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Research Article

A Radiological Investigation of Drinking Waters from Antalya, Turkey

Osman Ağar[1]*, Canel EKE[2], Mehmet Emin KORKMAZ[1]

[1]Karamanoğlu Mehmet Bey University, Kamil Özdağ Faculty of Science, Physics Department, 70100, Karaman-Turkey
[2]Akdeniz University, Faculty of Education, Department of Mathematics and Science Education, Division of Physics Education, 07058, Antalya-Turkey

* Corresponding Author : osmanagar@kmu.edu.tr

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Abstract: The present work intends to determine gross alpha and beta activity concentrations of some drinking water samples collected from Antalya, Turkey. Using EPA 900 counting method based on the assessment of the water quality, the radioactivity monitoring has been carried out. The data resulting from this measurement can provide the important information to evaluate the possible future changes.

1. Introduction

Waters are known to contain both alpha (e.g., ^{238}U) and beta (e.g., ^{40}K) emitters in widely changing concentrations. The concentration level of these emitters, in general, is corresponded to a small part of the total dose received from natural and artificial radioactivity [1]. Natural radionuclides in drinking waters have a significant impact on human health as internal expose due to the decay of these radioactive nuclides taken into the body through inhalation and ingestion. The high exposure dose rate could pose health problems for humans [2]. Therefore, the quality of drinking waters in different points should be checked frequently.

The aims of this study are; to investigate radiological characterization and calculate levels of gross alpha and beta activity of drinking waters from Antalya. In the next section, we describe material and method. In section 3, we present the results of our analysis. In the final section, we present our conclusion.

2. Material and Method

2.1. Sample collection and preparation

In the present work, levels of gross alpha and beta activity of drinking waters under the investigation are carried out by the EPA-900 method [4] which is established for drinking water standards to preserve public health. The method is based on the measurement of activities of gross alpha and beta particles in water. In order to measure concentrations the gross alpha and beta in waters, 11 different water samples are collected randomly from predetermined locations in the surrounding of Antalya in Turkey. The geological coordinates of the studied area is from 29º 20' to 32º 35' east longitude and from 36º 07' to 37º 29' north latitude in south west of Turkey [3]. Before measurement, procedures used in our previous studies are followed [5,6].

2.2. Analytical method

The instrument which is performed to determine the activities of gross alpha and beta is a multi-detector alpha/beta counting system (PIC-MPC 9604–α/β counter). The counting time is selected as 54,000 s both for gross alpha and beta activities in all samples. The counting gas P-10 which is a mixture of argon (90%) and methane (10%) is used. Lead shielding is

used for attenuation of external radiation. The operating voltage of the proportional counter is chosen as 1515 V. The system is calibrated using the standard reference sources of ^{241}Am (450 Bq) and 90Sr (600 Bq) for energy and efficiency calibration, respectively.

Determination of the minimum detectable activity is essential in assessing concentrations of gross alpha and beta activity. This quantity for gross alpha and beta are given by the equation below:

$$MDA = \frac{\frac{2.71}{t_S} + 3.29\sqrt{\frac{cpm}{t_S} + \frac{cpm}{t_B}}}{\%Eff} \cdot \frac{1}{60xV} \qquad (1)$$

Where *MDA* is minimum detectable activity for alpha and beta (Bq/L), *cpm* is alpha and beta background count rate (count per minute), t_S is count time of sample, t_B is count time of background, *%Eff* is percent efficiency of alpha and beta, *V* is volume of sample (L) and 60 is conversion factor.

2.3 Determination of the effective dose equivalent

The doses have been evaluated by the following equation [7,8]:

$$DR_W = A_W.IR_W.ID_F \qquad (2)$$

where DR_W is annual effective dose equivalent (μSv/year), A_W is gross alpha and beta activities (Bq/L), IR_W is amount of water intake for person in one year and ID_F is the annual effective dose conversion factors ($mSvBq^{-1}$). The annual effective dose equivalents are assumed for lactation age, children and adults that drink 250, 350 and 730 L of water per year, respectively. Finally, the individual effective dose equivalents are determined for adults who drink 2 L of water per day.

3. Results

Table 1 shows level of gross alpha and gross beta concentrations in drinking waters from Antalya. The mean values of gross alpha and beta activities of samples are compared to the results from some works in other areas of Turkey as given in Table 2. In order to determine the health risk for baby, children and adult members in studied area, annual effective doses (DRw) which is related to radiation exposure through ingestion of all water samples under investigation are calculated. DRw values of alpha/beta emitters are demonstrated in Fig. 1 (a) and (b), respectively.

Table 1. *The estimated activities of gross alpha and beta (Bq/L) in drinking waters*

Sample	Gross Alpha (Bq/L)	Gross Beta (Bq/L)
S1	0.024±0.015	0.022±0.006
S2	0.018±0.01	0.019±0.005
S3	0.015±0.01	0.031±0.006
S4	0.008±0.012	0.008±0.006
S5	0.044±0.01	0.014±0.006
S6	0.192±0.016	1.193±0.022
S7	0.131±0.021	0.554±0.014
S8	0.082±0.019	0.035±0.006
S9	0.277±0.055	0.075±0.007
S10	0.058±0.022	0.054±0.006
S11	0.12±0.045	0.174±0.009

Table 2. *Comparison of activity levels of gross alpha and gross beta (Bq/L) in other regions of Turkey*

Region	Gross Alpha (Bq/L)	Gross Beta (Bq/L)	References
Ereğli	0.017	0.029	[6]
Hatay	0.036	0.116	[9]
Artvin	0.0459	0.0912	[10]
Gaziantep	0.0498	0.1284	[11]
Samsun	0.0519	0.0778	[12]
Bolu	0.06811	0.16944	[13]
Antalya	0.088	0.198	Present work

4. Conclusion

In this study, gross alpha concentrations vary between 0.008 and 0.277 Bq/L, gross beta concentrations range from 0.019 to 1.193 Bq/L. Except for S6, activities of gross alpha and beta are below the recommended values of WHO which are not exceed permissible limit of 0.1 mSv/L [13] for drinking water quality.

To the best of our knowledge, this is the first study of activity levels obtained from drinking waters in Antalya, Turkey. These values can be used to interpret possible future changes. It can provide a good baseline to set standards for water quality.

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