

THE APPLICATION OF AMMONIUM—FERRIC (III) — HEXACYANO—FERRATE (II) IN THE PROTECTION OF CHICKEN MEAT FROM CONTAMINATION WITH RADIOCESIUM

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The objective of our study was to investigate the effects of AFCF on alimentary ^{137}Cs contamination of broiler chickens. The experiment involved 450 male broiler chickens, 35 days of age, and 1020 g average body weight. The activity of ^{137}Cs was measured in fresh homogeneous samples of meat and edible internal organs, at 24 hours and 7. and 14. days after the last application of protector or contamination (^{137}Cs). Two experiments were conducted — one in which the level of AFCF was increased from 100 — 500 mg/chick, and the other where the level of ^{137}Cs ranged from 1250 to 6250 Bq/chick. The results showed that 200 mg of AFCF per chicken is the most appropriate concentration. In cases of acute or chronic contaminations, the effects of applying AFCF at there different times: before, simultaneously with and after the contamination, was examined. The best protective effects were achived by simultaneous and post contamination applications. The conclusion of this work is that AFCF possesses great capacity to bind radiocesium in the alimentary canal and is most suitable for prevention of contamination of meat and edible organs.

Key words: ^{137}Cs , radioprotection, AFCF, broilers, meat

INTRODUCTION

The contamination of different animal products with ^{137}Cs can be an important problem for human health (Draganović and Vitorović, 1990; Stanković et al., 1990), because of its relatively long physical half-life (about 30 years). Ingested through animal food and drinking water, ^{137}Cs reaches the bloodstream and is widely distributed among soft body tissues and organs (Torstein et al., 1988). Fortunately, it was shown that per os administration of different complex salts to animals can have a positive effect which was confirmed

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by many test including the radio hygienical validity of animal products for human consumption (Joyce et al., 1991). One of these complex salts, ammonium ferrie hexacyanoferrate (AFCF), showed a high potential to bind ^{137}Cs in the gastrointestinal tract of domestic and grazing animals (cattle, sheep, pigs) (Bailer, 1988; Giese, 1988; Margenthal, 1988).

MATERIALS AND METHODS

The broilers, used in this study, were reared on a commercial farm ("13. May PKB") and fed with the usual mixtures (starter and grower). The investigations was conducted on a sample of 450 male chickens in four experiments. The birds were administered per os in additional liquid solution: CsCl of 1250 Bq/ml activity and AFCF protector. Experiment 1. was conducted to determine the optimal concentration of AFCF for the defined level of ^{137}Cs contamination (1250 Bq/chick). The concentration of AFCF applied was in the range of 100 — 500 mg in 1 ml aqueous solution, per chick. Experiment 2. was conducted to determine the binding ability of a defined concentration of AFCF (200 mg/chick) to increasing of ^{137}Cs (1250 — 6250 Bq/chick). Both, AFCF and ^{137}Cs were simultaneously administered to each chick. Experiment 3. was conducted to determined the optimal time of protector administration in the case of a single contamination and protection. AFCF (200 mg/chick) was applied 24 hours before, after and simultaneously to contamination (1250 Bq/chick). Experiment 4. was conducted to determined the optimal time of protection in the case of repeated contamination. AFCF (200 mg/chick) was applied four days consecutively before, after and simultaneously to four days of ^{137}Cs (1250 Bq/chick) contamination.

Birds were sacrificed 1., 7. and 14. days after contamination and protection. The concentration activity of ^{137}Cs in samples of the complete homogenous meat (red and white) and edible internal organs (liver, gizzard and heart) was counted using a high — resolution (185 keV at 1.33 MeV), low — background Ge detector (ADCAMP MCB — 350, ORTEC), at a relative efficiency of 28%. The detector was connected to a multichannel analyzed and microcomputer. The statistical significance, within and between the experimental groups) was tested using F and Tukey tests.

RESULTS AND DISCUSSION

Many studies have been carried out in order to decrease the radiation risk for human health and to find a suitable system for the protection of animal production from the elevated presence of ^{137}Cs in the environment (Joyce et al., 1991).

