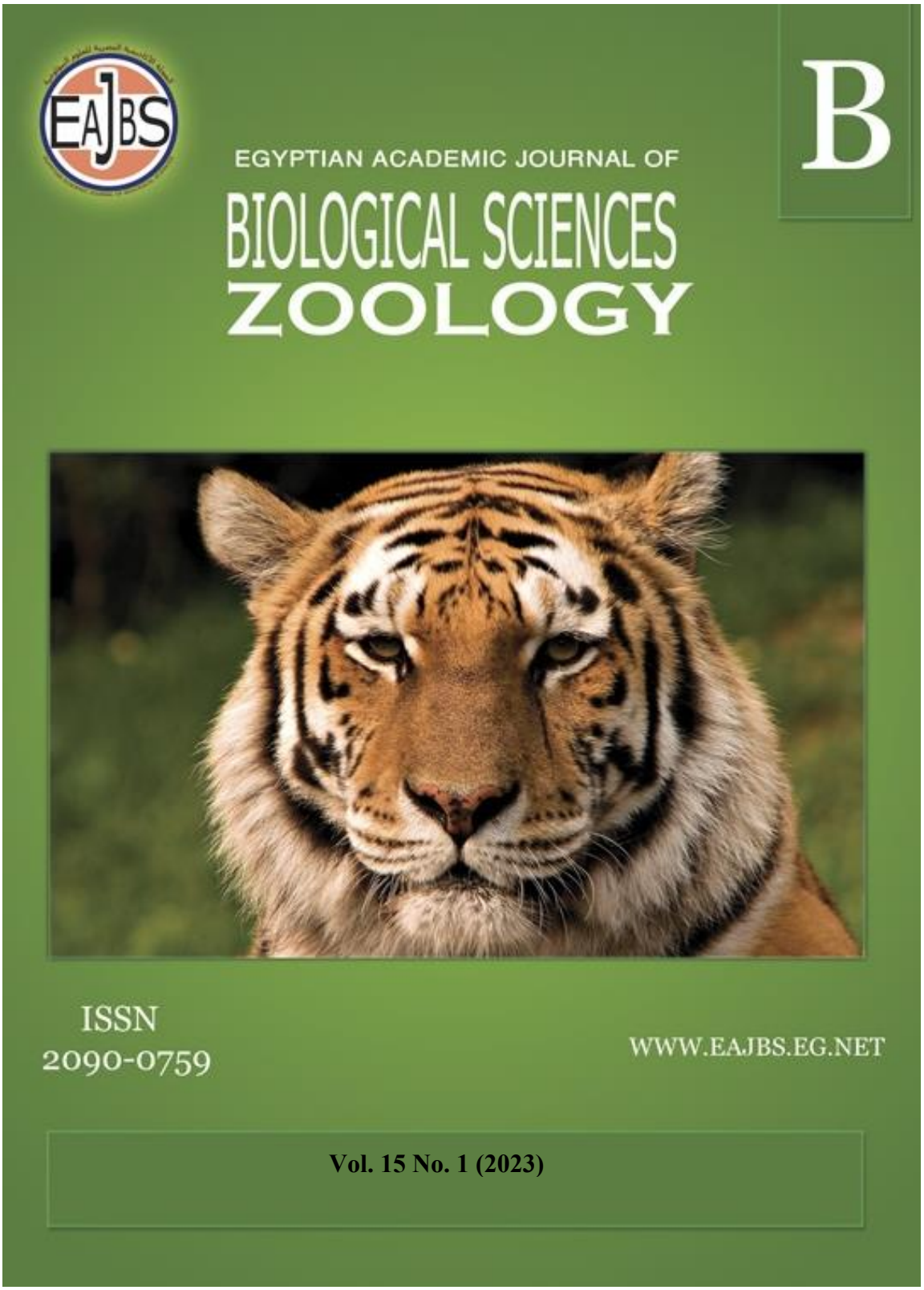


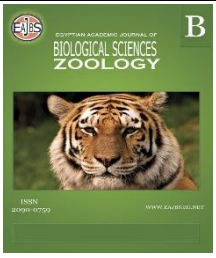
.

www.eajbs.eg.net

Citation: *Egypt. Acad. J. Biolog. Sci. (B. Zoology) Vol. 15(1) pp:129-138(2023)*
DOI: 10.21608/EAJBSZ.2023.291994

