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Measurement of Gross Alpha and Beta Activities in Mushroom Samples

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Abstract. Mushrooms are known as indicator organisms since they have properties to absorb heavy elements and air pollutants. Therefore, determination of natural radioactivity concentrations in them is very remarkable. In this study, the gross alpha and beta activities of 12 different mushroom samples collected from Trabzon (Turkey) are measured by using a gas-flow proportional counter. The measured values of gross alpha and beta concentrations vary from 21 Bqkg-1 to 292 Bqkg-1 and from 175 Bqkg-1 to 1156 Bqkg-1, respectively. Also, the obtained results are evaluated statistically.

Keywords: Mushroom, gross alpha/beta, radioactivity

Mantar Örneklerindeki Toplam Alfa ve Beta Aktivitelerin Ölçümü

Özet. Mantarlar ağır elementleri ve hava kirliliğine sebep olan maddeleri soğurdukları için indikatör organizmalar olarak bilinir. Bu nedenle, mantarların doğal radyoaktivitesini belirlemek çok önemlidir. Bu çalışmada, Türkiye'nin Trabzon bölgesinden alınmış 12 farklı mantar örneğinin toplam alfa ve beta aktiviteleri gaz akışlı orantılı sayaçla ölçülmüştür. Toplam alfa ve beta konsantrasyonların ölçülen değerleri sırasıyla 21 ile 292 Bqkg-1 ve 175 ile 1156 Bqkg-1 arasında değişmektedir. Ayrıca, elde edilen sonuçlar istatistiksel olarak değerlendirilmiştir.

Anahtar Kelimeler: Mantar, Toplam alfa/beta, radyoaktivite

1. INTRODUCTION

Mushrooms that have great importance for the history of humankind are important parts of the ecosystem. Although it is considered 1.5 million species of fungi in the earth, it has been only identified 69000 species until now [1]. Many countries of the world are rich in edible mushroom species and spontaneously grown due to the flora and climate conditions [2 – 3]. Generally, the mushrooms are consumed as food in the regions where they existed. On the other hand, these mushrooms can embody heavy metals such as cadmium, copper, arsenic and radioactive wastes at higher rates as important bioindicators of the natural ecosystem [4 – 5]. These contents in mushrooms can play a role health hazard, as has occurred in areas heavily contaminated by radioactive fallout since they have higher rates than in other eatables, in particular forest products [6 – 7]. For this reason, the main purpose of this study is to measure the activity concentrations of gross alpha and beta for mushroom samples of twelve different species (*Tramates hirsute, Hypholoma fasciculare, Astraeus hygometricus, Phylloparia rilais, Trametes versicolor, Trametes gibbosa, Xylaria hypoxylon, Daedalea quercina, Helvella crispa, Xylaria polymorpha, Ganoderma applanatum, Fomitopsis pinicola*) collected from surrounding of Trabzon. In the next section, we present the materials and method of the present study. In Section III, we show the result obtained by a gas-flow proportional counter and Section IV is devoted to our summary and discussion.

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2. MATERIAL and METHOD

2.1 Sample collection and preparation

Mushrooms were collected along with a piece of their substrate and put into paper bags until further processing. Geographical coordinate for mushroom samples of twelve different species from studied area in this work is at latitude of 40°34′ 00 and longitude of 41°50′ 05. Then, these materials were collected from habitat and dried with mild heat evaporator. Dried entire mushroom samples were pulverized with liquid nitrogen for determination of mass and put 100 ml beaker. Seventeen mushroom samples with densities varying from 0.683 g cm^{-3} to 0.886 g cm^{-3} were accumulated from superficial sheet deep in Trabzon city. The samples are kept at Karamanoglu Mehmetbey University, Science Faculty, Department of Biology.

2.2 Analytical methods

About 10 – 12 mg of dry mushroom was weighed in stainless steel planchets. The sample was spread in a planchet until it was homogeneous. A drop of distilled water was spread at the surface of sample and it was later dried under infrared lamp. Then, the samples are dried in an oven at about 105 °C for 90 min. Gross alpha and beta activity concentrations in samples were determined by a gas-flow proportional counter (PIC-MPC 9604-a/b counter). The counting gas (P-10) was a mixture of 90% argon and 10% methane. The background of each detector was determined by counting an empty planchet for 900 min. The counting time was set as 900 min both for gross alpha and beta activities. Alpha and beta efficiencies of gas proportional counter were checked with ^{90}Sr and ^{241}Am sources, respectively.

The activity of the samples can be calculated as follows:

$$A_{\alpha,\beta}(\text{Bq/kg}) = \frac{N_{et}(cpm)}{m(kg)(\%Eff)(A_f)\,(60)} \qquad (1)$$

where is N_{et} the net count under the spectrum for alpha and beta, respectively, m is the sample mass, A_f attenuation factor, *%Eff* is the efficiency of the counter to alpha and beta, respectively [8].

