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Assessment of Ingestion Dose and Lifetime Cancer Risk through Marine Food Samples of South West Coast of Kerala

Arunima S[1], P J Jojo[2]
[1]*Department of Physics, Research and Development Centre, Bharathiar University, Coimbatore - 641 046, INDIA.*
[2]*Centre for Advanced Research in Physical Sciences, Fatima Mata National College, Kollam-691001, INDIA.*

Abstract: Human exposure to radionuclides occurs as a result of transport along various environmental pathways. Ingestion of radio nuclides through food items is of more important. Activity concentrations of radio nuclides through marine food items were calculated and the ingestion dose and life time cancer risk was calculated. Ingestion dose estimated is (0.17±0.03) mSvy^{-1} and the life time cancer risk is (426±73) x10^{-6}.

Keywords: Marine food samples, Primordial radionuclides, high background radiation area, Life time cancer risk, Gamma ray spectrometry.

I. INTRODUCTION

Radioactive isotopes of elements (radionuclides) are naturally present in the environment. Humans are exposed to environmental radiation through inhalation of dusts (contaminated with radiation) and gases, ingestion of dusts, soils, water, vegetation, fish or meat and absorption of direct radiation from radioactive sources.[1] Radionuclides in air, soil, water, and rocks that make up earth's geosphere and atmosphere can be transferred into the biosphere by many organisms and can also cause bioaccumulation in the food chain[2]. Background levels of radionuclides in foods vary and are dependent on several factors, including the type of food and the geographic region where the food has been produced. The common radionuclides in food are potassium-40 (^{40}K), uranium- 238 (^{238}U) and thorium- 232(^{232}Th) .When large amounts of radioisotopes are discharged into the environment, they can affect foods by either falling onto the surface of foods like fruits and vegetables or animal feed as deposits from the air or through contaminated rainwater/snow. Radioactivity in water can also accumulate in rivers and the sea, depositing on fish and seafood[3]. The south west coastal region of Kerala on the coast of Arabian Sea is known as a High Background Radiation Area (HBRA) owing to the presence of thorium rich monazite sand available in abundance in the region[4] and the same area is selected for the study. Here, we have analysed 13 varieties of 22 fish samples. Activity concentrations of ^{40}K, ^{238}U and ^{232}Th were analyzed and the ingestion dose was calculated due to the primordial radionuclides based on the results of gamma ray spectrometry. Also life time cancer risk assessment was estimated.

II. MATERIALS AND METHODS

For collection, preparation and analysis of the samples we have followed IAEA Guidelines (Measurement of Radionuclides in Food and the Environment, IAEA, 1989). Locally dried fish samples were collected and its fresh weight is noted..Samples were dried under an IR lamp for 24 hours and further in a hot air oven at 110^{0}c for 24hours. The weights of the dried samples were noted. Dried samples were powdered using a grinder and sieved to get homogenized sample. These fish samples were further fired at about 300-320^{o}C in a muffle furnace to ash the samples. Ashed samples were then transferred to clean empty cylindrical plastic containers of specific size and were hermetically sealed. The samples were shelved for six weeks before gamma spectrometry analysis.

Gamma spectrometry was used for the analysis of gamma emitting radionuclides in environmental samples[5]. The detector used is 5"×4" NaI(Tl) detector based on Gamma ray spectrometry. The detector is housed in a 3" thick graded lead shield and PC coupled 8 K MCA. The measurement was carried out in three main steps: energy calibration, sensitivity calibration and gamma-ray analysis. The energy calibration was carried out by two radioactive calibration sources, ^{137}Cs and ^{57}Co. The sensitivity calibration was achieved by using three artificial standard sources of Ra, Th and K. The activity of ^{40}K was evaluated from the 1460 keV photo peak of its own gamma, the activity of ^{238}U from 1764 keV gamma ray of ^{214}Bi and that of ^{232}Th from 2614 keV gamma ray of ^{208}Tl. The counting times of sample were 60000s for obtaining the net activity. Selecting the respective peaks for the isotopes, the regions of interest (ROI) were selected and the corresponding gross counts were noted. The contribution of background was deducted from the

gross counts and the net activity was determined. The specific activities of the samples were determined using the wet weight of the samples and the ingestion dose was calculated. Minimum Detectable Level (MDL) of the spectrometer for ^{40}K, ^{226}Ra and ^{232}Th were 27.2 Bqkg^{-1},4.7Bqkg^{-1}and 14.3 Bqkg^{-1}respectively.