In our study, it was first necessary to investigate the presence of ^{137}Cs in chicken feed mixtures (starter and grower). The measured amount of ^{137}Cs in the starter was 26.1 Bq/kg fresh weight of sample (fw) and in the grower 31.2 Bq/kg fw. These results agreed with these of other authors (FAO report, 1987; Mičić et al., 1988; Stanković et al., 1980). In the tissues of chickens fed

with these mixtures low levels of ^{137}Cs activity were found. The average value in the meat was 2.5 Bq/kg fw and in the edible internal organs 5.6 Bq/kg fw.

The first step in the examination of the protective effect of AFCF was to determine the necessary concentration for chickens alimentarily contaminated with ^{137}Cs , when a minimal quantity of ^{137}Cs is distributed in the meat and edible internal organs. The results obtained (Figure 1) showed that the administration of AFCF in all of the five experimental groups (100 — 500 mg/chick) resulted in significantly lower ^{137}Cs levels in meat and edible internal organs, compared to the control group (without AFCF). A noticeable protective effect (about 96 — 99%) was achieved within the first 24 hours after the applied contamination and protection. With the further increase in concentration of liquid solution of AFCF (300 — 500 mg/chick), the measured ^{137}Cs activity level was not significantly changed. This prompted us the use 200 mg AFCF per chick in our further experiments. According to data in the literature, the optimal concentration of AFCF differed for different animals, body weight and type of feeding. A highly protective effect of AFCF (90%) was established with 3 g per day in dairy cattle (Giese, 1988) and also, with 2 g/day in swine (Giese, 1989), 1 g/day in lambs and 2 g/day in sheep (Bailer, 1988; Margenthal, 1988.).

Using the selected AFCF concentration of 200 mg/chick, we verified the effect of this protector after per os contamination or chickens with increased

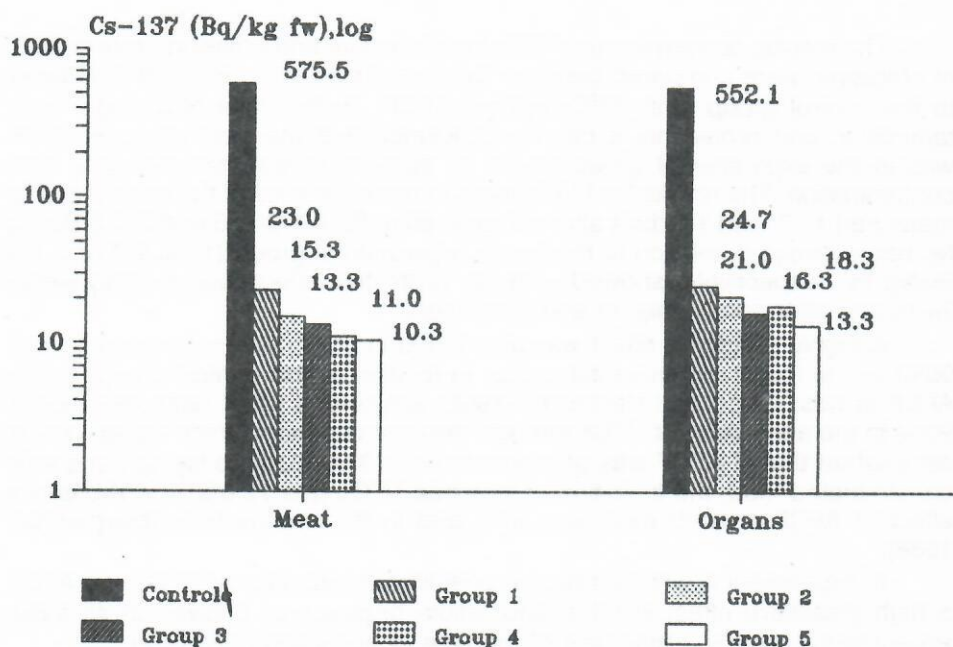


Figure 1. Cs-137 level in meat and edible internal organs in the control (without AFCF) and experimental groups of chickens, 24 hours after application of 1250 Bq/chick Cs-137 and different concentrations of AFCF (100, 200, 300, 400 and 500 mg/chick).

levels of ^{137}Cs (experimental groups: from 1250 to 6250 Bq/chick). The results obtained (Table 1) indicate that a very high degree of protection (95 — 99%) was achieved within first 24 hours with 200 mg AFCF, both for meat and the internal organs, regardless of the quantity of ^{137}Cs introduced.