Egypt. Acad. J. Biolog. Sci., 15(1):129-138(2023)

Egyptian Academic Journal of Biological Sciences
B. Zoology
ISSN: 2090 – 0759
http://eajbsz.journals.ekb.eg/



Preliminary Analysis of Gross Alpha and Beta Radiation in Coastal Areas

Venci Candida, X.[1]*, Sherin Sheeba Shalini, P.[1], Shenkani, K.[2] and Jenifer, V.[1]
1-Department of Zoology, Holy Cross College (Autonomous), Nagercoil, Affiliated to Manonmaniam Sundaranar University, Tirunelveli, Tamil Nadu, India.
2- Department of Zoology, JKK Nataraja College of Arts & Science, Komarapalayam, Namakkal, Affiliated to Periyar University, Salem, Tamil Nadu, India.
E-mail*: venciaugustine@gmail.com

ARTICLE INFO

Article History
Received:21/1/2023
Accepted:5/3/2023
Available:10/3/2023

Keywords:
Alpha activity, Beta activity, radiation, Dual channel alpha beta counter.

ABSTRACT

Radioactivity is a form of natural radiation, and it is measured in becquerels (Bq) using the SI system. Both human activities and natural processes can produce radioactivity. For this study, three regions on the South Tamilnadu coastline in India, namely Manavalakurichi, Colachel, and Kudankulam, were chosen. A dual-channel alpha-beta counter was used to measure gross alpha and beta activity based on the scintillation principle. The radioactive nuclide activity concentrations in soil and water were measured, and the levels were considered acceptable. The alpha and beta radiation levels in soil and water samples did not significantly differ. The study's results suggest that the risk of radiation danger in the study area is not significantly increased because the values obtained are within the generally accepted limits. The ANOVA experiments also revealed that there was no significant difference in the gross alpha and beta activity of soil and water samples. Moreover, the alpha and beta activity in drinking water was lower in all three areas than what is recommended by the WHO. Therefore, it can be concluded that the drinking water in these three regions is safe for consumption.

INTRODUCTION

Radionuclides and radioisotopes such as uranium, thorium, radium, and potassium exist in small amounts in the Earth's crust. The levels of natural uranium (U) and thorium (Th) in igneous rocks range from 0.1 to 5 mg/kg and 1 to 20 mg/kg, respectively, depending on the rock type. Felsic rocks, such as granite, usually contain more U and Th than mafic rocks, such as basalt (Patak, B 2012). The higher amounts of these radionuclides in the soil can act as a source of radionuclide transmission down the food chain, depending on their chemical composition and how plants and animals absorb radionuclides (Jabbar *et al*., 2010). Radioactivity in water is mainly caused by the presence of radioactive materials in the Earth's crust. Therefore, it is crucial to measure the radiation content in drinking water for human health and environmental contamination purposes (Jibiri, 2007). Soil radioactivity is typically important when creating baseline data for

future radiation assessment and protection purposes worldwide (Latha, A and Shanthi, G. 2016). The Gross Alpha and Beta analyses are simple radio-analytical processes that are utilised as the initial stage of a screening method. The baseline data for gross alpha and gross beta radiation in environmental samples that will be used as a comparison fingerprint for radioactivity levels are being prepared in the current investigation (Periyasamy *et al*., 2016). The weathering of rocks in the Western Ghats is responsible for the monazite deposits found on the coastlines of Kerala and Tamil Nadu (Manigandan 2014; Saroja 2008). This study aims to examine the levels of natural radioactivity in soil and water samples taken from the Colachel, Manavalakurichi, and Kudankulam coastal regions of southern districts in Tamilnadu, India.

MATERIALS AND METHODS

Study Area:

The study area selected for this study is mainly Manavalakurichi (Kanyakumari District), Colachel (Kanyakumari District) and Kudankulam (Tirunelveli District), the coastal regions of South Tamil Nadu, India.

