ISSN: 0974-2115
www.jchps.com Journal of Chemical and Pharmaceutical Sciences

Measurement the concentration of radon gas emitted from infant powdered milk consumed in Iraq using nuclear track detector CR-39

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ABSTRACT

In this study, radon and uranium concentration in a set of commercial children's milk consumed in Iraq, namely, (Nido, Nactalia, Novelac, Dovelac, Pediasure, Dialak2, Dialak1) using nuclear track detector CR-39 was determined. Indicated that the results were obtained the highest value of radon concentration in Dialak2 sample equal to (2607.3170 Bq/m^3) and uranium concentration is ((0.0483×10^{-5} ppm), while the lowest value of radon concentration in Dialak1 sample equal to (782.1950 Bq/m^3) and uranium concentration is (0.0142×10^{-5} ppm). The present results show that the radon gas and uranium concentrations are in the limited values of International Atomic Energy Agency (IAEA) that equal 2 ppm.

KEY WORDS: Natural Radioactivity, powdered milk, track detector CR-39.

1. INTRODUCTION

Measurements of radioactivity in environment and in foodstuffs are extremely important for controlling radiation levels to which mankind is direct or indirectly exposed. Besides natural radionuclides, due to several nuclear weapon tests and numerous nuclear reactor accidents, various artificial radioactive elements were introduced in the biosphere (Melquiades, 2002). Another important fact is that, importation of contaminated food from any region that suffered a nuclear accident can be indirectly affect people health around the world (Melquiades, 2004). Radionuclide elements coming from the fallout incorporates in biosphere. These elements present in atmosphere contaminate plants, soil and water and by different ways contaminate the environment. The radioactive elements transport in environment involves transference among three primary components: vegetation, soil and water (Ritchie, 1990).

Milk is the main basic foodstuffs for the infants especially for infants less than one year because they generally consume more milk on apery body weight basis than adults. So, the assessment of radioactivity and heavy metals levels in the powdered and the associated doses are of crucial importance for controlling the radiation levels and necessary in establishing rules and regulations relating to radiation protection (Quindos, 1994).

CR-39 used as the detector in the determination of the radioactive contaminants. This detector has a high sensitivity. The CR-39 detectors used for long-term measurement of radon exhalation rate (Unscear, 2000; Majeed Fouad, 2015). Radon concentration is determined by measuring the emitted alpha particles that causes damage to the detector surface. Radon levels show important spatial variations on a regional or local scale. The track density exposure time and calibration factor are necessary for calculating the radon concentration (Alsaedi Ali, 2014).

The aim of this study was to investigate the concentration and activity of radon gas in seven kinds of children's milk consumed in Iraq.

2. MATERIALS AND METHODS

Seven types of infant powdered milk consumed in Iraq were collected from local markets. The samples placed in a sealed- cup (its base 2.65 cm and height 11.4 cm as shown in Fig.1). The nuclear track detector CR-39 localized on the bottom surface of the seal cup cover, the detector is plastic material sensitive to alpha particles supported on a long-term. Leave a detector with the sample for 60 days in order to record the effects of emitted alpha particles from radon gas, which is the natural degradation product of U^{238}, detector was cutting into equal proportions (1×1 cm^2). The weight of the sample is 25 g calculated by sensitive balance.

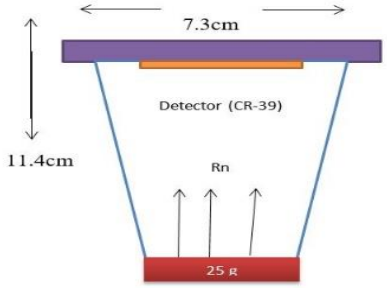

Figure.1. A schematic diagram of the sealed-cup technique

After the irradiation time, CR-39 detector was etched in 6.25 N of NaOH solution at temperature of (60 ± 1˚C) by thermostat water bath (WATER BATH HH-2) for 5 hour. After the process, the detector rinsed with distilled water and dried in air.

The effects of alpha particles have been calculated by optical microscope (type ALTABIO-1007) with magnification of (400×) connected with camera 14 mp. The measurements carried out in the laboratories of department of physics, college of education for pure sciences, University of Babylon.

3. RESULTS AND DISCUSSION

Table.1, presents alpha particle density for infant powdered milk for the samples under study calculated from the optical microscope as in Fig.2. The density of alpha particles were calculated by using the following relationship (UNSCEAR, 1993).

Track density $\frac{Average\ number\ of\ total\ pits\ (tracks)}{Area\ of\ field\ view}$ (1)

Table.1. shows the alpha particle density on the surface of the track detector.

Samples	Track density (track.mm^{-2})				mean
	N_1	N_2	N_3	N_4	
Nido	4	8	7	6	6.25
Nactalia	5	4	4	2	3.75
Novelac	4	7	5	12	7.00
Dovelac	4	4	4	3	3.75
Pediasure	7	6	6	5	6.00
Dialak2	11	5	19	5	10.00
Dialak1	1	2	2	7	3.00

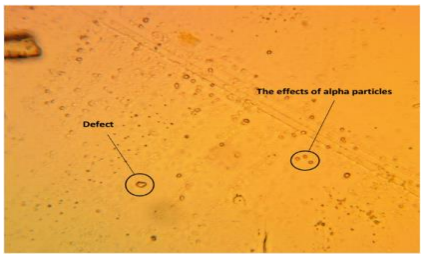

Figure.2. The etched track of sample 6 obtained from optical microscope

To calculating the concentration of alpha particles from radon emitted from samples of powdered milk, must be measuring the concentrations of the radon in the air include the seal cup from the equation (Abass Khalid, 2015)

$$C_a = C_\circ t_\circ \rho / t\ \rho_\circ \quad (2)$$

Where (C_o) is the concentration of radon during the calibration process equal to (367.5 Bq.m^{-3}), $_o$) is the track density per mm^2 on the calibrated dosimeter equal (50 Tr.mm^{-2}), (C_a) is the concentration of radon in the air inside the seal cup.) is the track density per mm^2 for detector with the samples, (t) exposure time and equal (60 days) in this study, and (t_o) exposure time for calibration.

