

INFLUENCE OF CATTLE FEED ON ^{137}Cs ACTIVITY IN MILK

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The influence of the Chernobyl nuclear plant accident in 1986 on ^{137}Cs activity in cattle feed and milk in the regions of the Republic of Serbia was analysed for the period 1986-1996. The average ^{137}Cs activity concentrations in cattle feed and ^{137}Cs activity in milk in Belgrade, Niš, Novi Sad, Zaječar and Užice were determined. The results indicate that the spatial distribution of ^{137}Cs activity in cattle feed (grass and alfalfa) were compared with corresponding ^{137}Cs activity in milk in the May - October feeding period, and activity concentrations in cattle feed (hay and silage) were compared with corresponding ^{137}Cs activity in milk in the November-April period. The obtained results indicate a strong influence of the cattle feeding regime on ^{137}Cs activity in milk. Thus, a direct correlation between the ^{137}Cs activity in cattle feed and in milk was established.

Key words: ^{137}Cs activity, milk, cattle feed, Chernobyl accident

INTRODUCTION

Due to the presence of radioactive materials in the environment and therefore in the "food chain", animal products become important pathways from the source of contamination to the human organism. Ingestion of biologically significant radionuclides such as ^{137}Cs and ^{90}Sr increases the degree of somatic and genetic risk and confirms the significance of continuous monitoring of radionuclide contents in food (Cardis et al., 1996; Dreicer et al., 1996).

The partial meltdown of the nuclear reactor at Chernobyl in April 1986 released high amounts of radionuclides into the environment, and spread them over a large part of Europe. Deposition of radiocesium from the Chernobyl accident in Serbia occurred at the beginning of May 1986. A large amount of ^{137}Cs was deposited on the ground, on forage crops, grass and feed plants, therefore, entering all compartments of the affected ecosystems. ^{137}Cs was soon detected in the milk of cows grazing on pastures or fed on hay-silage

mixtures harvested in the regions (Anderson and Lönsjö, 1988; Johanson et al., 1989).

Systematic measurements of radioactive contamination in various samples from the environment were performed in the Institute of Occupational and Radiological Health "Dr Dragomir Karajović" from 1986-1996. The content of radionuclides was determined in aerosol, soil, fallout (wet and dry deposition), rivers, lakes, drinking water, human and animal food (Pantelić et al., 1996; Maksić et al., 1997). The radioactivity in cattle feed increased in May 1986 due to the Chernobyl accident. The values of ^{137}Cs activity in cattle feed decreased during 1987 to 1996 in all regions in the Republic of Serbia (IORH, 1986-1996).

A large part of the radiocesium in May 1986 was deposited on the surface of the soil and plants. In the following years, the radiocesium was taken up by plants through the roots, and being present in a more bioavailable form, more easily penetrated the gastrointestinal tract of grazing animals (Ward et al., 1989). The measurements suggested that ^{137}Cs is more readily absorbed by the animal when incorporated in the plant than in fallout particles, as was found in the first year after the fallout (Howard et al., 1989). The degree of radionuclide transfer from the digestive tract depends on animal species and the type of feeding (Vitorović et al., 1997). The gastro-intestinal absorption of cesium was reported to be 60-80% for ruminants in general (Karlen, 1993). Radiocesium is deposited in all soft tissues and it is secreted in milk in the range of 5-12% of the amount ingested (Draganović and Vitorović, 1990).

The aim of the present study was to estimate the relationships between the ^{137}Cs activity in cattle feed and milk in the Republic of Serbia after the Chernobyl accident, from 1986 to 1996.

MATERIALS AND METHODS

From 1986 to 1996, samples of cattle feed (grass, alfalfa, hay, silage) were collected twice a year (in the spring and in the autumn) in the region of Belgrade, Niš, Zaječar, Užice, Novi Sad and Subotica. Milk samples were collected monthly in Belgrade, Niš, Zaječar and Novi Sad.

Activity of ^{137}Cs was measured using a high purity germanium detector (ORTEC, relative efficiency 25%, energy resolution 1.85 keV). Counting times were from 10000 s to 30000 s depending on the total activity of the sample. The total standard error was <10%. The activity of ^{137}Cs in feed and milk was expressed as Bq per kg of fresh matter or Bq/L.

For correlation analysis we have presented only the results from the regions where both milk and cattle feed samples were collected (Belgrade, Niš, Zaječar and Novi Sad). The calculations were based on the assumption that grass (hay) represents 75% and alfalfa (silage) 25% of total green mass fed, which is 25% of the total feed for dairy cows. The average ^{137}Cs activity values in grass and alfalfa were compared with the average milk ^{137}Cs activity for the May-September feeding period and the average ^{137}Cs activity values

in hay and silage were compared with the average milk ^{137}Cs activity for the November-December and January-April periods.