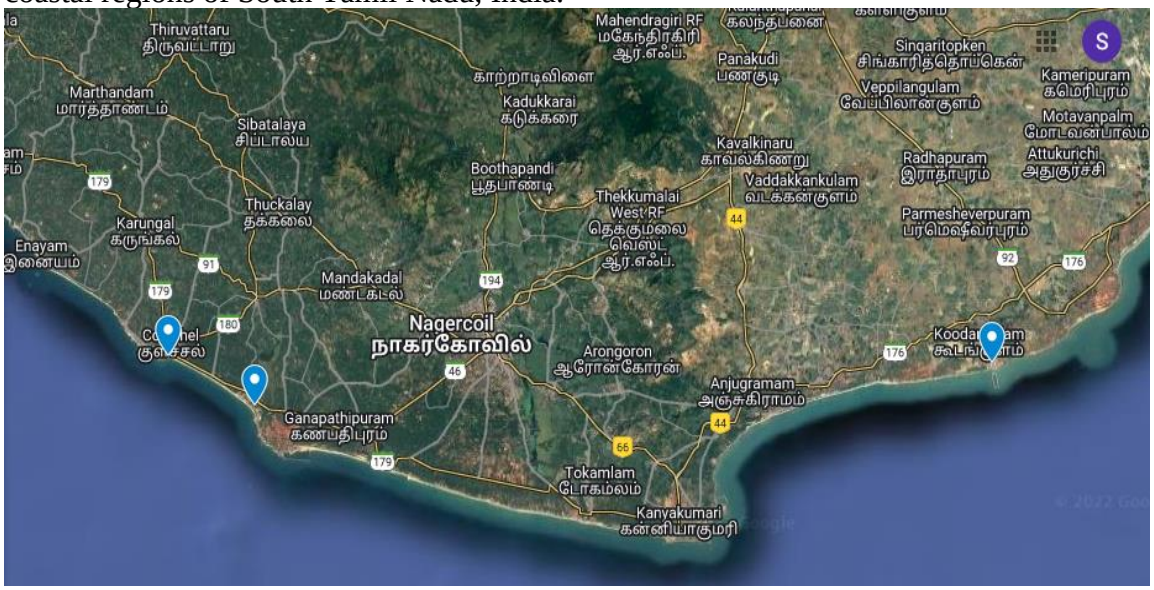


Fig.1: **Location map of the study areas**

Figure 1 shows the location map of the three study areas, Manavalakurichi, Colachel and Kudankulam.

Manavalakurichi is a small town in the Kanniyakumari district located in the southern region of Tamilnadu, India. It is situated about 60 kilometers away from Thiruvananthapuram, the main city of Kerala. The town's coordinates are 8.1471° N latitude and 77.3023° E longitude. Colachel is a natural harbour situated on the Malabar coast in the southern part of India, governed by the Kanyakumari District. It is located 20 kilometers northwest of Kanyakumari, which is India's southernmost point. The town's coordinates are 8.1786° N latitude and 77.2561° E longitude. Kudankulam is situated in the Tirunelveli district of Tamil Nadu, located at a distance of 20 miles from Kanyakumari, 30 kilometers from Nagercoil, 70 kilometers from Tirunelveli, and about 105 kilometers from Thiruvananthapuram. The town is notable for the Kudankulam Nuclear Power Plant. The coordinates of Kudankulam are 8.1798° N latitude and 77.7051° E longitude.

Soil Sample:

The laboratory received soil samples gathered from the Manavalakurichi, Colachel, and Kudankulam coastal areas. The samples were initially sun-dried by

spreading them out in a tray, with any organic material (roots, vegetation, pebbles, etc.) removed. With the aid of an agate mortar, the sample is ground into powder which is ready for radioactive analysis. To measure the alpha and beta activity, 0.020 g of the sample was obtained in the planchet and stored in the drawer assembly of the dual channel alpha beta counter for 600 seconds.

Water Sample:

Whatmann filter paper was used to filter 1.5 litres of drinking water that has been collected from each study region. The drinking water sample is quantitatively transferred to a tared 2-inch stainless steel counting planchet after being evaporated to a minimal volume of 1 ml. For a total of 600 seconds, the sample and planchet were held in the dual channel alpha beta counter's drawer assembly to measure the alpha and beta activity.

Dual Channel alpha Beta Counter:

Using a dual channel low background alpha beta counter calibrated with alpha (141Am) and beta (K40) standards, the prepared samples (water and soil) were counted to determine the concentration of alpha and beta activity.

The dual-channel alpha beta counter is the gross alpha and beta counting apparatus employed. The detection method used by the dual channel alpha-beta counter is called the scintillation principle. For alpha and beta radiation, the dual channel alpha beta counter uses a composite detector (Plastic Scintillator and ZnS (Ag) Scintillator) with drawer assembly. An equipment called a dual channel Alpha Beta counter is used to apply alpha-beta radiations for nuclear counting.

