

Determination of Alpha Particles Concentration in Toothpaste Using CR-39 Track Detector

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Abstract

The present study focuses on determination of alpha particles concentration in different samples of toothpaste by using nuclear track detector (CR-39). Nine samples of toothpaste have been collected from local Iraqi markets in Babylon Province. These samples have been chosen according to their most commonly use in Babylon Province. The samples were kept with CR-39 detector for six weeks period and then etched by 6.25 N of NaOH solution at temperature of 60°C for 5 hours. The results of the present work show that Sample 3 (Frosty) found to have a high alpha concentration about four times compared with Sample 4 (Aquafresh) and about 2 - 3 times compared with other samples.

Keywords

Alpha Concentration, CR-39 Detector, Fission Track Technique, Toothpaste

1. Introduction

The radioactive elements emit ionizing radiation like alpha particles (α), beta particles (β) and gamma rays (γ), and it is well-known that all these types of ionizing radiation have a biological effect on the living system. Alpha particles will travel only about (30 μm) in soft tissue and, therefore, are unable to penetrate paper, glass, or even dead superficial layer of skin. Beta particles have greater ability to penetrate the skin. In contrast, γ -ray is extremely penetrating. As such, a γ -ray presents a hazard both internally and externally. Radioactive elements emit alpha particles, which in direct physical contact, the insoluble parts of these particles enter the body of an exposed person, will stay there and consequently ionize the body organ and the tissue surrounding it and causing different types of cancer [1].

The health effects of alpha particles depend heavily upon how exposure takes place. External exposure is of far less concern than internal exposure, because alpha particles lack the penetration power of the outer dead layer of skin. However, if alpha emitters have been inhaled, ingested (swallowed) or absorbed into the blood stream, sensitive living tissue can be exposed to alpha radiation. The result of biological damage increases the risk of cancer; in particular, alpha radiation is known to cause lung cancer in humans when alpha emitters are inhaled [2].

The significant accumulation of radionuclide in and on the tissues, directly or indirectly exposed due to the lipsticks, toothpaste, vermilion, may cause health hazards [3].

The uranium concentrations have been determined for eleven building construction materials by using the fission track technique by L. A. Najam *et al.* [4]. Their results found that uranium concentration ranged between 0.22 ppm in ceramics and 1.86 ppm in marble and they were all below the allowed limit of 11.7 ppm.

Al-Hamzawi *et al.* [5], have used the fission track technique to determine trace concentration of uranium in human blood samples from two groups of male and female participants: leukemia patients and healthy subjects group. The blood samples of leukemia patients and healthy subjects were collected from three key southern governorates namely, Basrah, Muthanna and Dhi-Qar. Their results showed that the highest recorded uranium concentration in the blood samples of leukemia patients was 4.71 ppb (female, 45 years old, from Basrah) and the minimum concentration was 1.91 ppb (male, 3 years old, from Muthanna). For healthy group, the maximum uranium concentration was 2.15 ppb (female, 55 years old, from Basrah) and the minimum concentration was 0.86 ppb (male, 5 years old, from Dhi-Qar).

The aim of the present work is to determine alpha particles concentration in toothpaste samples which are available in the local market in Babylon Province in Iraq by using alpha-emitters registrations in (CR-39) nuclear track detector.

2. Experimental Part

The CR-39 plastic track detector is a $C_{12}H_{18}O_7$ polymer with density 1.3 g/cm^3 . In this work we used CR-39 produced by Fukuvi Chemical Industry Co., (Japan) in 1996. The concentrations of alpha particles emitted from the radioactive elements (U^{238} , Th^{232} , Ra^{226} and Po^{218}) from nuclei in toothpaste samples were determined by using the nuclear track detector (CR-39) of thickness $250 \mu\text{m}$ and area of about $(1 \times 1 \text{ cm}^2)$. The measurements carried out in the laboratories of department of physics, college of education for pure sciences, University of Babylon. The samples of 1 g weight were pressed in to a pellet of 1cm diameter and 1mm thickness using a mechanical press, and covered with nuclear track detector (CR-39) (see **Figure 1**) at distance of 5 cm from the neutron source (Am-Be), with thermal neutron flux $(5 \times 10^3) \text{ n}\cdot\text{cm}^{-2}\cdot\text{s}^{-1}$.

After the irradiation time six weeks the CR-39 was etched in 6.25 N (by NaOH solution) at temperature of 60°C by thermostat water bath for 5 hours. The detectors were then taken out from the etchant, rinsed with distilled water and dried in air. The tracks density were recorded using an optical microscope (type ALTAY BIO-1007) with magnification of $(400\times)$ connected with camera 5.1 mp.



Figure 1. Shows samples covered with nuclear track detector (CR-39).

The density of tracks (ρ) in the samples were calculated according to the following relation [6].

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

Fission track technique was used for determination alpha particles concentration in the toothpastes samples by making a comparison between track densities registered on the detectors of the sample and that of the standard sample. The alpha particles concentration in the unknown samples were determined by using the following relation [4], which is shown in **Figure 2**.

$$C_x = \rho_x (C_s / \rho_s) \quad (2)$$

C_s, C_x : Alpha particles concentration (ppm) for standard and unknown sample respectively.

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

The big and irregular pit appeared because damage of detector by chemical abrasive as marked with the red circle, while the pit of alpha particle small and regular, as marked with blue circle, as shown in **Figure 3**.