As environmental contamination with ^{137}Cs can be either single or repeated in experiments 3. and 4. we tried to simulate such conditions in broilers, in order to determine the best time for AFCF application.

Table 1. Protective effect of 200 mg AFCF in meat and edible internal organs, depending on the degree of contamination of chickens with ^{137}Cs (Bq/kg fw)

Group	AFCF (mg/chick)	^{137}Cs (Bq/chick)	Activity of Meat	^{137}Cs (Bq/kg fw) Organs
Control	—	5000	2597.0 \pm 308.4	1477.7 \pm 247.2
Control	—	1250	547.4 \pm 7.8	552.1 \pm 7.6
1	200	1250	15.5 \pm 1.5	21.0 \pm 11.0
2	200	2500	67.3 \pm 16.6	60.7 \pm 13.6
3	200	3750	74.3 \pm 12.7	73.3 \pm 2.1
4	200	5000	78.3 \pm 18.3	82.3 \pm 4.0
5	200	6250	139.7 \pm 46.0	187.0 \pm 40.4

Means \pm Standard deviation

The results, concerning the ^{137}Cs levels in meat and edible internal organs of chickens, were compared between the experimental groups and in relation to the control group (only ^{137}Cs without AFCF). In the case of a single contamination and protection, it can be concluded that the best effect of AFCF was in the experimental group where its application was simultaneous with contamination. The results for ^{137}Cs levels in meat samples of the control group measured 1., 7. and 14. days after contamination (574.4; 363.6 and 217.8 Bq/kg fw, respectively) in relation to the fourth experimental group (15.3; 9.7 and 7.0 Bq/kg fw, respectively) showed a highly protective effect (about 97%) within 24 hours, after contamination and protection.

A highly protective effect was also found in edible internal organs (about 95%) in the fourth experimental group, in relation to the control group. Using AFCF in rats, Giese and Hantzsch, (1968) achieved a great decrease (about 90%) in the absorption of ^{137}Cs through the gastrointestinal tract. Nazel, (1971) established that, if AFCF was administered simultaneously to laying hens with contaminated food, the inhibition of ingested ^{137}Cs was 72.6%. The Protective effect of AFCF in lamb meat was 67% and in the organs 90% (Margenthal, 1988).

In experiment 4. with four days repeated administration of ^{137}Cs and AFCF a high protective effect in meat and edible organs was achieved in all three experimental groups, regardless of the time of application (Table 2).

In the control group (meat — 2597.0 Bq/kg fw; edible internal organs — 1447.7 Bq/kg fw), a high level of activity of ^{137}Cs was measured 24 hours after the last contamination. The protection effect of 88% in the second experimental

group (protection prior to contamination) in relation to the control group, indicated the possibility of permanent administration of AFCF in chicken feed when there is ^{137}Cs contamination of the environment. Similarly to that the results obtained in the third experimental group indicated that a high protective effect was also possible after the contamination. As in experiment 3., the best protective effect (98%) was achieved in the case of simultaneous protection and contamination (fourth experimental group).

Table 2. Activity of ^{137}Cs measured in meat after different times from protection, in the case of repeated contamination (Bq/kg fw)

Group	Activity of ^{137}Cs Time of measurement (days)			Significance of differences (days)		
	1.	7.	14.	1 — 7	1 — 14	7 — 14
1.	2597.00	776.0	227.7	**	**	**
2.	313.7	146.7	66.0	N.S.	**	N.S.
3.	188.7	102.3	56.7	N.S.	N.S.	N.S.
4.	66.7	52.7	22.3	N.S.	N.S.	N.S.

** - $P < 0.01$; N.S. — Not Significant

Margenthal, (1988) reported that 2g of AFCF administered during 30 days of feeding with ^{137}Cs contaminated food (6000 — 7000 Bq/days) showed a high protective effect in preventing contamination of sheep meat.