The ingestion dose has been calculated using the equation (UNSCEAR , 2008)[6].

Ingestion dose, D (μSv y^{-1}) = (C_U DCF_U + $C_{Th}DCF_{Th}$ + C_K DCF_K) I

Where C_U – concentration of U (Bqkg^{-1}),

DCF_U– dose conversion factor for U (^{226}Ra) = 0.28 μSvBq^{-1},

C_{Th} – concentration of Th (Bqkg^{-1}),

DCF_{Th}– dose conversion factor for Th (^{228}Th)= 0.072μSvBq^{-1},

C_K– concentration of K (Bqkg^{-1}),

DCF_K– dose conversion factor for ^{40}K = 0.0062 μSvBq^{-1},

I – annual intake of the marine food as obtained from the dietary habit study(68± 26 kg y^{-1}).

The life time cancer risk (LCR) due to the ingestion of commonly used fish items as proposed by the United States Environmental Protection Agency, USEPA 1999[7]. The assessment of intake of radionuclide through food is based on the activity concentration of the radio-isotopes in fish samples and their average intake rate. The following equation was used to calculate the mortality cancer risk.[8],[9]

$LCR = A_{ir} \times A_{ls} \times R_c$

Where LCR, A_{ir}, A_{ls} and R_c are the lifetime cancer risk, annual intake of radionuclide (Bq), average span of life (70 y) and mortality risk coefficient (Bq^{-1}), respectively.

The values of mortality cancer risk coefficients used in the calculation of LCR were 9.56×10^{-9} (Bq^{-1}) for ^{226}Ra, 2.45×10^{-9} (Bq^{-1}) for ^{232}Th and5.89×10^{-10} (Bq^{-1}) for ^{40}K as suggested by USEPA 1999.

II. RESULTS AND DISCUSSION

The Table 1 shows the results of the gamma spectrometry analysis of marine food samples collected from the local market in the study area. No sample among these had uranium in the measurable amount , that is uranium level was below detectable level of 4.7 Bqkg^{-1}. Thorium was found to present at a low level. Among all the range of thorium was between 14.3 to 30 Bq/Kg. Levels of potassium was found to vary from 82 to 130 Bq/kg in the fish samples.

Table 1.
Activity levels of ^{238}u, ^{232}th and ^{40}k and estimate of ingestion dose and life time cancer risk.

Fish Samples	Uranium (U-238)	Thorium (Th-232)	Potassium (K-40)
	(Bq/kg)	(Bq/kg)	(Bq/kg)
Sardine	2.4±0.3	14.3±4	108±24
Lizard fish	2.4±0.3	18±4	90±14
Pony fish	2.4±0.3	14.3±4	130±34
Crocker	2.4±0.3	23±4	113±20
Pink perch	2.4±0.3	14.3±4	89±26
Tada	2.4±0.3	14.3±4	82±12
Prawn	2.4±0.3	30±6	118±28
Jew fish	2.4±0.3	14.3±4	94±14
Mackerel	2.4±0.3	14.3±4	110±18
False trivelli	2.4±0.3	19±4	85±14
Ribbon fish	2.4±0.3	14.3±4	115±24
Vellakannan	2.4±0.3	22±4	98±14
Eel	2.4±0.3	14.3±4	90±13

Ingestion dose($mSvy^{-1}$)	0.17±0.03
LCR ($x10^{-6}$)	426±73

Ingestion dose estimates have been made with the assumption that the samples contain uranium at a rate equal to half of the minimum detectable level of 4.7 $Bqkg^{-1}$ of the detecting system and also taking the average levels of ^{232}Th and ^{40}K. The estimated dose is (0.17±0.03) $mSvy^{-1}$ .The lifetime cancer risk is calculated and it amounts to (426±73) $x10^{-6}$.