RESULTS AND DISCUSSION

The average ^{137}Cs activity concentrations in cattle feed (*grass, alfalfa, hay and silage) in the Republic of Serbia (regions: Belgrade, Niš, Novi Sad, Subotica and Zaječar) are shown in Figure 1. The average ^{137}Cs activity concentrations in cattle feed (grass and hay) from the Užice region are shown separately in Figure 2. Higher ^{137}Cs activities in milk and feed in this region were due to the higher ^{137}Cs concentration in the fallout during 1986 (IORH, 1986).

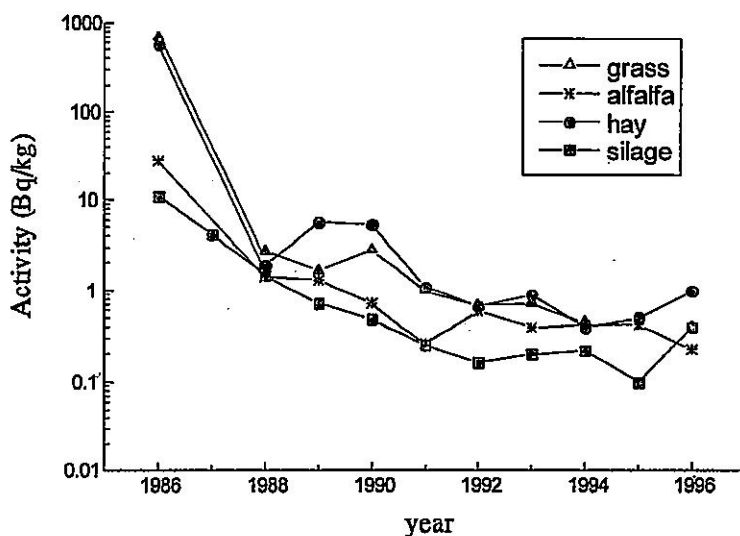


Figure 1 ^{137}Cs activity in cattle feed from 1986–1996 (average values for Belgrade, Niš, Zaječar, Subotica and Novi Sad)

The data for the ^{137}Cs activity in milk in Belgrade, Niš and Novi Sad regions are presented in figures 3-5. The values presented in Figures 3 and 4 are monthly values for the years 1986 and 1987, respectively. The annual average values of the ^{137}Cs activities for the ten-year period from 1986-1996 are presented in Figure 5. Data for the Zaječar region are given only for 1992 – 1996 (Figure 5).

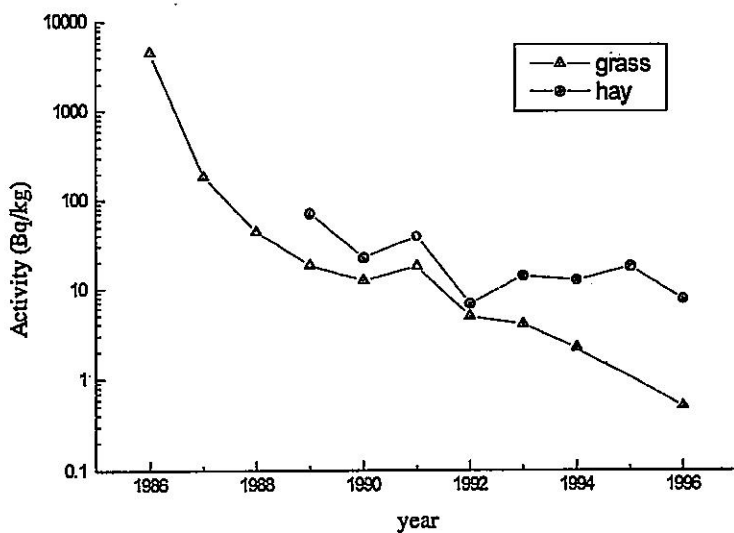


Figure 2 ^{137}Cs activity in cattle feed in the Užice region (1986-1996)