The following subsystems are present in the dual channel alpha beta counter system.

- LCD menu display with keypad.
- High voltage supply and pulse processing circuit.
- Microcontroller with RTC and memory.
- PC interface

Calculation of alpha and beta activity

Net Count = (Sample Count – Background Count)

Alpha/ Beta Activity = (Net Count /Tx100/Ex1/W) Bq/g

T = Time in Seconds = 600 Sec

W = Weight of the Sample in g = 0.020 g

E = Efficiency = 18.3 %

RESULTS

A dual channel alpha beta counter is utilised in the current study to examine the radioactivity concentrations in the three separate soil and water samples, and the results are recorded as follows. The primary study area is the coastal regions of South Tamil Nadu, India, namely Manavalakurichi (Kanyakumari District), Colachel (Kanyakumari District), and Kudankulam (Tirunelveli District).

Alpha Activity in Soil Samples:

Table 1 displayed the gross alpha counts of various soil samples. The gross counts for samples 2 and 3 (Colachel and Kudankulam) are both 0.2, while sample 1 (Manavalakurichi) has a gross count of 0.4. Table 2 displayed the net alpha counts for several soil samples. The Manavalakurichi sample has a net count of 0.4, the Colachel sample has a net count of 0.2, and Kudankulam sample has a net count of 0.2 like the gross count as the background radiation is 0.

Table: 1 Alpha gross count of different soil samples**.**

No of Runs	Background	Sample Count		
		Manavalakurichi	Colachel	Kudankulam
Cycle 1	0	0	0	0
Cycle 2	0	1	1	0
Cycle 3	0	0	0	1
Cycle 4	0	0	0	0
Cycle 5	0	1	0	0
Average	0	0.4	0.2	0.2

Table 2: Alpha net counts of different soil samples**.**

S.No	Sample	Background	Sample Count	Net Count
1.	Manavalakurichi	0	0.4	0.4
2.	Colachel	0	0.2	0.2
3.	Kudankulam	0	0.2	0.2

Table 3 displayed the computed alpha activity of various soil samples from the South Tamil Nadu coast. Manavalakurichi soil sample has an alpha activity of 0.1821 Bq/g. Both the Colachel and the Kudankulam soil samples have an alpha activity of 0.0911 Bq/g.

Table 3: The Alpha activity of different soil samples**.**

S.No	Sample	Alpha activity
1	Manavalakurichi	0.1821 Bq/g
2	Colachel	0.0911 Bq/g
3	Kudankulam	0.0911 Bq/g

Calculation of Beta activity in the Soil Sample:

The background beta count is detected as 16.2. Table 4 displayed the gross beta counts of various soil samples. Sample 1 (Manavalakurichi), Sample 2 (Colachel), and Sample 3 (Kudankulam) have gross counts of 18.4, 18.2, and 19.2, respectively. Table 5 displayed the net beta counts for several soil samples. Sample 1 (Manavalakurichi), Sample 2 (Colachel), and Sample 3 (Kudankulam) have net counts of 2.2, 2, and 3 respectively.

Table 4: Gross Beta count of different soil samples**.**

No of Runs	Background	Sample Count		
		Manavalakurichi	Colachel	Kudankulam
Cycle 1	2 1	22	22	26
Cycle 2	13	15	25	16
Cycle 3	13	13	12	16
Cycle 4	21	14	17	11
Cycle 5	13	28	15	17
Average	16.2	18.4	18.2	19.2

Table 5: Net beta count of different soil samples

S.No	Sample	Background	Sample Count	Net Count
1.	ManavalaKurichi	16.2	18.4	2.2
2.	Colachel	16.2	18.2	2
3.	Kudankulam	16.2	19.2	3

Table 6: Beta activity of different soil samples.

S.No	Sample	Beta activity
1	Manavalakurichi	0.9921 Bq/g
2	Colachel	0.9019 Bq/g
3	Kudankulam	1.3528 Bq/g

Table 6 displayed the beta activity of various soil samples from the South Tamil Nadu coastline after it was determined. Manavalakurichi soil sample has a beta activity of 0.9921 Bq/g. Beta activity is 0.9019 Bq/g in the Colachel soil sample and 1.3528 Bq/g in the Kudankulam soil samples.

