

## EFFECTIVENESS OF CESIUMBINDERS IN REDUCING Cs-137 TRANSFER INTO BROILER TISSUES

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*For groups of male broiler (10 birds per group) were used in order to examine the effects of different Cs-binders in cases of alimentary contamination with radiocesium-137. The first, control group received per os 3 ml CsCl solution per chick, total activity of 3120 Bq alone. The other three groups received the same level of contamination and different Cs-binders per os: second group-zeolite, third group - AFCF and fourth group - Fe-ascorbate.*

*Gammaspectrometric measurements of Cs-137 activity were performed on fresh homogenous samples of meat and edible organs taken 3 and 7 hours after contamination and protection.*

*Zeolite and AFCF showed significant protective effects. Reduction of radiocesium-137 accumulation in meat ranged between 60-70% and in edible organs it was greater than 50%, in comparison to the control group. Protection was shown by Fe-ascorbate, but the effectiveness was lower (20-40%).*

*Key words: Cs-137, Cs-binders, protection, broilers*

### INTRODUCTION

Radioactive contamination of the environment, widespread under peacetime and from accidents, is particularly noticeable in animal products. The first and main form of contamination presents the greatest problem, as it is related to direct radiocontamination of vegetation. The second, indirect form, when animals consume radioactive feed and water, jeopardises the most important consumer of products of animal origin - man. Long lived radionuclides like radiocesium-137 are the major hazard.

With this in view, various methods for radiation protection of domestic animals are being investigated. One of these is the use cesiumbinders which are

able to sequester cesium in the digestive tract of animals and reduce cesium transfer into body tissues.

The history of protector use started soon after the first nuclear accidents (Vitorović and Draganović, 1995). The effectiveness of different Cs-binders was investigated. Positive effects were obtained with clay minerals like bentonite (Beresford et al., 1989) and natural and synthetic zeolites (Pethes et al., 1988; Phillippo et al., 1988).

The objective of the present study was to estimate the effectiveness of AFCF, zeolite and Fe-ascorbate in reducing the transfer of radiocesium-137 into meat and internal organs of broiler chickens a short time after the contamination.

#### MATERIALS AND METHODS

Male broilers (6 weeks of age) were fed with the usual mixture and divided into four groups (10 birds per group). Each chick was given per os 3 ml CsCl solution, of total activity 3120 Bq. The control group received only Cs-137. Chicks from the other, three experimental groups received per os different Cs-binders immediately after contamination. Thus the second group was given 6 ml zeolite solution per chick (1.6 g clinoptilolite per chick). The clinoptilolite was obtained from zeolite tuff in Serbia, Yugoslavia and technologically processed in the Institute for Technology of Nuclear and other Raw Materials, Belgrade. The third group received 3 ml AFCF solution per chick (200 mg AFCF/chick) and the fourth group 1 ml Fe-ascorbate solution per chick (50 mg Fe in 1 ml solution). Birds were sacrificed at 3 and 7 hours after contamination and protection. Samples of total musculature and edible organs (heart, gizzard and liver) were taken from each chick, homogenized, packed in plastic boxes and stored deep frozen. The system was calibrated using standard Cs-137 (1000 Bq) in the same geometry and density as the samples of meat and edible organs. High resolution gamma spectrometry was used for measurement of the activity of the samples. A low-background HP Ge detector (EG&G ORTEC) with relative efficiency of 10% and energy resolution of 1.75 keV (1332.5 keV  $^{60}\text{Co}$  was employed. The detector was shielded with 10 cm lead, 0.5 mm cadmium and 1.5 mm copper. The influence of nonhomogeneity of various samples was calculated and included as a systematic measurement error (5%).

#### RESULTS AND DISCUSSION

The concentrations of Cs-137 found in meat of the experimental groups of broiler chickens are presented in Table 1.

Table 1. Effectiveness of treatment to prevent Cs-137 accumulation in total musculature of broiler chickens

Group	Time of sampling after introducing contamination			
	3 hours		7 hours	
	Cs - 137 (Bq/kg)	% activity of control	Cs - 137 (Bq/kg)	% activity of contro
Control	543.0 ± 120.8	100.0	621.8 ± 94.1	100.0
Zeolite	177.5 ± 42.6**	32.7	191.3 ± 51.4**	30.8
AFCF	220.4 ± 57.9**	40.6	133.0 ± 18.7**	21.4
Fe-ascorbate	247.1 ± 76.9**	50.5	534.2 ± 132.4**	85.9

\* p &lt; 0.05 vs. control; \*\* p &lt; 0.01 vs. control

Three hours after the contamination and protection significantly lower radiocesium-137 activity was obtained in the meat of broilers treated with Cs-binders than in the control group. Expressed in relation to the activity of controls the reduction of radiocesium-137 accumulation in the treated groups was 67.3% (zeolite), 59.4% (AFCF) and 49.5% (Fe-ascorbate). Seven hours after introducing contamination and protection the decrease due to Cs-binders was 69.2% (Zeolite), 78.6% (AFCF) and 16.1% (Fe-ascorbate). Zeolite and AFCF showed high and similar protection effects a short time after alimentary contamination of broilers with radiocesium-137. These results are in agreement with those obtained in mammals (Phillippo et al., 1988; Arnaud et al., 1988; Giese, 1989) and in chickens (Vitorović, 1992).

