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MEASUREMENT OF ALPHA EMITTER'S CONCENTRATION IN SOME SOFT DRINKS

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Abstract

Solid State Nuclear Track Detectors CR-39 (SSNTD) have been used for the measurement of concentration of alpha emitters (Uranium, radon, thorium, etc and their daughters) in some commonly used soft drink samples. This detector is sensitive to all alpha energies, with the capability of registering the tracks on both sides of the detector sheet. By analysing ten type samples, the highest concentration of alpha was found to be 57.5 ± 4.55 ppm by wt. and the lowest was 2.4 ± 1 ppm by wt. The average value is 16.85±1.79 ppm by wt., which is higher, compared to mineral water and lower than condensed milk.

1. INTRODUCTION

The alpha-emitting radioactive substances are harmful to normal tissues of human body because of their high attenuation power. Alpha emitters like uranium, thorium and their daughters are consumed in trace amounts by living species through their food chain and from the environment[1]. At present, soft drinks is a very common item in our daily food menu and there are various kinds of soft drinks in the market supplied by various companies. These soft drinks contain many organic molecules, minerals, water, sugar etc. But at the same time these items also contain a little amount of radioactive substances like alpha emitters that pose a great hazard by emitting alpha particles. These alpha particles may cause damage to normal tissues of various organs by their chemical and radioactive toxicity effects[2]. For this reason measurement of the concentration of alpha emitters have been done in various soft drinks samples, which are available in Bangladesh as well as other countries in this subcontinent. A few identical researches have been carried out in this region which may vary from one another[3]. So, the measurement of alpha emitter's concentration in soft drinks is necessary to investigate the role of alpha emitter in causing various diseases, especially cancer.

2. EXPERIMENTAL

In this study, ten types of widely-used soft drinks samples which are available in market were analyzed. For each sample about 500 cc of soft drinks was kept in a small clean vial (30 cm height and 9 cm diameter) and marked with a proper number for identification.

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Solid State Nuclear Track Detectors (SSNTD) with sheet thickness 300 μm are used in this study, which is usually known as CR-39 plastic detector[4,5]. The detectors are small rectangular pieces of size 1.0 cm × 1.5 cm were covered with plastic properly and hung inside the sample of the vial[6].

The open mouths of vial were closed properly and then preserved it in a suitable place free from disturbance. After completion of the exposure, these were etched in 6N NaOH solution at a constant temperature of 71°C for four hours in a constant water bath. After removal, the detectors were etched with a sharp pin simultaneously in a beaker. For immersing a detector in the beaker and to let it stand erect each detector was fixed with a paper clip properly at the bottom of the beaker[7].

The central portion of the detector strips was scanned by using a binocular research microscope at a magnification of 450 (45× objective and 10× eyepiece). The total circular field of view was chosen as a single field of view[8]. Alpha tracks were searched inside the circle and counted. Then the sliding base of the microscope was moved so that the beginning of the next field of view coincides with the end of the first field of view. The counts of each field of view was recorded in each block and after completion of scanning of a detector the counts were added and the number of blocks gave the average number of alpha track per cm^2 area of the field of view. To measure the area of a field, a standard calibration scale was used with the smallest division equal to 0.01mm.The standard scale was placed under the microscope along the horizontal and vertical sides of the fields successively and reading was taken in both sides.

The mathematical expression for track density is given by the relation

$$\rho_T = \frac{\sum_{i=1}^{n} N_i}{n \times A} \quad \text{--- --- --- --- --- --- ---} \quad (1)$$

Where, ρ_T = Track density (tracks per cm^2), $\sum_{i=1}^{n} N_i$ = Total number of tracks, n = Total number of fields counted, A = Area of the field of view.

It is usually assumed that track counts follow poissonian distribution, so the error σ (ρ_T) in the track density is given by

$$\sigma(\rho_T) = \frac{\sqrt{\sum_{i=1}^{n} N_i}}{n \times A} \quad \text{--- --- -- --- --- --- ---} \quad (2)$$

To measure background correction, an important parameter, detectors were placed in empty vials and were exposed for a long time. The detectors were etched simultaneously so that the etching conditions were exactly identical for both the background and experimentally exposed detectors. These detectors were then scanned under a microscope. Then the tracks were counted and track density was determined. The average of the background track density was subtracted from all the observed track densities[9].

3. RESULTS AND DISCUSSION

The alpha track density of different soft drinks samples are presented in table 1. The corresponding alpha emitters concentration expressed in parts per million (ppm) by weight is also presented in the same table.