Results of Alpha Activity in The Water Samples:

A background alpha count of 0.4 has been found. Table 7 displayed the gross alpha counts for the three water samples. The gross counts for Sample 1 (Manavalakurichi), Sample 2 (Colachel), and Sample 3 (Kudankulam) are 5.2, 5.6 and 3.8 respectively.

Table 8 displayed the net alpha counts for the three water samples. Sample 1 (Manavalakurichi), Sample 2 (Colachel), and Sample 3 (Kudankulam) each have a net count of 4.8, 5.2, and 3.4 respectively.

Table 7: Alpha gross counts of different water samples**.**

No of Runs	Background	Sample Count		
		ManavalaKurichi	Colachel	Kudankulam
Cycle 1	0	1	5	2
Cycle 2	1	6	3	3
Cycle 3	0	6	4	4
Cycle 4	0	7	6	5
Cycle 5	1	6	10	5
Average	0.4	5.2	5.6	3.8

Table 8: Alpha net count of different water samples.

S.No	Sample	Background	Sample Count	Net Count
1.	ManavalaKurichi	0.4	5.2	4.8
2.	Colachel	0.4	5.6	5.2
3.	Kudankulam	0.4	3.8	3.4

Table 9 displayed the alpha activity of various water samples from the South Tamil Nadu coasts after it was determined. Manavalakurichi water sample contains 0.8743 Bq/g of alpha activity. The Colachel and the Kudankulam water samples have alpha activities of 0.0972 Bq/g and 0.6193 Bq/g respectively

Table 9: The Alpha activity of different water samples.

S.No	Sample	Alpha activity
1	Manavalakurichi	0.8743 Bq/g
2	Colachel	0.0972 Bq/g
3	Kudankulam	0.6193 Bq/g

Results of Beta Activity in The Water Samples:

The background beta count is detected as 14.2. Table 10 displayed the gross beta counts for several water samples. Sample 1 (Manavalakurichi), Sample 2 (Colachel), and Sample 3 (Kudankulam) have gross counts of 35, 51.4, and 28 respectively. Table 11 displayed the net beta counts of various soil samples. The net counts for samples 1

(Manavalakurichi), 2, and 3 (Colachel and Kudankulam) are each 20.8, 37.2, and 13.8 respectively.

Table 10: Beta gross count of different water samples.

No of Runs	Background	Sample Count		
		ManavalaKurichi	Colachel	Kudankulam
Cycle 1	17	44	38	35
Cycle 2	15	35	43	26
Cycle 3	11	27	52	29
Cycle 4	12	31	65	21
Cycle 5	16	38	59	29
Average	14.2	35	51.4	28

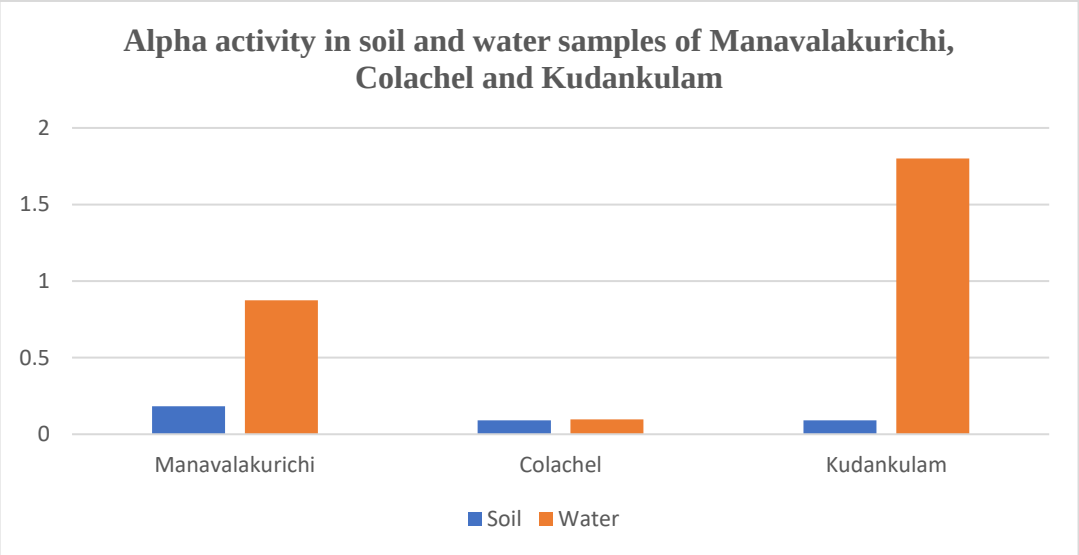
Table 11: Beta net count of different water samples.