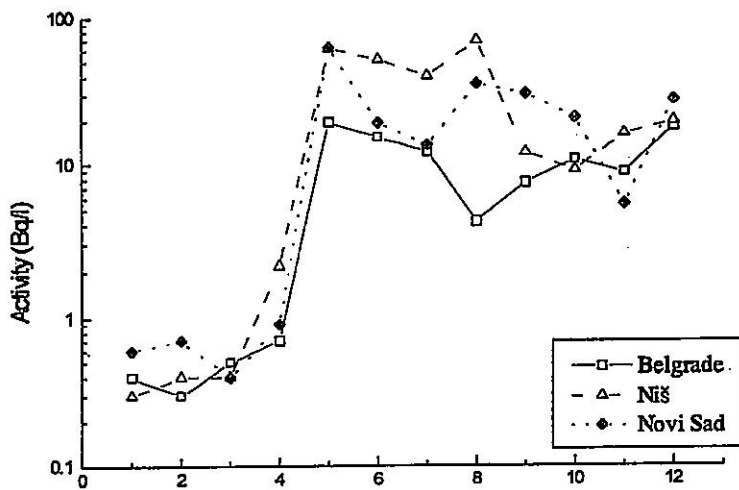


Figure 3 ^{137}Cs activity in milk in 1986

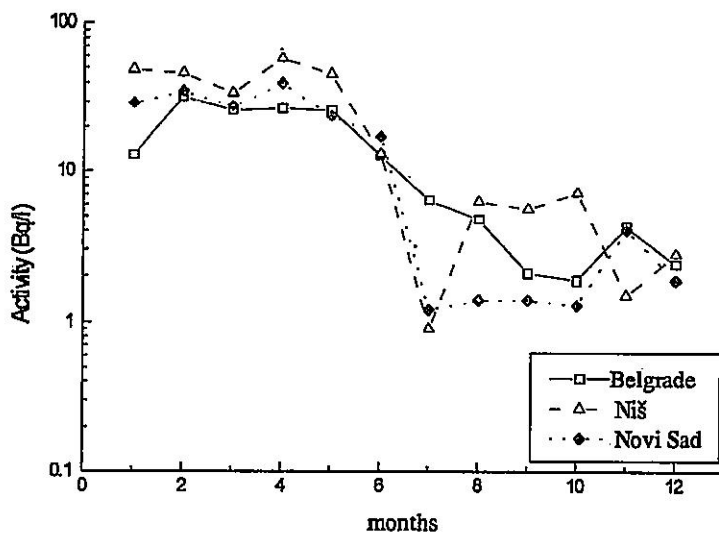


Figure 4 ^{137}Cs activity in milk in 1987

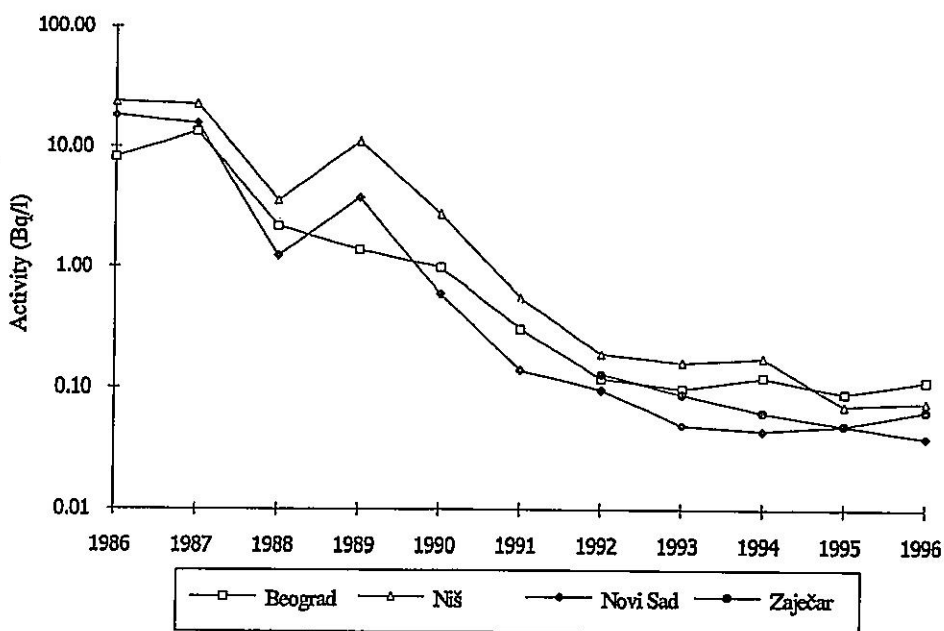


Figure 5 Average annual ^{137}Cs activity in milk from 1986-1996

The data presented in Figure 3 indicate that ^{137}Cs concentration in milk declined gradually a few months after the deposition of radioactivity (May 1986), but at the end of the year, the concentration rose again and soon reached the same level as in May and June 1986. The reason for the increase was the use of forage harvested in May and June. Afterwards, ^{137}Cs activity in the milk decreased from 1987 to 1996 in all regions in the Republic of Serbia (Figure 5).

