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URANIUM ESTIMATION IN TOOTHPASTES AND FRUIT JUICES USING SOLID STATE NUCLEAR TRACK DETECTORS

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ABSTRACT

A fission track analysis has been used to estimate the uranium concentration in some toothpastes manufactured in India and fruit juices derived from the fruits available in the local market of Amritsar. The uranium content in these toothpastes has been found to vary from 0.91 to 3.56 ppm. The uranium content in fruit juices has been found to vary from 0.25 to 1.69 ppb. The present investigations have been carried out with an aim to estimate the level of U content in these materials for the studies of radiation health hazards.

KEYWORDS

Fission track ; U content ; toothpastes ; fruit juices.

INTRODUCTION

The solid state nuclear track detector (SSNTD) technique, because of its simplicity and applicability has attracted many users in diverse fields such as anthropology, archaeology, biology, medical sciences and industrial technology (Fleischer, Price and Walker, 1975). The heaviest naturally occurring trace element, uranium plays an important role in these investigations. The technique has already been explcited by various authors (Fleischer and Lovett, 1968; Abdullaev, Zakhavataev and Perelygin, 1969; Carpenter and Cheek, 1970; Fisher, 1970; Chakravarti, Lal and Nagpaul, 1979; Suri, Singh and Virk, 1981) for the trace determination of uranium in semiconductors, water, milk powders, human blood, plants, soils, Indian Cigarettes (tabacco), tea leaves, portland cement, detergents and soaps, coal, flyash and steel etc. In our laboratory, we have applied this technique for the trace determination of uranium in some toothpastes manufactured by various agencies in India and fruit juices derived from the fruits available in the local market of Amritsar.

Toothpastes consist of various agents such as polishing agents or abrasive materials, humectants, binders, sweetening agents, flavouring agents, surfactants, flourides (which act as germicide) and water. Materials used under these subheadings may vary from one manufacturer to another depending upon their formulation. Minerals, inorganic and organic matters present in the toothpastes are generally contaminated with minor amounts of uranium.

Fresh fruits contain moderate sugar content, an adequate concentration of nitrogeneous constituents, small amount of metals (calcium, cobalt, copper, iron, magnesium, potassium and zinc) and non metals such as phosphorus, sulphur and iodine etc.

EXPERIMENTAL TECHNIQUE

For uranium estimation in toothpastes, we followed the external detector

method as suggested by Fleischer, Price and Walker (1975) and Fisher(1970) for bulk determination of uranium in homogeneous solids. Toothpastes were dried in an oven at 200°C for 24 hours. 50 mg of dried powder was homogeneously mixed with 100 mg of methyl cellulose used as a binding material. The mixture was pressed into a pellet by a specially designed hand pressing machine. The pellets were then covered on both sides with lexan plastic discs of the same diameter as the pellet. One such pellet was made of the standard glass dosimeter of known U content (20ppm). The pellets covered with lexan discs were enclosed in an aluminium capsule and were irradiated with a thermal neutron dose of $5X10^{15}$(nvt) from CIRUS Reactor of B.A.R.C., Trombay. After irradiation, the lexan discs were etched in 6N NaOH at 70°C for 30 minutes and were scanned for fission track density.

The uranium concentration was calculated using a simple relation for external detector method (Fleischer, Price and Walker, 1975):

$$U_x = U_s \left(\frac{T_x}{T_s}\right)\left(\frac{I_s}{I_x}\right)\left(\frac{R_s}{R_x}\right) \qquad (1)$$

Where the subscripts x and s stand for unknown, and standard respectively, U, the uranium concentration; T, the fission track density; I the isotopic abundance ratio of U^{235} to U^{238} and R the range of fission fragments in mg/cm^2. The correction factor (R_s/R_x) approaches unity for most of the silicate materials and plastics (Fleischer, Price and Walker, 1975).