CONCLUSIONS

On the basis of the results obtained the following conclusions can be drawn:

1. Feeding broiler chickens in an intensive rearing system with uncontaminated feedstuffs led to a very low ^{137}Cs level in the meat and edible internal organs (2.5 — 6.6 Bq/kg fw).

2. Determination of the optimal concentration of AFCF protector indicated that 200 mg per chick displayed a very high protective effect. The level of protection was 97% in the meat of the experimental groups 24 hours after oral intake of ^{137}Cs . Further increase of AFCF intake (300 — 500 mg/chick) did not show an improvement.

3. Using 200 mg of protector per chick, an increased ^{137}Cs radioactive contamination (from 1250 — 6250 Bq/chick) did not show any significant increase in the ^{137}Cs level in meat and edible internal organs. This confirmed the great absorptive ability of AFCF for ^{137}Cs in the digestive tract of animals.

4. In the case of single alimentary contamination of chickens with ^{137}Cs and protection with AFCF, it was shown that only simultaneous administration of AFCF with the contamination, gave almost complete protection (99%).

5. With repeated alimentary ^{137}Cs contamination of chickens repeated doses of AFCF led to a very marked decrease of ^{137}Cs level in the meat and edible internal organs, (about 90 — 95%).

6. Administration of protector AFCF through the drinking water would make it possible to achieve a high degree of radioprotection in the broiler industry, when there is ^{137}Cs contamination of feed.

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PRIMENA AMONIJUM - GVOŽĐE (III) HEXACIJANOFERATA (II) U ZAŠTITI PILEĆEG MESA OD KONTAMINACIJE RADIOCEZIJUMOM

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SADRŽAJ

Da bi se smanjio rizik po zdravlje ljudi iz animalne proizvodnje, nastoji se poslednjih godina da se pronade adekvatan sistem zaštite životinja, a time i samih namirnica animalnog porekla.

Poznati su pozitivni zaštitni efekti primene različitih kompleksnih soli u slučaju radioaktivne kontaminacije stočne hrane sa ^{137}Cs . Cilj ovog rada je bio

da se ispita efikasnost protekcioner soli AFCF u uslovima alimentarne kontaminacije brojerskih pilića radiocezijumom-137.

Ogled je obuhvatio 450 pilića muškog pola, uzrasta 35 dana, uzetih direktno iz industrijske proizvodnje. Per os su aplikovani vodeni rastvori kontaminanta u vidu CsCl i protektora AFCF. Pilići su žrtvovani 24 sata, 7 i 14 dana od poslednje aplikacije. Meren je nivo aktivnosti ^{137}Cs u homogenizovanim uzorcima celokupnog mesa pilića (tamno i svetlo) kao i u jestivim unutrašnjim organima (m. želudac, jetra i srce). Ceo rad je podeljen u četiri eksperimenta.

U prvom eksperimentu ispitivana je optimalna koncentracija (od 100 do 500 mg/pile) soli i ustanovljeno je da je količina od 200 mg AFCF po piletu minimalna a dovoljna da maksimalno spreči deponovanje ^{137}Cs u meso i jestive unutrašnje organe. Drugi eksperiment je potvrdio visoku efikasnost zaštite primenom 200 mg soli po piletu, pri rastućem nivou kontaminacije pilića ^{137}Cs (1250 — 6250 Bq/pile). U trećem i četvrtom eksperimentu ispitivano je optimalno vreme davanje protektora (pre, posle ili istovremeno) u odnosu na vreme kontaminacije. Pri tome, treći ogled — jednokratni je predstavljao simulaciju akutnog stanja dok je četvrti ogled — višekratni predstavljao simulaciju hronične kontaminacije. U ovom eksperimentu, protektor i kontaminant dati su četiri dana uzastopno, jedan za drugim. I u jednom i u drugom eksperimentu, unošenjem protektora istovremeno ili neposredno po kontaminaciji postižu se visoki efekti zaštite. U odnosu na kontrolne grupe, nivo aktivnosti izmerenog ^{137}Cs u mesu i jestivim unutrašnjim organima bio je niži za 90-99%.

