THE PRESENCE OF ^{226}Ra IN THERMAL SPRINGS OF CROATIA AND HEALTH RISK FROM MINERAL WATER CONSUMPTION

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INTRODUCTION

The presence of ^{226}Ra in water and possible health effects require particular attention considering the great radiotoxicity of ^{226}Ra, its long half-life ($T_{1/2}$= 1.622 yrs) and its high potential for causing biological change (1). Numerous studies have shown that many thermal water springs around the world contain relatively high levels of natural radionuclides, in particular ^{226}Ra which may present a possible risk of increased exposure to ^{226}Ra in the general population (2).

The purpose of this study was to determine ^{226}Ra concentrations in thermal water springs in the Republic of Croatia at six sampling sites, mostly spas and health resorts. These thermal waters have been used for medical and bathing purposes, for therapy, rehabilitation and recreation, and also for drinking for its good mineral composition.

Radium contamination in the samples of thermal waters was measured in order to estimate the radiation doses received by the population - patients or tourists during a stay in the spa, and to calculate the radiation dose originating from drinking spring waters. Equivalent dose received from a medical drinking cure over a four week period was estimated and compared to the dose received from ingestion of public system tap water over a year.

The Republic of Croatia is one of the richest countries in hot springs in the world and many health resorts are based on thermal and mineral water springs. Considering popularity of the spas and habit of the Croatian population to use beneficial effects of these springs it is of interest to estimate to what extent is radioactivity of thermal and mineral waters absorbed by bathing and drinking practices.

MATERIAL AND METHODS

The samples were collected several times over the period of last four years at six locations of selected thermal water springs, most popular tourist spas and health resorts, majority of which are clustered in North-western Croatia.

In all samples ^{226}Ra was determined by alpha spectrometric measurements after radiochemical separation. The counting time for each measurement was 60000 s or longer.

RESULTS AND DISCUSSION

Values of the average ^{226}Ra concentrations measured at six locations of selected thermal water springs are given in Figure 1 showing deviations from the average values in the observed period.

In the spas in which waters were used for bathing and drinking, ^{226}Ra activities measured in the samples of thermal waters did not exceed maximal permissible level of 1000 Bqm^{-3} for drinking water (3). In Croatia, health-based acceptable level of exposure from drinking water is based on the latest IAEA recommendation taking 1000 Bqm^{-3} as the maximum permissible level for ^{226}Ra in drinking water which is a derived concentration (DC) for a group of individuals (3). Guideline activity refers exclusively to ^{226}Ra concentration in municipal drinking water supplies and there is no regulation that would refer to the occurrence of ^{226}Ra in other water categories, such as thermal and mineral waters, and to possible contribution by routes of exposure other than ingestion. In other words, natural mineral water has not been included in the existing Croatian legislation on drinking water and has not been taken into consideration as a distinct category of water although the analyses show that ^{226}Ra concentrations contained in thermal and mineral waters are higher than in other categories of water in Croatia.

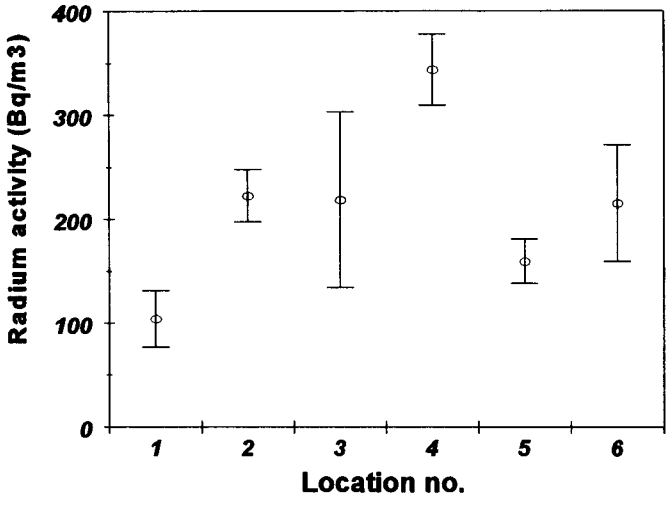

Figure 1. Average ^{226}Ra concentrations measured at six thermal springs

According to the study by Marović and co-workers ^{226}Ra concentration measured in the tap water in several major urban centres of Croatia was 2.1 ± 1.4 Bqm^{-3} (4).

In selected spas all waters have been used for medical and bathing purposes, and also recommended for drinking cure. The water from location no. 1 (Figure 1.) known for its good mineral content, is bottled and commercially sold in the country and abroad.

Considering relatively high ^{226}Ra content in thermal waters of the spas and health resorts of Croatia and on the assumption that a drinking cure contains 1 L of mineral water daily for one week, a possible influence on body burden from drinking this water would be higher than from consumption of the tap water over a year.

Estimating the dose due to consumption of spring waters with increased radium content, it has to be emphasized that these waters are applied as medicinal waters for definite periods and in given amounts. Therapeutical application usually takes daily doses of 0.2-1 litres for several weeks.

Table 1. The effective dose received from a medical drinking cure

Effective dose over four weeks (mSv)		
Sampling location no.	**0.2 L/day**	**1 L/day**
1	$1.28 \cdot 10^{-4}$	$6.41 \cdot 10^{-4}$
2	$2.74 \cdot 10^{-4}$	$1.37 \cdot 10^{-3}$
3	$2.70 \cdot 10^{-4}$	$1.35 \cdot 10^{-3}$
4	$4.24 \cdot 10^{-4}$	$2.12 \cdot 10^{-3}$
5	$1.97 \cdot 10^{-4}$	$9.83 \cdot 10^{-4}$
6	$2.65 \cdot 10^{-4}$	$1.33 \cdot 10^{-3}$

The assumed received dose is compared to that received by consuming only tap water over a year. The effective doses received from a medical drinking cure, that is 0.2 L/day of thermal water over the period of four weeks (Table 1) were estimated to be 1.3 times higher than the dose received from drinking 2 L/day tap water over a year ($3.37 \cdot 10^{-4}$ mSv). The doses received from 1 L/day of thermal water over a four-week period estimated to be as were much as 2 to 6 times higher, than the dose received from drinking tap water over a year.

According to ICRP recommendations (5) the limit for public exposure should be expressed as an effective dose of 1 mSv in a year. Since the doses obtained in our study are well below the recommended dose of 1 mSv the practice of using thermal waters (bathing and drinking for medical therapy, recreation and rehabilitation) should not be restricted provided that other sources of exposure are taken into account and controlled.

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