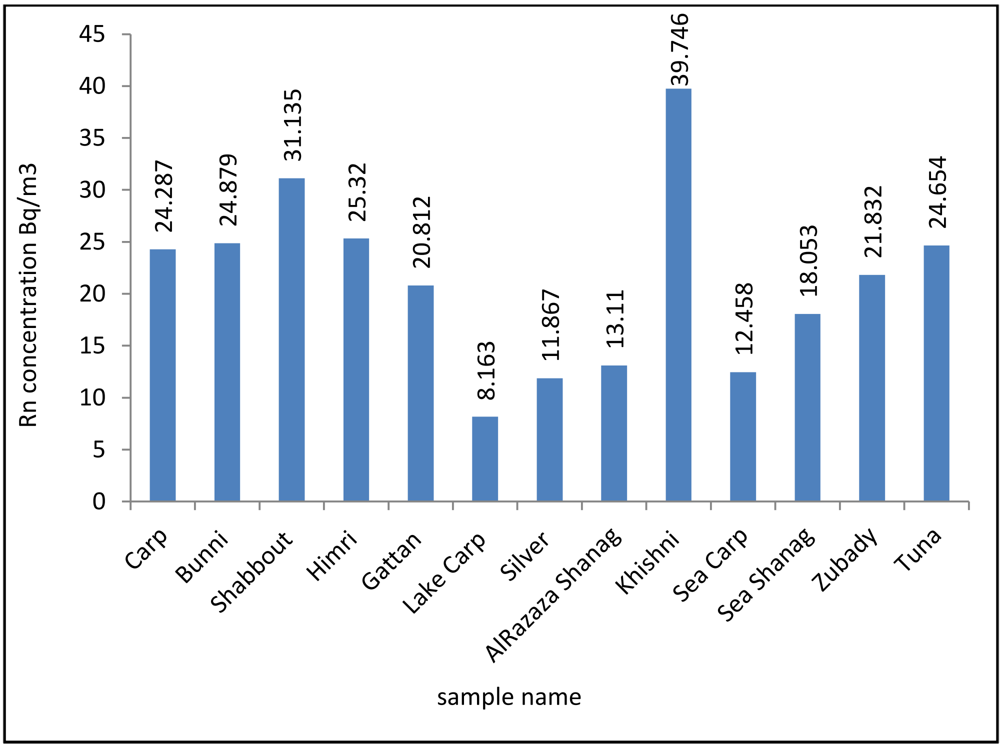

Figure 2. radon concentration distribution in test tube air.

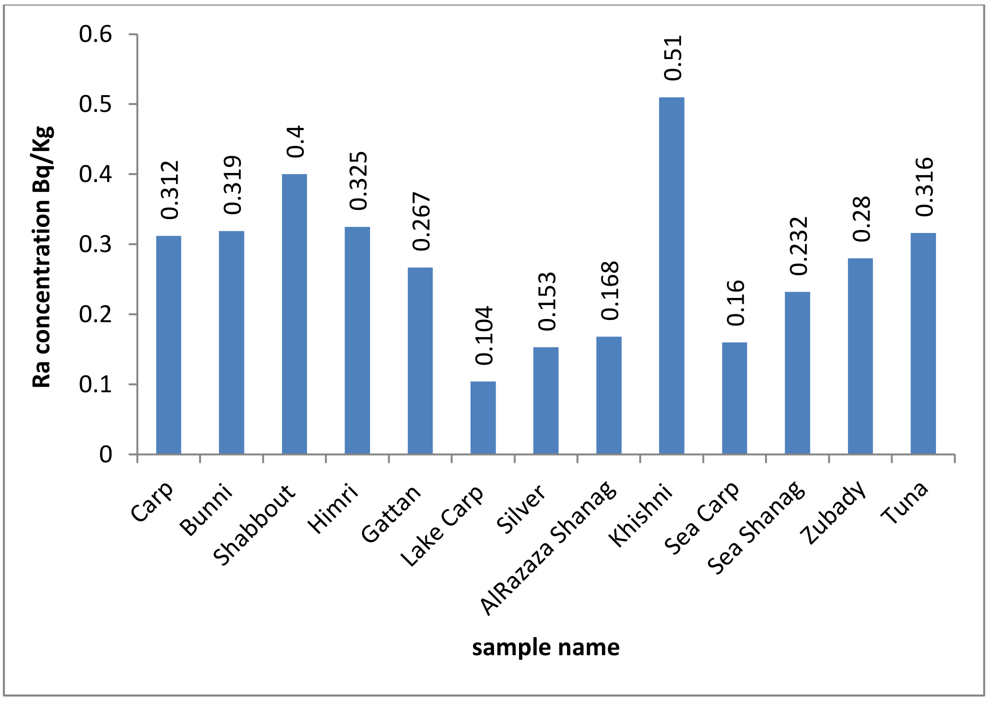

Figure 3. Ra concentration distribution in fish sample.