The experimental technique for uranium estimation in fruit juice is the same as that reported for liquid phase materials (Fleischer and Lovett, 1968; Chakravarti, Lal and Nagpal, 1979; Suri, Singh and Virk, 1981). A known volume (0.1 cc) of each sample of fruit juice was taken on the surface of lexan polycarbonate plastic disc and was allowed to evaporate in dust free atmosphere. The non-volatile constituents of the juice were left over the disc in the form of a thin film. The dried specimens covered with lexan discs were enclosed in an aluminium capsule and were irradiated with a total integral thermal neutron dose of $5x10^{16}$ (nvt). A standard glass sample of known uranium content (20 ppm) serving as a thermal neutron flux dosimeter was also exposed alongwith the samples. After irradiation the lexan discs were etched. The induced tracks were counted over the entire surface of the detector discs and the uranium concentration was calculated using the formula (Fleischer and Lovett, 1968):

$$C_w = \frac{TM}{VGN_A E \sigma \phi} \qquad (2)$$

Where T is the total number of fission tracks, $G \simeq 1$, M = 238, V = 0.1 cc, $N_A = 6.023x10^{23}$, $\sigma = 4.2x10^{-24}$ cm^2 and $\phi = 5x10^{16}$ (nvt).

RESULTS AND DISCUSSION

The uranium content of various toothpastes calculated by using Equation(1) is given in Table 1. The uranium content has been found to vary from 0.91 to 3.56 ppm. Signal toothpaste manufactured by Hindustan Lever Ltd., Bombay has a minimum uranium content of 0.91 ppm, whereas Viccovajardanti manufactured by Vicco Laboratories, Bombay has yielded a maximum content of 3.56 ppm. High value of uranium in Viccovajardanti paste may be due to the presence of minerals derived from the plant sources. The uranium content in the toothpastes is quite low and is not harmful for society.

The uranium content in fruit juices determined by Equation(2) are summarized in Table 2. The present investigations are based on the uranium estimation studies in fruit juices extracted from eight different varieties of fruits viz. grapes, orange, loquat, sapodilla, mango, apple, lemon and pine apple. The uranium content have been found to vary from 0.25 to 1.69 ppb. Grape juice has given minimum content of 0.25 ppb. whereas pine apple juice has yielded maximum content of 1.69 ppb.

TABLE 1 U Content in Toothpastes

Sr. No.	Name of Toothpaste	Manufacturing Agency	U Content (ppm)
1	Signal	Hindustan Lever Ltd, Bombay	0.91
2	Close up	Hindustan Lever Ltd, Bombay	1.04
3	Promise	Balsara Hygiene Products, Bombay	1.48
4	Cosmo	Hindustan Rimmer, Delhi	1.78
5	Colgate	Colgate Palmolive Ltd, Bombay	1.82
6	Flash	Flash Laboratories Pvt., Ltd. Bombay	2.41
7	Forhans	Geoffrey Manners and Co.Ltd. Bombay	2.71
8	Binaca	CIBA-GEIGY of India Ltd. Bombay	2.76
9	Neem	Calchemico, Calcutta	2.76
10	Viccovajardanti	Vicco Laboratories, Bombay	3.56

The variation of U content in different fruit juices may be due to the nature of plant producing the fruit and difference in the radioactive contents of the plant growing soil. The uranium content of fruit is directly related with that of the plant producing it which may be used an indication for the mineralized ground. Magnesium and phosphorous being carriers of uranium may be responsible for the variation of U content in fruit juices. The consumption of fruit juice at the rate of even one litre per day is quite safe as the total U intake in whole life span (say of 60 yrs) will only be $\sim$0.37 mg. which is quite low as compared to the maximum permissible human intake of 40 mg/day (Morgan,1973).

TABLE 2 U Content in Fruit Juices

Sr. No.	Fruit Juice	Total No. of tracks	U Content (ppb)
1	Grapes	13358	0.25
2	Orange	33403	0.63
3	Loquat	45573	0.86
4	Sapodilla	63728	1.20
5	Mango	69597	1.31
6	Apple	77113	1.45
7	Lemon	79080	1.49
8	Pineapple	89592	1.69

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