INVESTIGATION ON FOOD RADIOACTIVITY AND ESTIMATION OF INTERNAL DOSE BY INGESTION IN CHINA

H. Zhu, J. Zhang, P. Han, X. Huang and S. Wang

Institute of Radiation Medicine, Chinese Academy of Medical Sciences, P.O. Box 71, Tianjin 300192, China

ABSTRACT

Activity concentrations of ^{40}K, ^{87}Rb, U, Th, ^{226}Ra, ^{228}Ra, ^{210}Pb, ^{210}Po, ^{227}Ac, ^{14}C, ^{3}H, ^{90}Sr, ^{137}Cs, ^{144}Ce and ^{106}Ru in 14 categories of Chinese food were determined in 1982- 1986. The food samples were collected from normal radiation background area and two elevated natural radiation areas. Based on typical Chinese diet composition, our determined results of the food and reported available typical contents in water, Annual Intake and Committed Dose Equivalent of these radionuclides by ingestion for Chinese male adult were estimated. The total Committed Dose Equivalent is about 0.35 mSv/a. Relative contributions of different categories of food and radionuclides to the total are discussed.

INTRODUCTION

Internal dose of the public from environmental radiation by ingestion depends on radionuclide concentrations in different categories of food (including drinking water) and local dietary habits. Asian dietary habits are quite different from those in other parts of the world. Purposes of this paper are presentation of current levels of important radionuclides in Chinese food and drinking water and estimation of resulting Annual Intake (AI) and Committed Dose Equivalent (CDE).

MATERIALS AND METHOD

Activity concentrations of ^{40}K, ^{87}Rb, U, Th, ^{226}Ra, ^{228}Ra, ^{210}Pb, ^{210}Po, ^{227}Ac, ^{14}C, ^{3}H, ^{90}Sr, ^{137}Cs, ^{144}Ce and ^{106}Ru in 14 categories of Chinese food were determined on cooperation with 30 radiation protection units during 1982- 1986. The samples were collected from 14 provinces in normal radiation background area and two elevated natural radiation areas. Almost all of the samples were got from lately harvested products. A given radionuclide in all samples was analysed in the same laboratory and measured with calibrated instruments by use of the same standard solution to ensure analytical quality. Almost in the same period as our survey, two other nationwide surveys on contents of some radionuclides in water were accomplished too and some available data have been published recently[1-3].

Based on typical composition of Chinese diet[4], our determined concentrations, reported mean contents of the nu-

clides in water and accepting 1.65 L per day as mean consumption[5], AI and CDE of these radionuclides by ingestion for Chinese male adult were estimated.

RESULTS AND DISCUSSION

1. Radionuclide contents in Chinese food and water

The results showed in Table 1 indicate that in normal radiation background area the concentrations of natural radionuclides in food and water were generally higher than those of artificial ones, ^{40}K is the highest in food, followed by ^{14}C, ^{3}H, ^{87}Rb, while ^{3}H is the highest in water, followed by ^{40}K. In addition, some findings are of significance: quite high concentrations were noticed in certain kinds of food for particular nuclide, for example, tea and kelp for most nuclides, pork for ^{3}H, ^{14}C, ^{137}Cs and ^{210}Po, egg for Ra. It was found that the contents of U and Th Series nuclides in samples collected from Yangjiang high background area were higher than those from normal area, while around the U mining area, only contents of U Series nuclides showed to be obviously high.

Table 1. Average concentration range of radionuclides in various food and water

Radionuclide	Concentration range in food, Bq/ Kg	Average concentration in water, Bq/ L
^{40}K	23.8- $3.9\times10^{}$	0.3
^{87}Rb	0.53- 6.9×10^{-1}	/
U	8.4×10^{-3}-6.9×10^{-1}	3.3×10^{-3}
^{226}Ra	1.3×10^{-2}-2.0	1.1×10^{-2}
^{210}Pb	9.1×10^{-2}-4.0	0.7×10^{-2}
^{210}Po	4.9×10^{-2}-4.0	0.5×10^{-2}
Th	1.9×10^{-3}-0.2	0.1×10^{-2}
^{228}Ra	1.5×10^{-2}-4.2	0.6×10^{-2}
^{227}Ac	1.3×10^{-4}-2.2×10^{-2}	/
^{14}C*	7.0 -1.47×10^{2}	/
^{3}H*	2.34 -13	7.7
^{90}Sr	3.8×10^{-2}-12	1.37×10^{-2}
^{137}Cs	3.2×10^{-2}-1.6	5.0×10^{-4}
^{144}Ce	undetectable- 1.0	/
^{106}Ru	9.5×10^{-3}-5.2×10^{-1}	/

* including both artificial and natural sources

2. Public AI of the radionuclides by ingestion in normal radiation background area of China

The estimated results showed in Table 2 indicate that ^{40}K, ^{14}C, ^{3}H and ^{87}Rb are the nuclides with more contribution to the total than the others. Most of these AI come from food, while only the AI for tritium and U come from drinking water.

