Gross Alpha and Beta Radioactivity in Surface Soils of the Agricultural Lands along the Western Regions of Kanya Kumari District; Tamil Nadu; India.

[1]Jani Subha T, [2]Leema Rose G, [3]Vinoth Kumar K C
[1]Associate Professor, [2]Associate Professor, [3]Associate Professor
[1]Department of Chemistry
[1]Rohini College of Engineering and Technology,Kanyakumari,India

ABSTRACT : *In this study, gross alpha and beta radioactivity in the surface soils collected from agricultural lands of Kanya kumari District, Tamil Nadu were measured. The gross alpha radioactivity ranged from 3.95 ± 0.04 to 27.20±0.091 Bqg^{-1}and the gross beta radioactivity ranged from 10.05± 2.65 to 83.35±6.54 Bqg^{-1}.The estimated soil-to-plant transfer factors for gross alpha (TF_α) and beta (TF_β) for the coconut crunch obtained from the coconut plantation in the agricultural lands was also presented. It was found that TF_α varied in the range from 0.035 to 0.139, TF_β varied in the range from 0.035 to 0.107.*

Key words: Gross alpha activity, Gross beta activity, Transfer factor, Coconut crunch

I INTRODUCTION

Radioactivity is an ionizing radiation that is given off by substances, like uranium, as they decay. About half of the ionizing radiation that man is exposed to comes from nature. Radioactivity or radioactive decay is the spontaneous decay or change of one atom into another [1]. It is said that an unstable atomic nucleus loses energy by emitting radiation such as alpha particle and beta particle with neutrino or only a neutrino in the case of electron capture and gamma ray, or electron in the case of internal conversion [2]. A material containing such unstable nuclei is considered to be radioactive. In radioactive decay the decaying nucleus is called the parent radionuclide, and it decays by producing at least one daughter nuclide [3,4]. It is a nuclear transmutation resulting in a daughter containing a different number of protons or neutrons (or both). When the number of proton changes, an atom of a different element is created. At first the decay processes to be discovered are alpha decay, beta decay, and gamma decay. Alpha decay occurs when the nucleus ejects an alpha particle (helium nucleus) and beta decay occurs when the nucleus emits an electron or positron and a neutrino, in a process that changes a proton to a neutron or the converse and the gamma decay occurs when the energy of an excited nucleus is emitted as a gamma ray.

Radiation is a natural part of our environment. Consequently the sources of radiation can be classified into natural background sources and manmade sources. Naturally occurring radiation is found in the food and water that is consumed, and the construction materials used in buildings, while terrestrial radiation comes from soil enriched with naturally occurring uranium and natural forms of energy such as oil and gas. In addition to terrestrial radiation, exposure to radiation comes from space or "cosmic radiation" which increases with altitude. The higher the altitude above sea level, the greater is the exposure to cosmic radiation. Most of the exposure to ionizing radiation comes from the naturally occurring radioactive gas called radon. It is formed from the radioactive decay of uranium, which has been found since the earth formed and has a half-life of 4.5 billion years. On an average, the radiation exposure due to all natural sources amounts to about 2.4 mSv a year and this figure vary significantly, depending on the geographical location.

The areas that have greater dosage of radiation than the country-wide averages are termed as natural high background areas [5]. In the world, exceptionally high natural background radiation areas include Ramsar in Iran, Guarapari in Brazil, Karunagappalli in India[6], Arkaroola in Australia and Yangjiang in China. The highest level of purely natural radiation ever recorded on the earth's surface was 90 µGy/h on a Brazilian black beach composed of monazite [7]. Nearby tourist beaches in Guarapari and Cumuruxatiba were later evaluated at 14 and 15 µGy/h.[8,9]. In India monazite mainly occurs in beach placers and occasionally in inland dunes. Monazite content in the beach sands generally vary from 0.1 to 5.0%. Thorium content in the monazite ranges from 7 to 10% in terms of ThO_2. These areas include the Chavara – Neendakara and Vizhinjam – Kovalam coastal stretch in Kerala and the Midalam – Manavalakurichi – Muttom – Vattakottai coastal stretch and the inland dunes in Tamil Nadu. The NHBRA is widely distributed in other locations of the country. A population of nearly half a million is subjected to radiation exposures ranging between 3 and 20 mSv per capita per year reside in these areas. The highest exposed coastal stretch is the Midalam – Muttom stretch situated at the tip of the southern peninsula. In these areas the isolated villages show radiation exposure upto 45 mSv per capita per year [10].