We obtained the highest value of radon concentration in the air for Dialak2 sample which equal (73.5 Bq.m^{-3}) and the lowest value was in the Dialak1 sample which equal to (22.05 Bq.m^{-3}), as listed in the Table.2.

Through the Radon concentration in air we can calculated the radon concentration in each sample from the following equation (Al-Bataina, 1997).

$$C_W = \frac{C_a\, \lambda_{Rn}\, ht}{L} \quad (3)$$

where (C_a) is the concentration of radon in the air space given in Bq/m^3, and (λ_{Rn}) radon decay constant and equal to (0.1814 / Day), (h) distance from the sample surface inside the seal cup to the surface of detector is equal to (8.8 cm), and (L) is the thickness of the sample is equal to (2.6 cm)

The highest value of radon concentration in a Dialak2 sample equal to (2607.317 Bq/m^3), while the lowest value was in a Dialak1 sample equal to (782.195 Bq/m^3). The value of radon concentration in the Dovelac and Nactalia samples equal to (979.74 Bq/m^3), for the Nido sample equal to (1629.307 Bq/m^3), in the Pediasure sample, which amounted to (1564.39 Bq/m3), and the Novelac sample reached (1825.1818 Bq/m^3).

The activity of Radon in the samples (A_{Rn}) in (Bq) unit could be determined through the relation (Yousuf, 2013; Abed, 2011).

$$A_{Rn} = C_W V \quad (4)$$

Where ^{2}h; (V) the volume of samples given in (cm^3) and the radius of the seal cup equal to (r=3 cm). The highest value of the activity of Radon in the Dialak2 sample equal to (0.1495 Bq), while the lowest value was in the Dialak1 sample equal to (0.0448 Bq), while the activity of radon gas for other samples ranging between these two values, as listed in Table.2.

For uranium, concentration we can determined through the number of atoms of radon:

$$A_{Rn} = \lambda_{Rn} N_{Rn} \quad (5)$$

We obtained the number of radon atoms in the Dilaik2 sample larger than the rest of the samples, as shown in Table.2.

Using the equation of radiative equilibrium for determine the number of atoms of uranium in the samples from the equation:

$$N_U \lambda_U = N_{Rn} \lambda_{Rn} \quad (6)$$

Where 4.883×10^{-18} sec^{-1}),

The Dialak2 sample contain the largest number of uranium atoms equal to (0.0306×10^{18} atom), while the lowest number of uranium atoms in the Dialak1 sample equal to (0.009×10^{18} atom), as shown in the Table.2.

After calculating the number of uranium, atoms in each sample we can calculated the mass of uranium (W_u (g)) in each sample from the following equation:

$$W_U = \frac{N_U A_U}{N_{av}} \quad (7)$$

Where A_U: mass number of uranium U^{238}, N_{av}: Avogadro number (6.02×10^{23} mol^{-1}).

The uranium mass in the Dialak2 sample is (1.209×10^{-5} g), the bigger than another samples.

Finally, we can calculated the mass of uranium in unit (ppm) from the following equation:

$$C_U(ppm) = \frac{W_U}{W_S} \quad (8)$$

Where (W_S) mass of the sample.

We observed from the table (2) the higher value of the uranium mass in unit (ppm) in the Dialak2 sample equal to (0.0483×10^{-5}) and the lowest value in the Dialak1 sample equal to (0.0142×10^{-5}).

Table.2. show all calculated for milk samples in this present work

Sample	C_a (Bq/m^3)	C_w (Bq/m^3)	A_{Rn} (Bq)	N_{Rn} (atom)	N_U (atom×10^{16})	W_U (gm×10^{-6})	C_U (ppm×10^{-7})
Nido	45.9375	1629.3070	0.09340	0.51488	1.91227	7.5576	3.023
Nactalia	27.5625	977.7438	0.05600	0.30870	1.14650	4.5310	1.812
Novelac	51.4500	1825.1218	0.10463	0.57670	2.14180	8.4640	3.385
Dovelac	27.5625	977.7438	0.05605	0.30870	1.14600	4.5290	1.812
Pediasur	44.1000	1564.3900	0.08968	0.49437	1.83600	7.2560	2.900
Dialak 2	73.5000	2607.3170	0.14950	0.82410	3.06000	12.0900	4.830
Dialak 1	22.0500	782.1950	0.04480	0.24690	0.90000	3.5560	1.420

4. CONCLUSIONS

From our results we can observed that the radon activity depends on consternation of radon in materials. ^{222}Rn concentration in the milk samples varies from 782.1950 Bq/m^3 to 2607.3170 Bq/m^3 with mean 1480.545 Bq/m^3. Also activity of radon highest in Dialak2 and lowest in Dialak1. In our research, it calculated the number of radon and uranium atoms, and mass of uranium. The less values of radon activity for all calculated samples its find in Dialak1 children milk. Finally, we recommend using milk Dialak1 which contains the radioactive less activity than other types of milk, so for the safety of our children.

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