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Measuring and Study the Uranium Concentration in Different Types of Powder Milk

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Abstract
The uranium concentration and the related radiation hazard in eight types of powder milk were estimated. The uranium concentration in these sample is measured by using the solid- state nuclear track detectors technique. The result show that the maximum uranium concentration was found in(NaNa-NaNa) (2.804 ppm), While the minimum concentration was found in (Guigoz) (1.272 ppm). The result show that the average hazard index of these samples was up to (0.18) , which is the limit being less than 1, and the effective dose average was around (0.677mSv/h).
Keywords: uranium, effective dose , CR-39.

Introduction

The knowledge of radionuclides distribution and radiation levels in the environment is important for assessing the effects of radiation exposure due to both terrestrial and extraterrestrial sources. Natural background radiation is of terrestrial and extraterrestrial origin. Terrestrial radiation is due to radioactive nuclides present in varying amounts in rocks, building materials, water, soils and atmosphere. Some of these radionuclides from these sources are transferred to man through food chain or inhalations, while the extraterrestrial radiation originates from outer space as primary cosmic rays [1]. The radioactivity measurements in environment and 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. Another important fact is that, importation of contaminated food from any region that suffered a nuclear accident, can indirectly affect people's health [2]. Among different kinds of foodstuffs milk is a reliable indicator of the general population intake of certain radionuclides,since fresh milk is consumed by a large segment of the population, and contains several biologically significant radionuclides[3] . By these considerations, the aim of the present study has been to determine the activity concentration of uranium, in different powder milk samples and to estimate its effective ingestion dose.

Solid state nuclear track detectors (SSNTDs) are used for measuring concentration and spatial distribution of isotopes if they emit heavy charge particles, either directly or as a result of specific nuclear reactions[4]. The damage caused by these particles along their path is called track (latent track), may become visible under an ordinary optical microscope after etching with suitable chemicals [5]. The latent track can be observed after using a chemical etchant analysis, which makes to analyze the damage regions, where the damage regions have a high activity and effectiveness (in comparison with undamaged regions). The shape of the etched track depends on the charge, velocity of the incident particle, concentration and temperature of the etchant solution, in addition to the environmental circumstances.[6].

CR-39 is organic detector which is used in this work. The chemical composition for this material is (C12H18O7) and has density (1.32g.cm-3). The use of the CR-39 plastic as a nuclear particle detector has become generalized in the field of dosimetry, spectroscopy and environmental science due to its high sensitivity [7].

The detector sheets of 500μm thick were cut into small pieces each of (1.6cm × 1.6cm) area. The irradiation source consists of a rod of (Am – Be) surrounded by a paraffin wax, which is used to moderate the fast neutrons to thermal neutrons energies. (Am – Be) neutron source which is used for irradiation the samples with thermal flux (10^5 $n.cm^{-2}.s^{-1}$). It emits fast neutrons from the (α, n) reaction such as:

$$^{9}_{4}Be + ^{4}_{2}He \rightarrow ^{12}_{6}C + ^{1}_{0}n + 5.7M.eV$$

Materials and Methods

The eight samples was pressed into a pellet of (1.6 cm) diameter and (1.5 m) thickness. these were put in contact with (CR – 39) detector in a plate of paraffin wax at a distance of (5 cm) from the neutron source as shown in Fig.(1)[8].

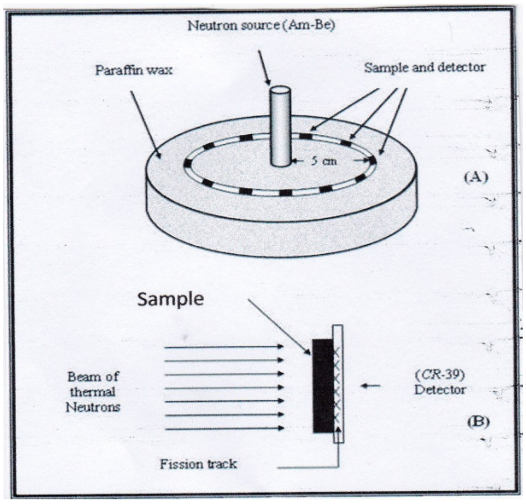

Figure.1: (CR-39) Detector for Powder Milk Sample [9].