S.No	Sample	Background	Sample Count	Net Count
1.	ManavalaKurichi	14.2	35	20.8
2.	Colachel	14.2	51.4	37.2
3.	Kudankulam	14.2	28	13.8

The beta activity of different water samples from the coastal region of South TamilNadu was calculated and shown in table 12. The beta activity in Manavalakurichi water sample is 3.7518 Bq/g. The beta activity in Colachel water sample is 6.7099 Bq/g and the beta activity in Kudankulam water sample is 2.4892 Bq/g.

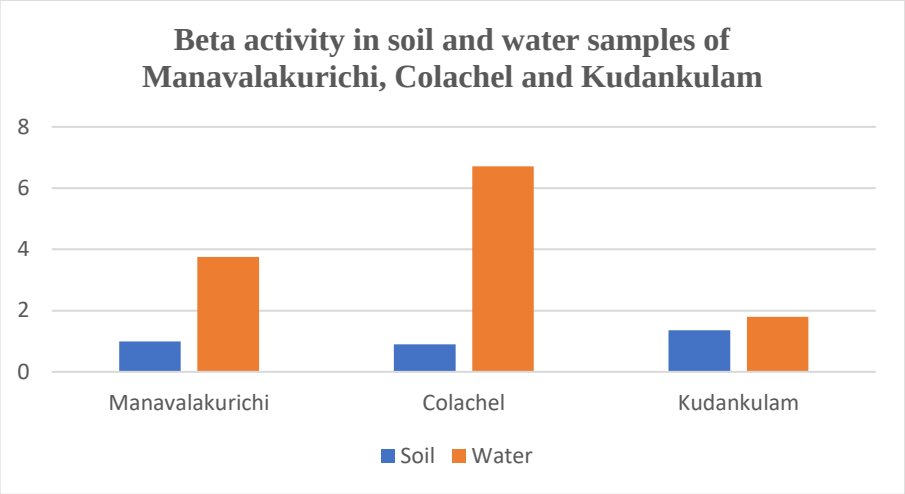
Table 12: Beta activity of different water samples.

S.No	Sample	Beta activity
1	Manavalakurichi	3.7518 Bq/g
2	Colachel	6.7099 Bq/g
3	kudankulam	2.4892 Bq/g



Graph 1: Alpha activity in soil and water samples of Manavalakurichi, Colachel and Kudankulam

Graph 1 represents the comparison of alpha activity in soil and water samples of Manavalakurichi, Colachel and Kudankulam. Graph 2 represents the comparison of beta activity in soil and water samples of Manavalakurichi, Colachel and Kudankulam.



Graph 2: Beta activity in soil and water samples of Manavalakurichi, Colachel and Kudankulam

In both alpha and beta radiation the p value in the single factor ANOVA is more than 0.05, the significant level and so we accept the null hypothesis. So, we could conclude that there is no significant variation in the alpha and Beta radiation of soil and water samples.

DISCUSSION

Contamination of water by radionuclides poses numerous health risks, especially when these substances are ingested by humans. Radionuclides dissolved in water release alpha and beta particles and gamma photons, which gradually expose biological tissues (Alam *et al*., 1999; Gruber *et al*., 2009). Research on both humans and animals has shown that exposure to radiation at low to moderate levels may increase the long-term risk of cancer (Amrani and Cherouati, 1999; Collman *et al*., 1991; Gofman, 1990). To safeguard the public from exposure to radiation levels above safe limits, it is necessary to establish a standard to address the potential adverse effects of ingesting radionuclides through drinking water.

As the first step of the radiological component of drinking water quality, the World Health Organization's drinking water quality recommendations advised measuring the concentrations of gross alpha and gross beta activity in drinking water (WHO, 2004). For naturally occurring radioactivity, radiation exposure due to gross alpha is typically more concerning than that due to gross beta (Bunotto and Bueno, 2008). This is because alpha particles have a high LET, which allows them to deposit more energy in a medium over a shorter distance. Making sure the committed effective dose of 0.1 mSv from a year of drinking water consumption is not exceeded is the main goal of the evaluation of the gross alpha and gross beta activities. The RDL of 0.1 mSv, as suggested by the International Commission for Radiological Protection (ICRP, 1990) and the International Basic Safety Standards, is equal to 10% of the dosage limit for members of the public (IAEA). Additionally, they are accepted by the majority of the Food and Agriculture Organization (FAO), the European Commission, and the World Health Organization (WHO) members (Muhammad *et al*., 2010).