Table 2. Public AI by ingestion for Chinese male adult (Bq/a)

Radionuclide	Food		Water		Total
	AI	%	AI	%	
U Series: U	10.4	34.3	19.9	65.7	30.3
^{226}Ra	22.1	77.0	6.6	23.0	28.7
^{210}Pb	69.1	94.3	4.2	5.7	73.3
^{210}Po	59.8	95.2	3.0	4.8	62.8
Th Series: Th	5.3	89.8	0.6	10.2	5.9
^{228}Ra	30.2	89.3	3.6	10.7	33.8
Others: ^{227}Ac	0.3		/		
^{40}K	2.3×10^{4}	99.2	1.8×10^{2}	0.8	2.3×10^{4}
^{87}Rb	1.3×10^{3}		/		
^{14}C	1.6×10^{4}	97.5	4.0×10^{2}	2.5	1.6×10^{4}
^{3}H	2.1×10^{3}	31.3	4.6×10^{3}	68.7	6.7×10^{3}
4 Artificial nuclides	1.1×10^{2}	92.7	8.6	7.3	1.2×10^{2}

3. Public CDE of the radionuclides by ingestion in normal radiation background area of China

Based on above mentioned AI, public CDE of these nuclides were estimated and are showed in Table 3. Because ^{40}K in the body is under close homeostatic control, the CDE here is quoted from the world average[6]. It can be seen from the Table that the total CDE was estimated to be about 0.35 mSv, the part contributed by natural nuclides accounted 99.4 % of the total, the most important contributors were ^{40}K, ^{210}Pb and ^{210}Po. The estimated value is quite consistent with the world average published in UNSCEAR 1988 Report [6]. The food with the biggest contribution to the total are vegetable, yam, flour, rice and water. In addition, It was found that the total CDE for U Series and Th Series nuclides in Yangjiang high background area were about 2.5 and 6.7 times those in normal area respectively, while in the U mining area, only the CDE of U Series nuclides was 6.4 times that in normal area and the value of Th Series was almost the same as that in normal area.

Table 3. Estimated CDE by ingestion for Chinese male adult

Radionuclide	Food (Sv)	Water (Sv)	Total (Sv)	Relative contribution(%)
U Series: U	6.7×10^{-7}	1.28×10^{-6}	1.95×10^{-6}	0.5
^{226}Ra	6.9×10^{-6}	2.06×10^{-6}	8.96×10^{-6}	2.5
^{210}Pb	9.7×10^{-5}	5.90×10^{-6}	1.03×10^{-4}	28.9
^{210}Po	2.6×10^{-5}	1.30×10^{-6}	2.73×10^{-5}	7.7
Th Series: Th	3.9×10^{-6}	0.44×10^{-6}	4.34×10^{-6}	1.2
^{228}Ra	1.0×10^{-5}	1.19×10^{-6}	1.12×10^{-5}	3.1
Others: ^{227}Ac	1.1×10^{-6}	/	1.1×10^{-6}	0.3
^{40}K			1.80×10^{-4}	50.6
^{87}Rb	1.7×10^{-6}	/	1.7×10^{-6}	1.7
^{14}C	9.0×10^{-6}	0.41×10^{-7}	9.41×10^{-6}	2.6
^{3}H	3.5×10^{-8}	7.68×10^{-8}	1.11×10^{-7}	0.0
Artificial:				
^{90}Sr	2.2×10^{-6}	2.97×10^{-7}	2.49×10^{-6}	0.5
^{137}Cs	4.9×10^{-7}	0.4×10^{-8}	4.94×10^{-7}	0.1
^{144}Ce	3.2×10^{-8}	/	3.2×10^{-8}	0.0
^{106}Ru	3.9×10^{-8}	/	3.9×10^{-8}	0.0
Total CDE	1.59×10^{-4}	1.31×10^{-5}	3.51×10^{-4}*	100.0

* including ^{40}K

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