In the present investigation, the study area comprises of five coastal agricultural lands which lie in and around the natural high background radiation area and five inland agricultural lands located five kilometers interior away from the coastal lands. The coastal soil found here is enriched with natural radioactive minerals and the radioactivity emitted by these minerals are taken up by plants and distributed to the trunk, leaves, fruits etc. As excess radioactivity is harmful to human life it becomes necessary to determine the amount of radioactivity in soil and plants grown in such high radiation background areas. Though the inland areas do not lie under the NHBRA the radioactivity analysis in the soil of inland area will help to ensure the extent of radioactivity

towards the interior areas. Hence the present study on fertility status takes into account the measurement of radioactivity in soil and plant food as an important parameter.

II METHODOLOGY

The present investigation on radioactivity studies in soil samples and plant food was carried out in five coastal agricultural lands in and around the NHBRA and in five inland agricultural lands five kilometers away from the coastal agricultural lands along the western stretch of Kanya kumari district. The vegetative cover found here is coconut. The soil and coconut samples were collected from all the ten agricultural lands during June 2018.

2.1. Processing of soil and coconut samples

The collected soil samples were dried in a hot air oven at a temperature of 150ºC for 4 hours and then cooled. Ten grams of the resulting dried and cooled soil samples were powdered using an agate mortar, packed in polythene bags, labeled properly and were taken to the laboratory for radioactivity analysis. Coconut samples were collected from the respective agricultural lands. Approximately 250g of coconut crunch samples from all the sampling locations were washed thoroughly and dried in a hot air oven at a temperature of 150ºC for 4 hours and then cooled. The cooled coconut crunch were powdered well then taken in a nickel crucible and were burnt to ash in an electric Bunsen burner at a temperature of 400ºC for 4 hours. The ash of the coconut crunch was packed in polythene bags and taken to the laboratory for radioactivity analysis.

2.2. Determination of gross alpha, beta activity and transfer of radioactivity from soil to plant

The gross alpha and beta activity of the soil, coconut crunch samples and percentage of monazite content in the soil samples were determined using alpha counter Am 241 and beta counter K 40. Transfer factor is defined as the ratio of the radioactivity per unit dry weight of plant to the radioactivity per dry weight of soil in the rooting zone [11]. The soil to plant transfer factor was determined according to the relation IAEA, 1994 standard. The dry weight was preferred because the amount of radioactivity per gram dry weight is less variable than the amount per unit fresh weight as it reduces uncertainties [12].

III RESULTS AND DISCUSSION

The present study concentrates on the radioactivity in the soil of agriculture lands along the coastal and inland areas and the uptake of radioactivity by the crop grown in those particular lands. Table 3.1, Table 3.2, Figure 3.1 and Figure 3.2 provide the relative radioactivity in soil and coconut crunch samples along the coastal and inland areas. Table 3.3 and Figure 3.3 depict the transfer factor of alpha and beta radioactivity for soil/coconut in the coastal and inland samples

Table 3.1. Relative radioactivity of soil samples in the sampling locations.

Sampling locations	Activity(Bqg^{-1})	
	Gross α	Gross β
C_1	10.95±0.035	30.99±3.65
C_2	12.39±0.063	37.25±4.12
C_3	15.95±0.42	51.30±2.38
C_4	27.20±0.091	83.35±6.54
C_5	12.35±0.045	37.10±3.10
I_1	3.95±0.04	10.05±2.65
I_2	BDL	BDL
I_3	BDL	BDL
I_4	17.20±0.001	43.55±4.54
I_5	10.35±0.075	31.10±3.80

Table 3.2 Relative radioactivity of coconut samples in the sampling locations.