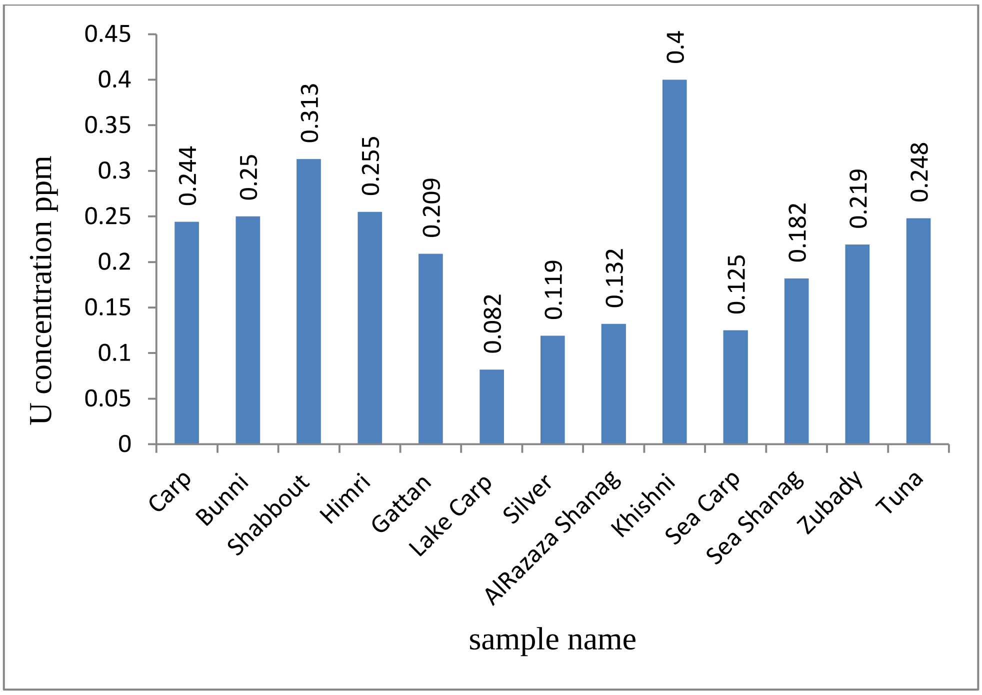

Figure 4. U concentration in fish samples

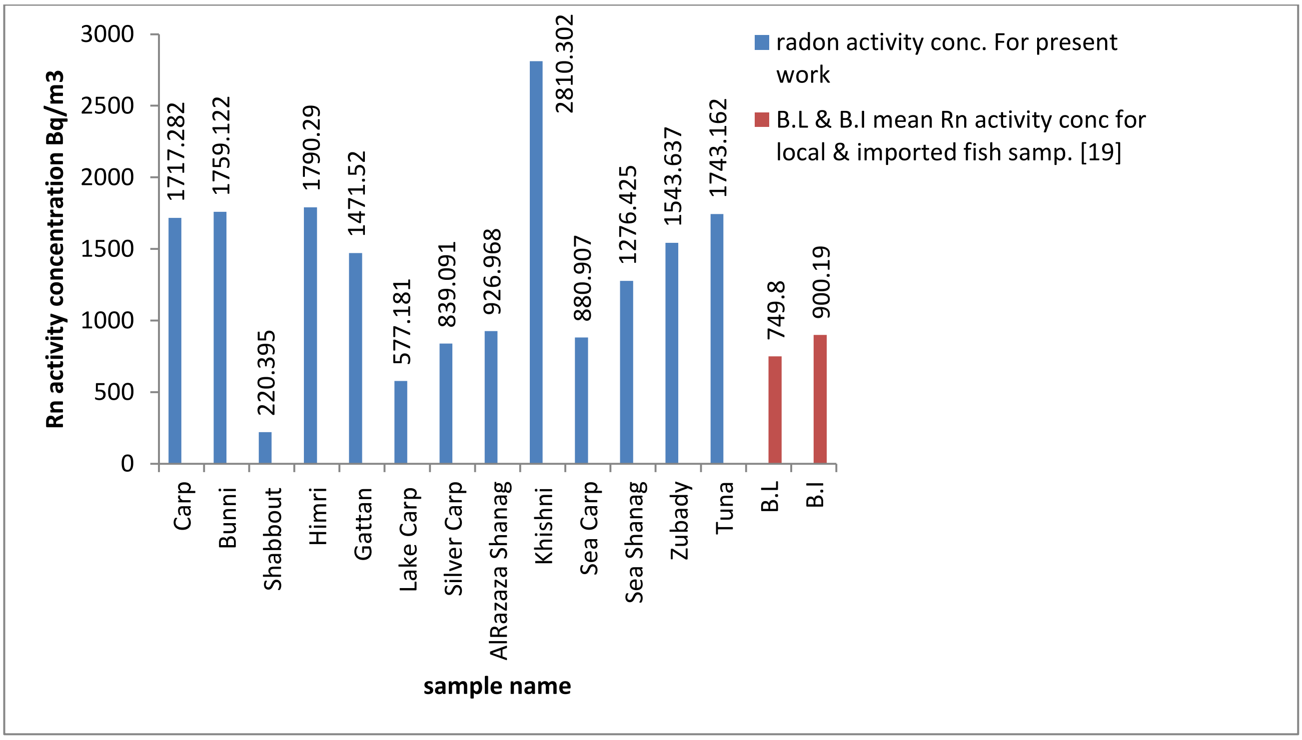

Figure 5. Rn activity concentration $\boldsymbol{C_{Rn}}$ for this study and [19].

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