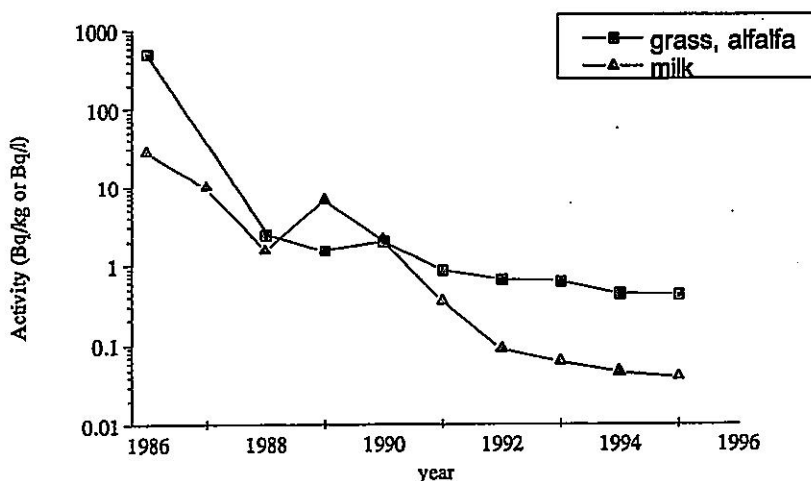


Figure 6 ^{137}Cs activity in cattle feed (grass, alfalfa) and milk (averaged values for the period May - October)

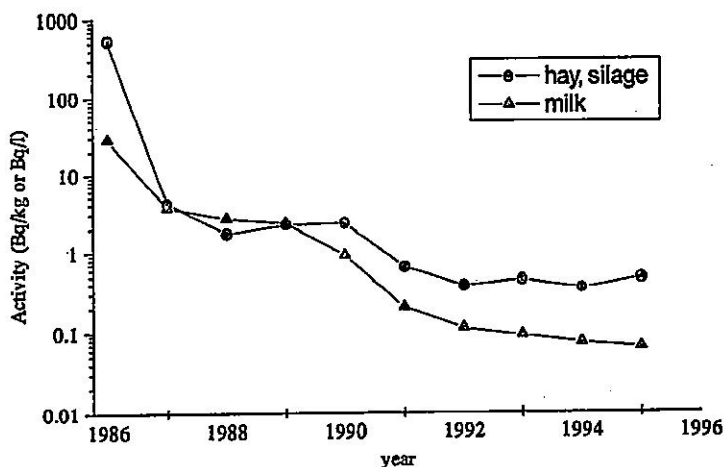


Figure 7 ^{137}Cs activity in cattle feed (hay, silage) and milk (averaged values for the period November - April)

To relate the ^{137}Cs activity in cattle feed and milk, we have chosen only the data from the regions of Belgrade, Niš, Zaječar and Novi Sad. These results are presented in Figure 6 and 7. The correlation coefficient between ^{137}Cs activity in cattle feed (grass, alfalfa) and ^{137}Cs activity in milk was 0.97. The correlation between ^{137}Cs activity in cattle feed (hay, silage) and ^{137}Cs activity in milk was 0.99. These results strongly confirm the influence of the change of cattle feeding regime on ^{137}Cs activity in the milk. Also, transfer of ^{137}Cs activity from feed to milk was 9-14% for grass and alfalfa and 13-29% for hay and silage in the last few years.

CONCLUSIONS

The Chernobyl nuclear plant accident resulted in considerable radioactive contamination of the environment in the Republic of Serbia, mainly during the first half of 1986. The significant ^{137}Cs activity measured in cattle feed in 1986, decreased gradually in the period 1986-1996. The radiocesium concentration in milk decreased only a few months after the deposition, and then at the beginning of winter, the concentration rose again and soon reached the maximum level for 1986, due to the use of hay and silage prepared in 1986. Afterwards ^{137}Cs activity in milk continuously decreased from summer 1987. The variations of ^{137}Cs activity in milk correspond relatively well with the estimated seasonal variation of ^{137}Cs intake from different feeds.

The presented results confirm that there was a direct correlation between the contamination of cattle feed and the contamination of milk and the strong influence of the cattle feeding regime on ^{137}Cs concentration in milk.

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AKTIVNOST ^{137}Cs U MLEKU U ZAVISNOSTI OD NAČINA ISHRANE STOKE

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SADRŽAJ

U radu je diskutovan uticaj Černobiljske nesreće na sadržaj ^{137}Cs u uzorcima stočne hrane i mleka u Republici Srbiji u periodu 1986-1996. godina. Rezultati merenja srednjih vrednosti aktivnosti ^{137}Cs u stočnoj hrani i mleku u Beogradu, Nišu, Novom Sadu, Zaječaru i Užicu ukazuju na neravnomernu raspodelu aktivnosti ^{137}Cs u padavinama tokom 1986. godine. Poređenje rezultata merenja specifične aktivnosti u stočnoj hrani (trava i lucerka) sa sadržajem ^{137}Cs u mleku u periodu od maja do oktobra, kao i poređenje sadržaja ^{137}Cs u stočnoj hrani (seno i silaža) sa sadržajem ^{137}Cs u mleku u periodu od novembra do aprila pokazuje da promena načina ishrane značajno utiče na aktivnost ^{137}Cs u mleku. Takođe je utvrđena i direktna korelacija između kontaminacije stočne hrane i kontaminacije mleka.