Sampling locations	Activity (Bqg^{-1})	
	Gross α	Gross β
C_1	0.80±0.015	1.87±0.21
C_2	1.10±0.011	2.75±0.37
C_3	2.22±0.007	3.96±0.27
C_4	1.07±0.017	3.50±0.31
C_5	0.76±0.007	3.13±0.25
I_1	0.20±0.010	1.08±0.11
I_2	BDL	BDL
I_3	BDL	BDL
I_4	0.87±0.017	1.50±0.34
I_5	0.51±0.067	1.13±0.05

Table 3.3. Transfer factor of radioactivity for soil/coconut in the coastal and inland samples

Sampling locations	Transfer x 10^{-2}	
	TF_α	TF_β
C_1	7.2	6.05
C_2	8.85	7.4
C_3	13.9	7.75
C_4	3.95	4.2
C_5	6.15	8.5
I_1	4.9	10.7
I_2	-	-
I_3	-	-
I_4	5.3	3.5
I_5	4.9	3.65

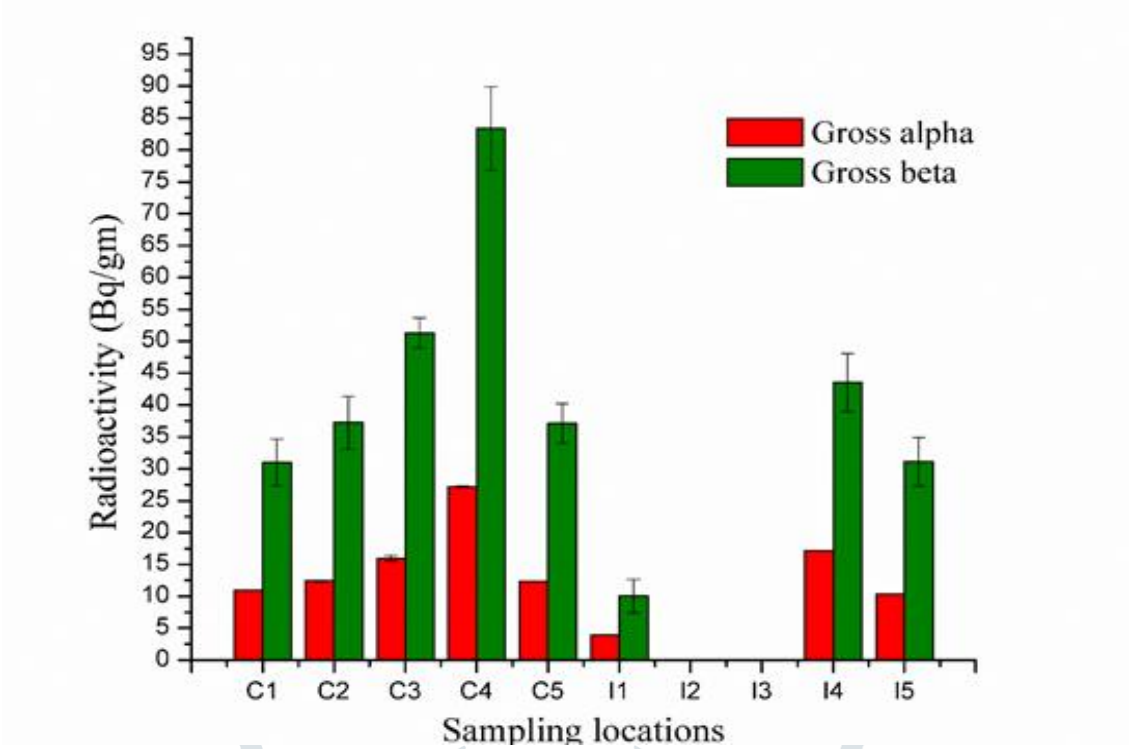

Fig.3.1. Relative radioactivity of soil samples in sampling locations

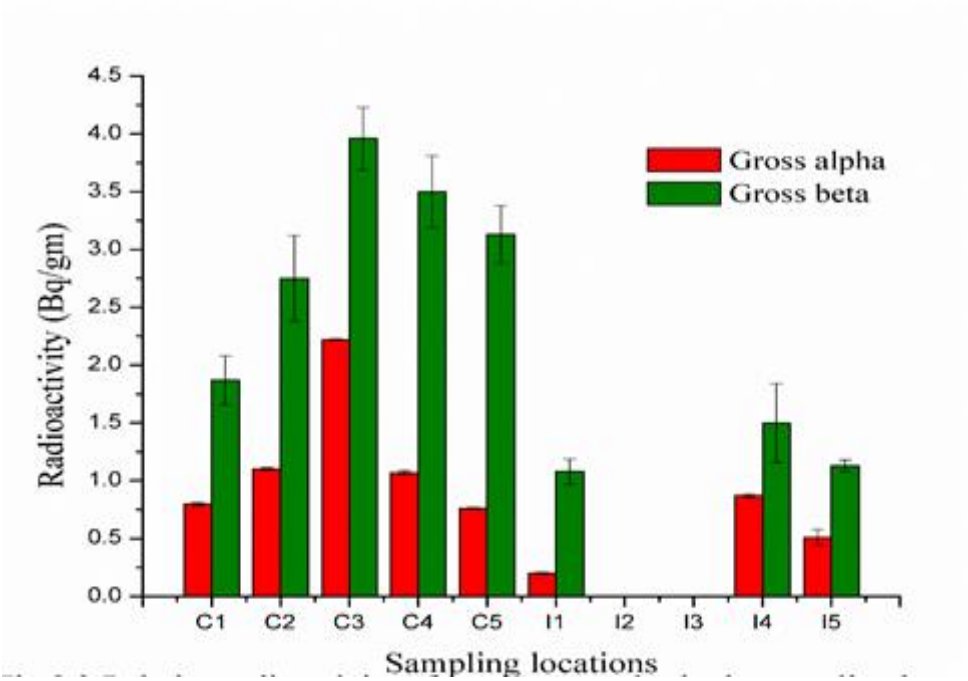

Fig.3.2. Relative radioactivity of coconut crunch samples in sampling locations

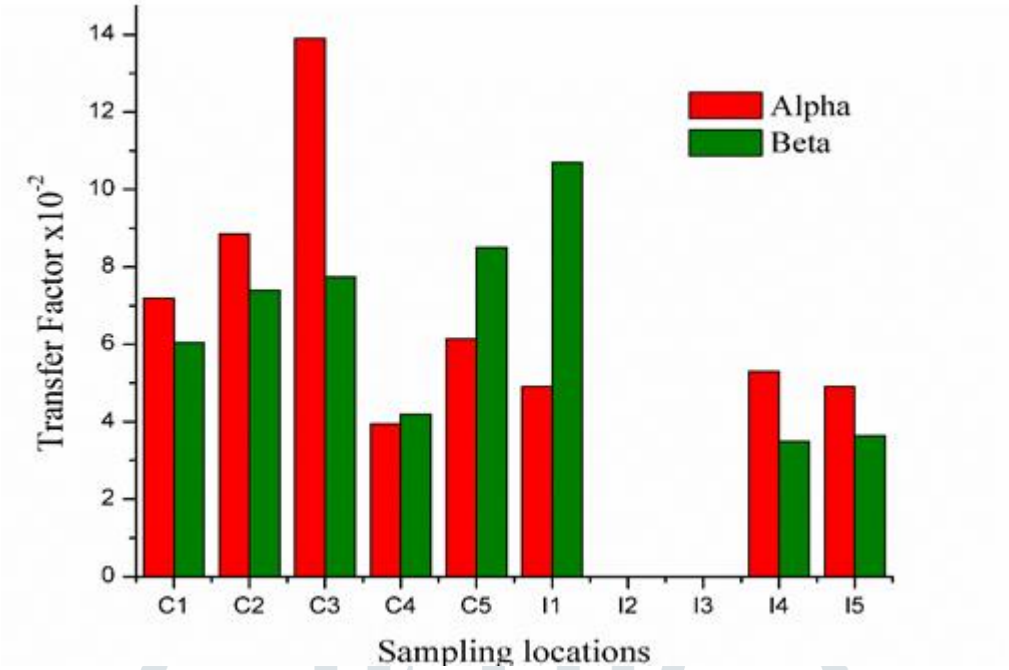

Fig.3.3. Transfer activity of radioactivity for soil/coconut crunch samples in the sampling locations

The above results reveal that the relative radioactivity in the soil samples was the maximum in all the sampling locations. The variations in alpha and beta activity in soil samples were proportionate to the percentage of monazite present in the sampling locations. These results are in correlation with the earlier studies [13, 14, 15]. The sampling locations I_2, I_3 does not lie in the high background radiation region and they are termed as low radiation background areas as they are located far away from the high radiation prone region. Hence the soil of these locations showed insignificant values. The gross alpha and beta activities along the inland area were comparatively lower than the gross alpha and beta activities of coastal area. The transfer factor values in the present study parallel the standards of IAEA [16].

As radiation is a natural part of our environment and to be more specific, the selected coastal agricultural lands are situated near the natural high background radiation areas this radioactivity study was undertaken. The present investigation determines the gross alpha and beta activity of the soil and coconut samples and transfer factor. The gross alpha and beta activities in soil decreased with the increased distance from the coastal sampling locations towards the inland sampling locations. The gross alpha activity in all the sampling locations was less than the gross beta activity in the soil and coconut samples. The alpha and beta uptake factor in the coastal sampling locations were comparable to that of the inland sampling locations.