III. CONCLUSION

According to UNSCEAR 2008, typical range of total ingestion dose due to various food items is 0.2 to 1 $mSvy^{-1}$.The obtained value is below this range. The estimated carcinogenic risk was found to be (426±73)$x10^{-6}$ and it is comparable to other areas in the world having thorium rich monazite sand (Khandaker et al., 2015)[10]. Present study concludes that radionuclide intake from consumption of locally available marine samples poses no significant health hazard to public health in terms of the cancer risk.

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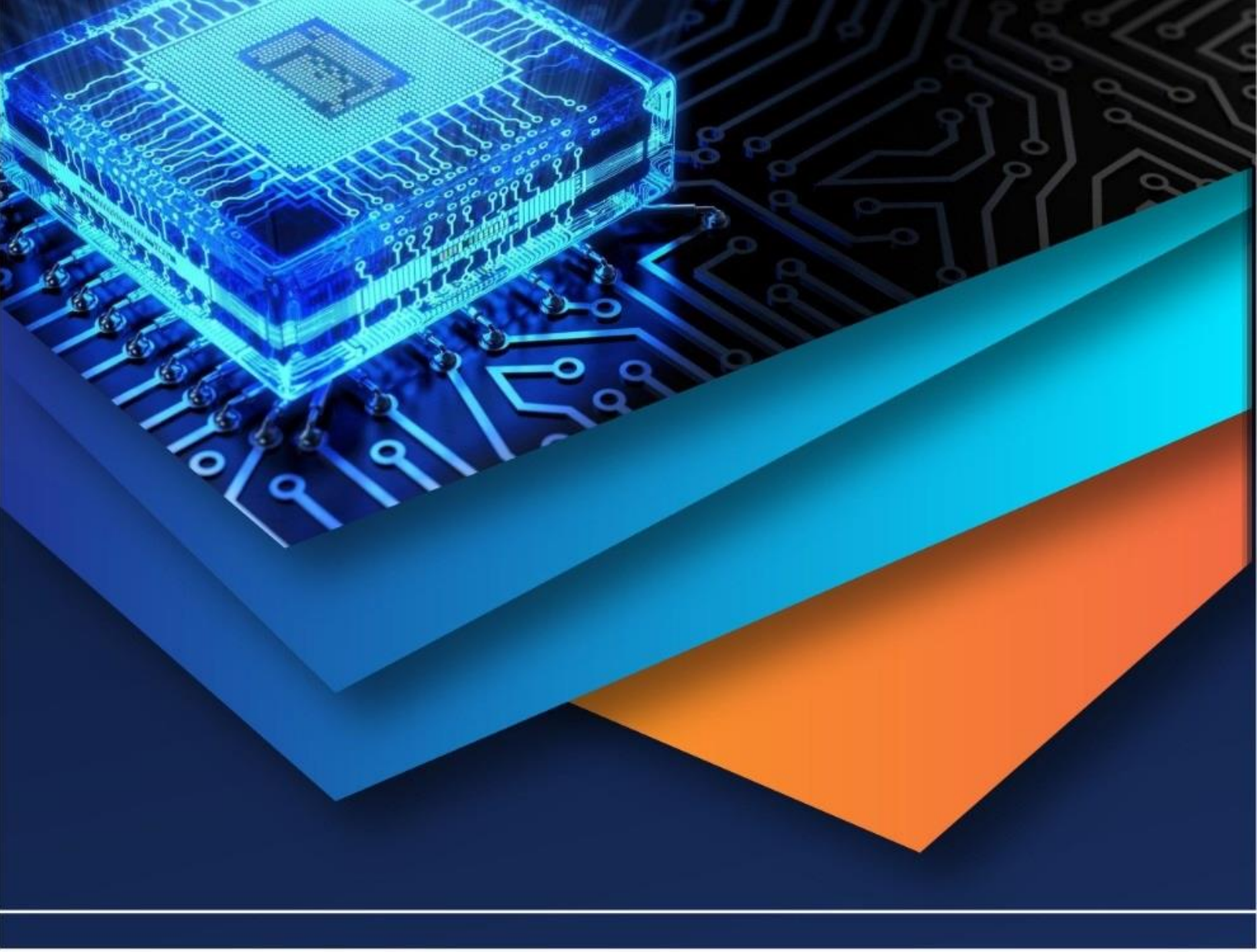

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