3. Results and Discussion

Table 1 presents alpha particle concentration for toothpaste for the samples under study. We find that the highest average alpha particle concentration in samples is found in Sample 3 (Frosty) which is (1.96 ppm), while

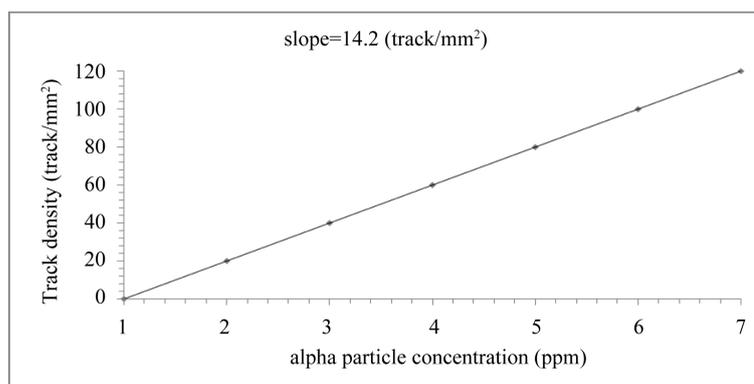


Figure 2. Alpha particles concentration for standard samples.

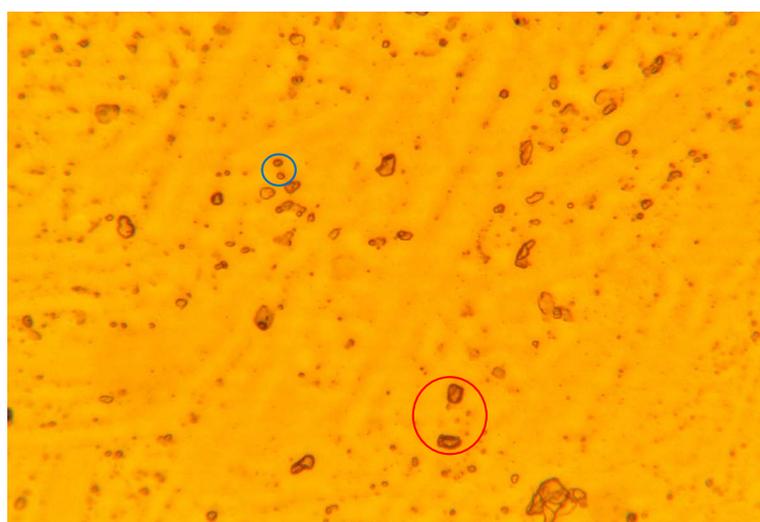


Figure 3. Shows the etched track in sample No. 3, which we obtain from optical microscope.

Table 1. Alpha particles concentration for toothpaste samples.

No. of sample	Brand	Country of made		Samples				
				1	2	3	4	Mean
1	Signal	France	Track density (track·mm ⁻²)	5	7	5	13	7.5
			Alpha particles concentration (ppm)	0.35	0.49	0.35	0.91	0.525
2	Sanino	Turkey	Track density (track·mm ⁻²)	13	11	20	7	12.75
			Alpha particles concentration (ppm)	0.91	0.77	1.4	0.49	0.892
3	Frosty	China	Track density (track·mm ⁻²)	30	33	29	20	28
			Alpha particles concentration (ppm)	2.1	2.31	2.03	1.4	1.96
4	Close up	Indonesia	Track density (track·mm ⁻²)	8	5	9	11	8.5
			Alpha particles concentration (ppm)	0.56	0.35	0.63	0.77	0.595
5	Aquafresh	Turkey	Track density (track·mm ⁻²)	3	8	7	10	7
			Alpha particles concentration(ppm)	0.21	0.56	0.49	0.7	0.49
6	Sanino	China	Track density (track·mm ⁻²)	6	8	12	11	9.25
			Alpha particles concentration (ppm)	0.42	0.56	0.84	0.77	0.647
7	Signal2	Turkey	Track density (track·mm ⁻²)	11	8	9	12	10
			Alpha particles concentration (ppm)	0.77	0.56	0.63	0.84	0.7
8	Colgate	Brazil	Track density (track·mm ⁻²)	17	9	14	8	11.25
			Alpha particles concentration (ppm)	1.19	0.63	0.98	0.56	0.787
9	Crest	Germany	Track density (track·mm ⁻²)	10	8	5	6	7.25
			Alpha particles concentration (ppm)	0.7	0.56	0.21	0.42	0.507

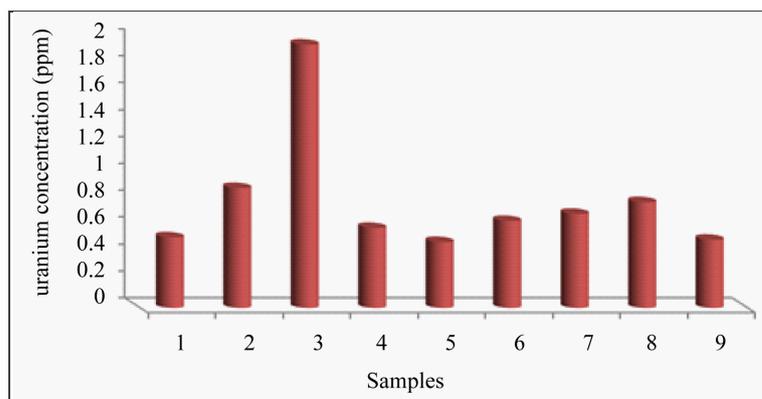


Figure 4. The concentration of alpha particles for toothpaste samples.

the lowest average alpha particle concentration is found in Sample 5 (Aquafresh) which is (0.49 ppm) as shown in **Figure 4**. All the results obtained are within the international levels as given by UNSCAR (United Nations Scientific Committee on the Effect of Atomic Radiation) data [6]. The concentration of alpha particles in toothpaste is related to the amount and quality of fluoride exists in toothpaste.

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