IV CONCLUSION

The results of radioactivity analysis show accumulation of alpha and beta activity in the soil samples, and a comparatively low uptake of alpha and beta activity in the coconut crunch samples. The true cause of this accumulation is the presence of naturally occurring radionuclides in the soil samples and not anthropogenic factors. Hence no remedial measure can be suggested to reduce the contamination of radioactivity in plant food other than trying to minimize the mineral quarrying along the coastal areas.

REFERENCES

[1]. Radioactivity Physics Fundamentals, Will Schmidt, Available From: <http://www.journal-ofnuclearphysics.com/files/Radioactivity physics.pdf>[Dec. 14/2016].
[2]. Stabin Michael G, “Radiation Protection and Dosimetry: An Introduction to Health Physics”, Springer. ISBN 978-0-387-49982-6, 2007. doi:10.1007/978-0-387-49983-3.
[3]. Best Lara, Rodrigues, George, Velker, Vikram,” Radiation Oncology Primer and Review Demos Medical”, Publishing ISBN 978-1-62070-004-4, 2013.
[4]. Loveland W, Morrissey D, Seaborg G.T,”Modern Nuclear Chemistry”-Wiley-Interscience. p. 57,2006, ISBN 0-471-11532-0.
[5]. Nuclear Energy, Available From: <https://www.nei.org/Knowledge-Center/Other-Nuclear-EnergyApplications/Food-Agriculture>June 17/2017].
[6]. Backgrounder on Biological Effects of Radiation, 2017, Available From: <https://www.nrc.gov/reading-rm/doc-collections/fact-sheets/bio-effects-radiation.html>[June 17/2017].

[7].United Nations Scientific Committee on the Effects of Atomic Radiation 2000. "Annex B". Sources and Effects of Ionizing Radiation. vol. 1. United Nations. p. 121. Retrieved 11 November 2012.
[8].Freitas A.C, Alencar A.S, 'Gamma dose rates and distribution of natural radionuclides in sand beaches—Ilha Grande, Southeastern Brazil'. Journal of Environmental Radioactivity. 75 (2): 211–23, 2004, ISSN 0265-931X. PMID 15172728. doi:10.1016/j.jenvrad.2004.01.002. Retrieved 2December2012.
[9].Vasconcelos, Danilo, C, Natural Radioactivity in Extreme South of Bahia, Brazil Using Gamma-Ray Spectrometry(PDF). International Nuclear Atlantic Conference. Rio de Janeiro: Associação Brasileira de Energia Nuclear, 2009, ISBN 978-85-99141-03-8. Retrieved 2 December 2012.
[10].Estimation of Radioactivity in the Living and Nonliving organisms encountered in the inland region of a Natural high background radiation area, N. Nagaraj, M.phil thesis, August 2005, Page -6.
[11].Herb S, "Measurement of radioactivity of 238U, 226Ra, 210Pb, 228Th,232Th, 228Ra,137Cs, and 40K in tea using gamma-spectrometry", Journal of Radio analytical and Nuclear Chemistry; Vol. 274, No. 1 : 63–66, 2007.
[12].Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate Environments‖, A Guide Book Technical Report Series No.364, IAEA, Vienna 1994.
[13]. Selin Roselet, M & Mary Helen, H,' Derived radioactivity concentration factors studied in water, sediment and fish samples collected from a pond at Puthoor, Kanyakumari district, Tamilnadu',J. Chem. Pharm. Res., 2013, 5(4):103-105.
[14]. Sarojini, V,Tamil Selvi A, Chithambarathanu T, 'Estimation of radiation at Thengaipattinam of Kanyakumari district, Tamilnadu', IJRET: International Journal of Research in Engineering and Technology, Volume: 04 Issue: 12, 2015.
[15]. Brijesh Pathak ,Archana Pathak,'Estimation of gross alpha activity in soil and plant samples in Udaipur, Rajasthan', International Journal of Scientific & Engineering Research, Volume 3, Issue 6, 2012, ISSN 2229-5518.
[16].Handbook of Parameter Values for the Prediction of Radionuclide Transfer in Temperate nvironments‖, A Guide Book Technical Report Series No.364, IAEA, Vienna 1994.