After irradiation for 7days, (CR – 39) detectors were etched in (N=6.25) NaOH solution at temperature of 60 °C for (7hr) then washed by distilled water and dried. The induced fission tracks densities were recorded using optical microscope.

The density of the tracks in the detectors was calculated according to the following relation:

$$\rho_x = \frac{N_{ave}}{A} \quad \text{..(1)}$$

where

ρ_x: Track density Track / *mm2*.

N_{ave}: Average of total tracks.

A: Area of field view.

The Uranium concentrations in the samples have been measured by comparison between track densities registed on the detectors of the unknown samples and that of the standard samples according to [10]:

$$\frac{C_x}{\rho_x} = \frac{C_s}{\rho_s} \quad \text{..(2)}$$

where

C_x, C_s : Uranium concentration (*ppm*) for standard and unknown sample respectively.

ρ_x, ρ_s: track density (*track/mm2*) for standard and unknown sample respectively.

The ratio of (ρ_s/C_s) deduced from the calibration curve shown in Fig.(2), where:

$$Slope = \frac{\rho_s}{C_s} \quad \text{..(3)}$$

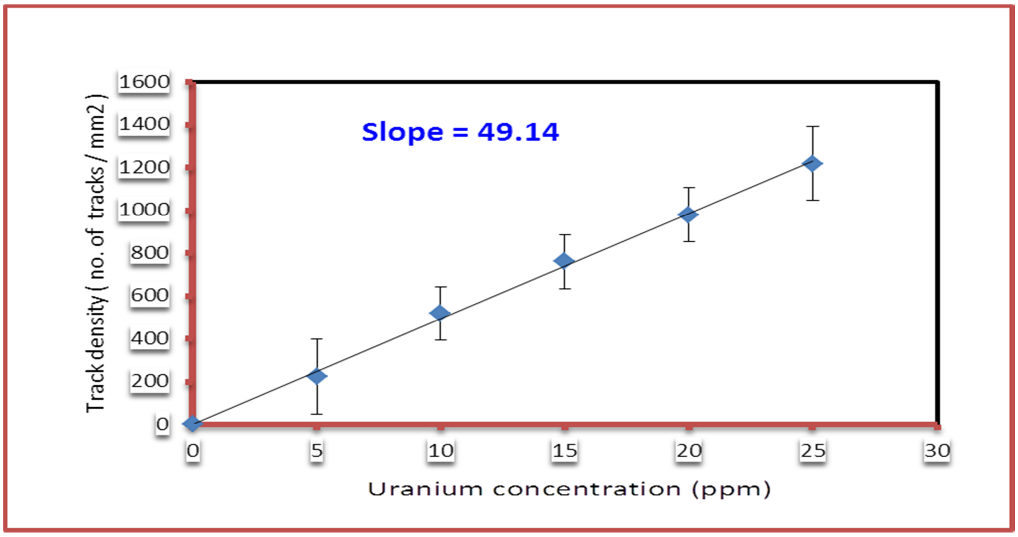

Figure.2:The relationship between the track density and uranium concentrations for standard samples

Absorbed dose:

Absorbed dose was calculated by the following equation [11]:

$D_{Ti} = 1.6 \times 10^{-10} \times S.A \times E$ …………………………..(4)

Where : D_{Ti} is the absorbed dose in the organ or tissue.

$S.A$ specific activity in (Bq / g) of the radionuclide in the tissue

E energy of alpha or beta particles in (MeV)

Equivalent Dose:

Equivalent dose (H_{Ti}) in organ or tissue of a certain type of radiation was calculated from multiplying absorbed dose (D_{Ti}) in this tissue of the specific type of radiation by the radiation weighting factor for this type of radiation W_R [12]:

$H_{Ti} = D_{Ti} \times W_R$ …………………………………………..(5)

Effective Dose:

The effective dose (E) can calculated from following relation [12]:

$E = \sum W_{Ti} \times H_{Ti}$ ………………………………………..(6)

Where: W_{Ti} is the weighted factor for each organ or tissue.