3. RESULTS

The levels of gross alpha and beta activities in mushroom samples of 12 different types collected from Trabzon are given in Table 1. As it can be seen in Table 1, the range of estimated activity concentrations of gross alpha and beta in samples under investigation varied from 292.673 (*Daedalea quercina*) Bq·kg^{-1} to 21.244 (*Ganoderma applanatum*) Bq·kg^{-1} and from 1156.243 Bq·kg^{-1} (*Helvella crispa*) to 175.124 Bq·kg^{-1} (*Phylloparia rilais*), respectively.

Table 1. Estimated activity concentrations of gross alpha and beta (in $Bq \cdot kg^{-1}$) in mushroom samples.

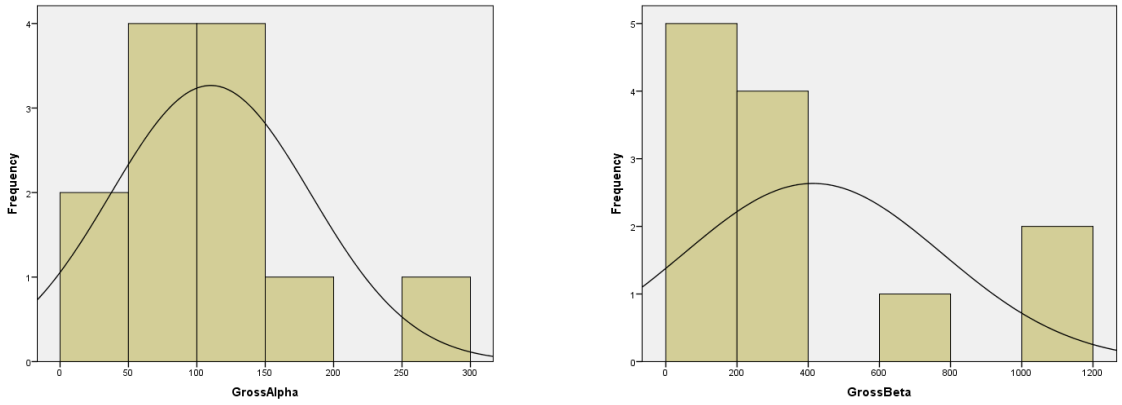
Sample	Residue (mg)	Gross alpha	Gross beta
Tramates hirsuta	11.1468	154.471	220.974
Hypholoma fasciculare	11.1396	143.559	1096.841
Astraeus hygometricus	11.1189	110.137	176.963
Phylloparia rilais	11.0648	60.153	175.124
Trametes versicolor	10.9397	60.960	191.458
Trametes gibbosa	11.1311	47.132	190.754
Xylaria hypoxylon	11.1501	136.163	701.156
Daedalea quercina	11.0849	292.673	286.515
Helvella crispa	11.1453	149.178	1156.243
Xylaria polymorpha	11.0462	52.029	334.297
Ganoderma applanatum	11.0823	21.244	195.634
Fomitopsis pinicola	11.1194	93.569	233.376

The statistical data corresponding to the measured activities of gross alpha and beta in mushroom samples done by using SPSS computer software is shown in Table 2. Table 2 represents the arithmetic and geometric mean values, standard deviation, skewness, kurtosis coefficient and the type of theoretical frequency distribution that best fits each empirical distribution. Figure 1 shows the corresponding frequency distribution of the activities detected for gross alpha and beta. From Table 2, it can be easily seen that the positive values of skewness calculated for activity concentrations of gross alpha and beta (1.36 and 1.54, respectively) displayed the asymmetric distribution with the right tail being longer than the left as can be seen in Figure 1. Similarly, the positive values of kurtosis coefficient of gross alpha and beta activities (2.64 and 0.90, respectively) indicated a higher and narrower distribution than normal. Consequently, the log–normal distribution of the above-cited activities concentrations was obtained.

Table 2. Statistical values of concentrations of gross alpha and beta activity ($Bq \cdot kg^{-1}$) in mushroom samples under investigation

Statistic data	Gross alpha	Gross beta
Arithmetic mean	110.11	413.28
Arithmetic standart deviation	21.15	104.90
Geometric mean	89.37	315.50
Skewness	1.36	1.54
Kurtosis	2.64	0.90
Frequency-distribution	log-normal	log-normal

[a] Values followed by different letters in the same row differ significantly at $p < 0.05$



(a) (b)

Figure 1. The frequency of concentrations of (a) gross alpha and (b) beta activity.

4. CONCLUSIONS

In this paper, the activity levels of gross alpha and beta in mushroom samples collected from Trabzon by using a gas-flow proportional counter were determined. Most of the gross alpha activity in mushroom is attributed to decay of uranium and thorium isotopes. Also, main sources of the gross beta activity are arisen from radioactive potassium (^{40}K) isotope. The results may be also used as reference data for monitoring possible radioactivity pollutions in future.

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