The current study recorded that the activity concentrations of radioactive nuclides in the soil and water of the current study area were within acceptable limits. However, the alpha and beta activity in water samples was higher than in soil samples taken from

specific southern Tamil Nadu coastal locations. This may be due to the low penetration of alpha particles. In both soil and water samples, the alpha activity was modest compared to the beta activity, and there was no significant difference in alpha and beta radiation between soil and water samples.

According to Nandhakumari P *et al*., 2014, the sediment has a greater t-activity level than water or fish, with 114.764 Bq/kg compared to 0.043 Bq/l and 57.38 Bq/kg, respectively. With 357.25 Bq/kg, sediment showed the same pattern of high activity, while water and fish showed just 0.28 Bq/l and 123.67 Bq/kg, respectively. This result however did not correlate with our results which showed higher alpha and Beta activity in water samples than in sediments or soil alpha activity of various soil samples from the South Tamil Nadu coast. Manavalakurichi soil sample has an alpha activity of 0.1821 Bq/g. Both the Colachel and the Kudankulam soil samples have an alpha activity of 0.0911 Bq/g. Manavalakurichi soil sample has a beta activity of 0.9921 Bq/g. Beta activity is 0.9019 Bq/g in the Colachel soil sample and 1.3528 Bq/g in the Kudankulam soil samples. Manavalakurichi water sample contains 0.8743 Bq/g of alpha activity. The Colachel and the Kudankulam water samples have alpha activities of 0.0972 Bq/g and 0.6193 Bq/g respectively. The beta activity in Manavalakurichi water sample is 3.7518 Bq/g. The beta activity in Colachel water sample is 6.7099 Bq/g and the beta activity in Kudankulam water sample is 2.4892 Bq/g.

The WHO (2004) recommends that the activity be kept below the allowed limits of 0.5 Bq/l for gross alpha and 1.0 Bq/l for gross beta activity in drinking samples. Our results of both alpha and Beta activity in all three areas were lower than the permissible limits recommended by WHO. According to Idoko, EE, 2020, the Alpha activity concentrations for water samples are significantly greater than those for soil samples. This may also suggest that the majority of alpha emitters are more prevalent in water than in soil. This result coincides with the alpha activity of the current research which recorded higher alpha activity in water than in soil samples of all three selected areas. Idoko, EE, 2020 also stated that soil samples have higher beta activity concentrations than water samples do. This result doesn't coincide with our results.

The results of the current investigation suggest that the drinking water samples from the study area had low radioactivity, with all measurements falling below the World Health Organization's drinking water guidelines of 1.0 Bq/l for gross beta radioactivity and 0.5 Bq/l for gross alpha activity. This means that the drinking water in the research areas Manavaakurichi, Colachel and Kudankulam is radioactively safe to use rather than radioactively contaminated. The same result was recorded by Amin, MR, 2017.

Therefore, it can be concluded that the gross alpha and Beta activity seemed to be higher in water samples than in soil samples collected from the same selected areas Manavalakurichi, Colachel and Kudankulam. But the ANOVA studies clearly indicate that there is no significant difference in the gross alpha and Beta activity of soil and water samples. Also, the drinking water in all three selected areas showed lesser alpha and Beta activity recommended by the WHO. So, it can be insisted that the drinking water in all three selected places is safe to drink.

CONCLUSION

Radioactivity is a term used to describe naturally occurring radiation, with the Becquerel (Bq) being the unit of measurement for radioactivity in the SI system. Both human involvement and naturally occurring radioactivity are possible. The current study focuses on three coastal areas in South Tamilnadu (Manavalakurichi, Colachel, and Kudankulam). To measure alpha and beta activity, the dual channel alpha-beta counters that use the scintillation principle are used. According to the study, the activity concentrations of radioactive nuclides in the soil and water in the area are within acceptable limits. Compared to the soil samples, the alpha and beta activity in water

samples is higher. However, in both soil and water samples, the alpha activity is modest in comparison to the beta activity, and there is no significant difference in the gross alpha and beta activity of soil and water samples. The study indicates that the values obtained are within the acceptable upper limits for advisory levels and do not considerably increase the risk of radiation danger for people in the research area. Therefore, it can be concluded that the drinking water in all three selected areas is safe for consumption and further studies are needed for confirmation.