Hazard-Index: H_{ex}

Hazard-Index illustrates how dangerous process resulting from inhalation, ingestion as in the following equation [13]:

$H_{ex} = \frac{(S.A)^{238}U}{185} \leq 1$ ……………………………………..(7)

Where: $(S.A)^{238}U$ represents a specific radioactivity of uranium. When the value of this factor is one or more, it means that there is a risk and be outside the scope of permissible limits [13].

Results and discussion:

The track Density, Concentration and activity concentration for different types of baby milk is represented in table (1). Fig (1), show that the maximum value of uranium concentration was (34.629 Bq/kg) in NaNa milk . and the minimum value was (15.709 Bq/kg) in Guigoz milk. As well as , the values of absorbed dose, effective Dose, and Hazard-Index for different types of baby milk are calculated and shown in Table (2). The table (2) show that the hazard index is within the allowable limits set by the World Health Organization and the effective dose values which are within the permissible limits of exposure which (1mSv/y) is set by the World Health Organization and the International Atomic Energy Agency.

Conclusion

Natural radioactivity such as uranium radionuclides were determined for most available powder milk samples collected from the local markets. The measured activities for uranium were below the detection limits when compared to World Health Organization (WHO) standard. Moreover, radioactive contamination is as the result of drinking contaminated milk from exposed animals. A long accumulation of high concentration of the natural radionuclides is capable of causing serious health impairment . It will be advisable that the milk from cow, goat and sheep should be checked periodically over a long period because of their grazing habits. Regular monitoring of these radionuclide's in milk and in other food to prevent excessive buildup of radionuclides in the food chain.

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Table (1). The values of track Density, Concentration and activity concentration for different types of baby milk.

Sample	Track Density ($track/mm^2$)	Concentration (ppm)	Activity concentration (Bq/kg)
Similac	247.041	1.398	17.265
Dielac	318.047	1.799	22.218
Guigoz	224.852	1.272	15.709
Novalac	276.627	1.565	19.328
Liptomil	431.953	2.444	30.183
NaNa-NaNa	495.562	2.804	34.629
France Lait	380.178	2.151	26.565
S-26 Gold	470.414	2.661	32.863

Table (2). The values of absorbed dose, Effective dose and Hazard index for different types of baby milk.

Sample	D (Gy/h)	E (mSv/h)	H (ex)
Similac	0.000392139	0.470566562	0.093324
Dielac	0.000504636	0.605563155	0.120097
Guigoz	0.000356797	0.428156972	0.084914
Novalac	0.000438996	0.5267947	0.104476
Liptomil	0.000685544	0.822653375	0.163151
NaNa-NaNa	0.000786526	0.94383142	0.187184
France Lait	0.000603369	0.724042902	0.143595
S-26 Gold	0.000746415	0.89569817	0.177638

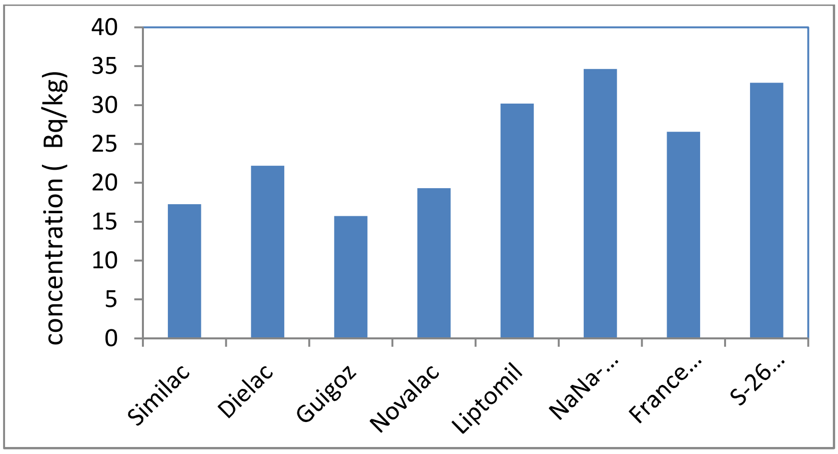

Figure (3). Activity concentration of uranium in milk samples

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