Fig. 1 Shows the concentration of alpha emitters in different soft drinks samples. From table 1 it is seen that the highest value of the concentration of alpha emitters was 57.5±4.55 ppm by wt and the lowest value of the concentration of alpha emitters was 2.4±1 ppm by wt. The average concentration of alpha emitters was 16.85±1.79 ppm by weight.

The comparison of concentration of alpha emitters in soft drink, condensed milk and mineral water sample presented in the table 2. Fig. 2 shows the comparison of concentration of alpha emitters in soft drinks, condensed milk and mineral water samples.

Table 1: Concentration of alpha emitters in different soft drinks samples (500ml)

Sample	Track density cm^{-2}	Alpha emitters concentration (ppm by wt.)	Average alpha emitters concentration (ppm by wt.)
1	100±2.3	33±1.95	
2	82±1.96	23±1.8	
3	34±1.1	5.1±1.3	
4	133±30.9	57.5±4.55	
5	71±15.6	18±1.77	16.85±1.79
6	30±9.3	4.2±1.5	
7	75±16.3	21±1.75	
8	55±10.7	12.25±1.55	
9	36±11.1	5.68±1.32	
10	22±9.7	2.4±1	

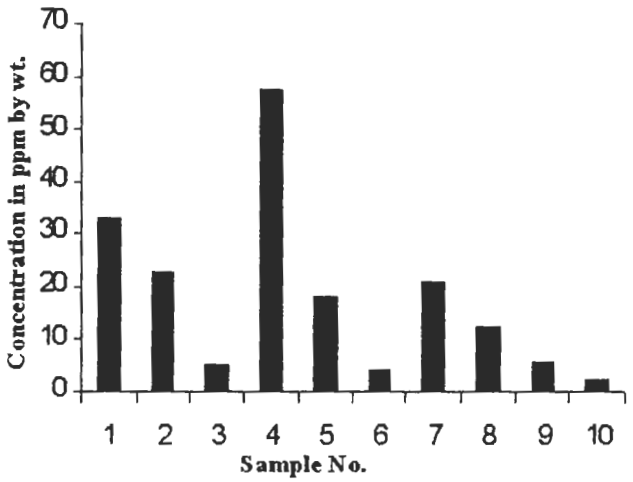

Fig. 1: Concentration of alpha emitters in different soft drinks samples

Table-2: Comparison of concentration of alpha emitters in soft drinks, condensed milk and mineral water sample[10]

Sample	Soft Drinks	Condensed Milk[10]	Mineral water[10]
Average concentration in ppm by wt.	16.85±1.79	18±1.67	5.77±1.34

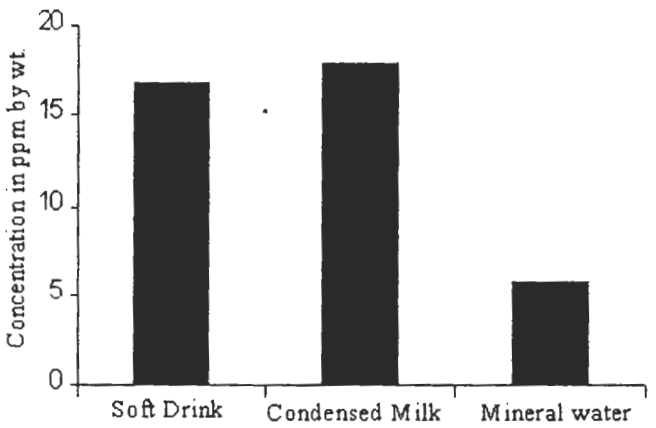

Fig. 2: Comparison of concentration of alpha emitters in soft drinks, condensed milk and mineral water samples

Alpha emitting radionuclides are radioactive isotope (Uranium, Radon, etc) due to which the internal body tissues are irradiated continuously until the isotope is eliminated through the urine and faeces or else loses its radioactivity by natural decay. Such a radiation effect may cause somatic mutation in the cell, which may alter the control mechanism of the cell leading to the unregulated division or cancer.

4. CONCLUSIONS

Concentration of alpha emitters in some commonly-consumed soft drinks sample in Bangladesh has been measured by using solid state nuclear track detector (SSNTD). This method is a well combination of simplicity, accuracy and reliability for measuring alpha emitters concentration in liquid samples. If these emitters remain in liquid food like soft drinks, which is a very common item in our everyday life, they will pose more harm to human body. But there is no standard level in this case for this region and people are also not aware about the harmful effects of radiation. But it is necessary to maintain a maximum permissible level of radiation in liquid food staffs like soft drinks [11,12]. This result would help in that purposes. Based on this technique further extensive measurements for other liquid food samples are required.

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