The radioactivity of edible organs and effects of Cs-binders are presented in Table 2.

Table 2. Effectiveness of treatment in preventing Cs-137 accumulation in edible organs of broiler chickens

Group	Time of sampling after introducing contamination			
	3 hours		7 hours	
	Cs - 137 (Bq/kg)	% activity of control	Cs - 137 (Bq/kg)	% activity of contro
Control	3451.0 ± 420.2	100.0	2592.2 ± 720.1	100.0
Zeolite	1266.6 ± 291.2**	36.7	1330.0 ± 298.3**	51.3
AFCF	859.2 ± 223.1**	24.9	1246.3 ± 221.2**	48.1
Fe-ascorbate	1965.0 ± 415.1**	56.9	2091.0 ± 232.1**	80.7

\* p &lt; 0.05 vs. control; \*\* p &lt; 0.01 vs. control

Similarly to the meat all three Cs-binders showed significant protection effects in the edible organs of broilers contaminated with radiocesium-137, three hours after alimentary contamination. Various forms of iron (iii) hexacyanoferrates (ii) known as Prussian Blue were investigated (Nigrović, 1965; Draganović et al., 1988; Giese, 1988; Hove and Ekern, 1988; Jones, 1988; Vitorović, 1992) showed that ammonium-iron hexacyanoferrate (AFCF) has high binding capacity to

cesium and is not absorbed but remains stable in the digestive tract and is apparently non-toxic in the dose required to control cesium absorption. Expressed as a proportion of the activity of control chickens the accumulation of radiocesium in edible organs was markedly lower: 65.3% (Zeolite), 51.9% (Zeolite), 51.9% (AFCF) and 19.3% (Fe-ascorbate). Deposition of radiocesium-137 in the edible organs was higher than in the musculature.

Seven hours after introducing contamination the decrease was: 48.7% (Zeolite), 51.9% (AFCF) and 19.3% (Fe-ascorbate).

### CONCLUSIONS

Zeolite and AFCF showed significant protective effects in broilers contaminated per os with radiocesium-137. The reduction of radiocesium accumulation in meat and edible organs was often higher than 60%, in comparison to the control group. Fe-ascorbate also showed a protective effect but its effectiveness was lower. The results of this study demonstrate that it is possible to obtain animal products for human consumption with lower radiocesium-137 activity in a short time after the contamination, by using AFCF and zeolite and possibly Fe-ascorbate, as Cs-binders. This suggests that the presence of low concentrations of Cs-binders in standard feed mixtures for animal nutrition can reduce the radiation risk for the most important consumer of animal products-man.

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#### EFIKASNOST SUPSTANCI ZA VEZIVANJE CEZIJUMA NA SMANJENJE PRELASKA Cs-137 U TKIVA BROJLERA

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#### SADRŽAJ

U ovom radu su prikazani rezultati ispitivanja efikasnosti zeolita, AFCF i Fe-askorbata na smanjenje prelaska Cs-137 u mišiće i jestive unutrašnje organe (srce, bubac, jetra) brojlerskih pilića, alimentarno kontaminiranih sa radiocezijumom-137. Pilići, uzrasta 6 nedelja, su bili podeljeni u 4 grupe sa po 10 jedinki u grupi. Svi su dobili po 3 ml rastvora CsCl ukupne aktivnosti 3120 Bg. Prva grupa je bila kontrolna. Ostale tri grupe su dobijale pored Cs-137 i odgovarajući radioprotektor. Druga grupa 6 ml rastvora zeolita (1,6 g klinoptilolita po piletu), treća 3 ml rastvora AFCF (200mg AFCF po piletu), a četvrta 1 ml rastvora Fe=askorbata (50 mg Fe i 1 ml rastvora). Posle 3 i 7 sati od kontaminacije žrtvovano je po 5 jedinki iz svake grupe, a u uzorcima mesa i jestivih unutrašnjih organa izvršeno je gamaspektrometrijsko merenje aktivnosti radiocezijuma-137.

Dobijeni rezultati su pokazali da zeolit i AFCF imaju veliku efikasnost (više od 60%) u sprečavanju prelaska Cs-137 u meso i jestive unutrašnje organe iz digestivnog trakta. Nešto slabiji efekat ispoljila je primena Fe-askorbata. Kako su ovi značajni radioprotekcionni efekti postignuti za kratko vreme (3 i 7 sati) posle kontaminacije nameće se zaključak da se za praksu može preporučiti dodavanje ovih radioprotekcionnih sredstava, u malim količinama, kao stalnih sastojaka smeša za ishranu domaćih životinja. To se prvenstveno odnosi na akcidentalne uslove ali može biti i preventivna mera u mirnodopskim uslovima.