REFERENCES

Alam, M. N. C., Kamal, M. I., Ghose, M., Islam, S., & Anwaruddin, M. 1999. Radiological assessment of drinking water of the Chittagong region of Bangladesh. *Radiation Protection dosimetry,* 82(**3**)*: 207*–214.

Amin, M. R. 2017. Gross Alpha and Beta Activities and Trace Elements Levels in Drinking Water of Saudi Arabia. *Pelagia Research Library - Advances in Applied Science Research*, 8(**1**): 62-69.

Amrani, D. and Cherouati, D. E. 1999. Health effects from radon-222 in drinking water in Algiers. *Journal of Radioiological Protection*, 19(**3**): 275–279.

Brijesh Patak. 2012. Estimation of gross alpha activity in soil and plant samples in Udaipur. *International journal of scientific &Engineering Research*, 3.

Bunotto, D. M. and Bueno, T. O. 2008. The natural radioactivity in Guarani aquifer groundwater, Brazil. *Applied Radiation and Isotopes*, 66(10): 1507–1522.

Collman, G. W., Loomis, D. P. and Sandler, D. P. 1991. Childhood cancer mortality and radon concentration in drinking water in North Carolina. *British Journal of Cancer,* 85(**4**): 626-629.

Gofman, J. W. 1990. Radiation- induced cancer from low dose exposure: An independent analysis (1st ed.). San Francisco California 94101 USA: Committee for Social Responsibility, Inc. CNR Book Division. P.O. Box 11207.

Gruber, V., Maringer, F. J., and Landstetter, C. 2009. Radon and other natural radionuclides in drinking water in Austria: measurement and assessment. *Applied Radiation and Isotopes*, 67(**5**): 913–917.

ICRP 1990. International Commission on Radiation Protection.

Idoko, E. E., Tijjani, S. B., Rose A., Patrick O. A. and Onoja, R.O. 2020. Determination of gross alpha and beta radioactivity concentration along jakara waste water canal, Kano Metropolis, Kano State, Nigeria. *Science World Journal*, 15(**1**): 1-6.

Jabbar A, Tufail M, Arshed W, Bhatti A, Ahmad SS, Akhter P. 2010. Transfer of radioactivity from soil to vegetation in Rechna Doab, Pakistan. *Isotopes in Environment and Health Studies*, 46(495).

Jibiri, N.N., Farai, I.P. and Alausa, S.K., 2007. Estimation of annual effective dose due to natural radioactive elements in ingestion of food stuffs in tin mining area of Jos Plateau, Nigeria. *Journal of Environmental Radioactivity*, 94: 31-40.

Latha, A., and Shanthi, G. 2016. Study of gross alpha and gross beta activity concentration in sediment and soil samples of three southern districts of Tamil Nadu. IRA-International Journal of Applied Sciences, 4(**2**): 319-332.

Manigandan. P.K, Chandra Shekar. B. 2014. Evaluation of radionuclides in the terrestrial environment of western ghats. *Journal of Radiation Research and Applied Sciences,* 7: 310-316.

Muhammad, B. G., Jaafar, M. S. and Akpa, T. C. 2010. A survey of gross alpha and beta activity concentrations in groundwater from Katsina area of Northern Nigeria. *Radiation Protection Dosimetry*, 142: 127-133.

Nandhakumari, P., TamilSelvi A., Sarojini, V. and Palavesam, A. 2014. Analysis of radioactivity content in sediment, water and fish collected from Rajakkamangalam Estuary of Kanyakumari district in Tamilnadu, India. *IOSR Journal of Environmental Science, Toxicology and Food Technology (IOSR-JESTFT)*. 8(**12**): 1-3.

Periyasamy, M., Christopher, S., Syed Mohamed, Sadiq Bukhari, A. and Mohamed Shamsudin. 2016. Gross Alpha and Beta radioactivity studies in Dindigul and Erode Districts, Tamilnadu. *International Journal of Advanced Science and Research*, 1(**2**): 22-26.

Ragel Mabel Saroja. R. (2008). High Background radiation sweeping along the southwest coast of Tamilnadu, India. *Current Science*, 94:10.

WHO. 2004. Guidelines for drinking water quality (3rd ed.). Geneva: World Health Organisation.