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SHORT LIVED RADIONUCLIDES IN FOOD AND FEED AFTER THE NUCLEAR ACCIDENT IN CHERNOBYL

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This paper presents the results of identification of short-lived radionuclides (I-131, Cs-136, Ce-141, 144, Ru-103, 106, Ba (La)-140, Zr-95, Nb-95, Sb-125, Rh-102) and evaluation of their mass activities in food (milk and dairy products, meat, honey, fruit, vegetables) and animal feeds (oilseed rape, alfalfa, fresh green mass) after the nuclear accident at Chernobyl, in 1986. The results indicate that in the first month after the accident and afterwards, in the first half year, the contribution of short-lived radionuclides in the total activity of the samples ranged from 2-64%, varying with type of food and feed, locality and time of sampling. In relation to the activity of I-131, the short lived radionuclides contributed from 1.3 to 470%, while in relation to the activities of the isotopes Cs-134 and Cs-137, the activity of the short-lived radionuclides ranged from 12% to more than 300% in the first half year after the accident.

Key words: radionuclides, nuclear accidents, food, feed, gamma spectrometry

INTRODUCTION

After the nuclear accident at Chernobyl in 1986, radioactive material was widely dispersed over the territory of the Soviet Union and European countries. Only 25% of the released material escaped during the first day of the accident, the rest escaping over the next nine days. The release represented about $2x10^{18}$ Bg or about 3-4% of the core inventory of the plant. It comprised 10% of Cs-134, 13% of Cs-137, 20% of I-131, 15% of Te-132 and 3-6% each of other radionuclides. The transit time of 36 hours over a distance of some 1200 km indicated an average transfer speed of 10 m/s. More than 20 nuclides were identified during the initial period and after-words. The more volatile fission products such as I-131, 132, Cs-134, 137, were dominant as expected, but nuclides from less volatile elements such as Zr-95, Ce-141, 144 and others were also present, carried by fuel fragments. Single fuel fragments containing mainly Ru-103, 106 with a total average activity of 10 kBq appeared as hot particles (IAEA Safety Ser. 75, 1986).

Generally, during the accident and afterwards, only I-131, Cs-134 and Cs-137 have been systematically measured in food, while others were only reported in air or depositions (UNCEAR Rep., 1988). The Swedish report on radiocontamination of zooplankton in lakes is among the rare exceptions (Moberg, 1991).

The radioactive material deposited in Yugoslavia contained both long-lived and short-lived radionuclides, but the level of radiocontamination was rather nonuniform, mainly due to meteorological conditions. The level of radioactivitiy found in food and feed strongly varied with locality and time of sampling. Nevertheless, immediately after the accident some of the short-lived radionuclides, besides I-131, reached food and feed in considerable amounts (Đurić, 1988; Popović, 1988). Sheep breeding was the most endangered within the meat production process, while alfalfa and oleaceous plants were the most contaminated among fodder plants, due to the season (Đurić, 1989).

MATERIALS AND METHOD

Samples of food and feed were collected randomly over the country. The activity of the radionuclides in fresh, nonmineralized samples was determined on a Ge(Li) detector (ORTEC, relative efficiency 23%) and a 4096 channel analyzer (ND-100) by standard gamma spectrometry.

Calibration was performed with a point etalon source of Eu-152 (EGMA3, 2.579×10^5 Bq'on 1. 5. 86, estimated with the overall uncertainty of 3%) for the energies from 121. 78-1403.08 keV. The efficiency for different geometries (a Marinelli beaker 0.6l for fluids and a 200g PVC cylinder for solids) and different matrices were determined using secondary standards for fluid and solid state carriers (Đurić, 1986).

The counting time interval was 4,000-40,000 s depending on the total activity of the sample. The total error of the activity estimation was less than 20% on average.

RESULTS AND DISCUSSION

During May and June 1986, about twelve of the short-lived (besides I-131) or the comparatively short-lived radionuclides were identified in nearly all of the investigated samples of food and feed: I (Te)-132, Cs-136, Ce-141, 144, Ru 103, 106, Ba(La)-140, Zr-95, Nb-95, Mo-99, Sb-125, Rh-102. Their activities varied in a large range from 0.1 Bq/kg to several kBq/kg depending on locality, time of sampling, type of food or feed and the half life of the radionuclide itself (Popović, 1989; Popović, 1992). Some of the radionuclides (Ru-106, Sb-125, Rh-102) however, could be detected only after the decay of interfering gamma lines, in the samples collected in June and afterwards. The isotope Ag-110m from the material used to bury the reactor, was detected in the majority of the samples, too. Its activity in food was below 5Bq/kg, but it was significantly higher in most feeds.

Table 1. The contribution of short-lived radionuclides to the total activity of food and fodder in the first half of 1986

Food & feed	% in the total activity	% compared to I-131	% compared to Cs-134+137
cow milk	26	45	188
sheep milk	1.5	1.3	73
fresh cheese	13	18	98
lamb	6.5	14	13
lamb giblets	8.4	41	12
game	18	100	23
fruit	40	470	79
vegetables	50	164	264
honey	6.3	7.4	70
fresh green mass	49	470	120
oilseed rape	64	305	308
alfalfa	28	–	38

Generally, the contribution of short-lived radionuclides to the total activity of food and feed (Table 1.) was significant and ranged from 2 to 64%. A higher percentage was found in vegetables, fruit, fresh green mass and oilseed, mainly as a result of deposited radiocontamination. Compared to the activity of I-131 and the activity of Cs-134 and Cs 137, the activity of the short-lived radionuclides could not be neglected, especially taking into account the half lives of some of the radionuclides (284 days for Ce-144; 2.77 years for Sb-125; 368 days for Ru-106; 206 days for Rh-102 etc).

It can therefore be concluded that in the estimation of the total dose ingested in the first month and immediately afterwards, in the first year after nuclear accidents of this kind, one should also consider the contribution of short-lived radionuclides.

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KRATKOŽIVEĆI RADIONUKLIDI U HRANI I HRANIVU POSLE NUKLEARNE NESREĆE U ČERNOBILU

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SADRŽAJ

U radu su dati rezultati identifikacije kratkoživećih radionuklida i procena njihove aktivnosti u uzorcima hrane i hraniva posle nuklearne nesreće u Černobilju, aprila 1986. godine. Neposredno posle nesreće i kasnije, u prvoj polovini godine, doprinos kratkoživećih radionuklida u ukupnoj aktivnosti ispitanih uzoraka bio je od 2-64%, zavisno od vrste uzoraka, mesta i vremena uzorkovanja. U odnosu na aktivnost I-131, udeo kratkoživećih radionuklida bio je u opsegu od I-470%, a u odnosu na aktivnost izotopa Cs-134 i Cs-137 u prvih par meseci posle nesreće, ovaj procenat je iznosio i do 300%.