

# NATURAL SEPIOLITE EFFICIENCY IN REDUCING $^{137}\text{Cs}$ TRANSFER AND DEPOSITION INTO MEAT AND EDIBLE ORGANS OF BROILER CHICKENS

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**Abstract:** The objectives of the present study were to examine the level of radiocesium deposit in meat and edible organs of broiler chickens as well as to investigate efficiency of natural sepiolite in reducing  $^{137}\text{Cs}$  deposition in meat, liver and gizzard of alimentary contaminated broiler chickens. Broiler chickens (six weeks of age) were fed with the standard diet and each broiler was given a single oral dose of  $^{137}\text{Cs}$ , total activity of 3750 Bq. The broilers were divided into two groups (10 broilers per group). The group 1 was control (received only radiocesium). The broilers of the group 2, in addition to radiocesium received natural sepiolite solution (2 g sepiolite per bird). After 24 hours, all broilers, from each group, were stunned and killed. The samples of meat, (breast and legs), liver and gizzard were taken from each broiler, for gamma spectrometry determination of radiocesium activity. After 24 hours of contamination, 56 % of introduced  $^{137}\text{Cs}$  radioactivity was deposited in the meat (breast and legs muscles), 1 % in the liver and 2,4 % in the gizzard of broiler chickens 42 days of age. Natural sepiolite demonstrated insufficient protective action. Compared to the control group, percentage reduction (decreasing percentage) of  $^{137}\text{Cs}$  deposition in meat was 16 %, in liver 5 % and in gizzard 12 %.

**Key words:**  $^{137}\text{Cs}$ , deposition, broilers, sepiolite

## Introduction

Practical experience gained after the Chernobyl accident has shown that natural clay minerals were effective in preventing high radiocesium levels in animal products. Natural zeolite – clinoptilolite, as one of the most important natural ion exchangers, has been used for adsorption of radioactive caesium in broiler chicks (*Vitorović et al., 2002; Mitrović et al. 2007*) and pheasant

(Vićentijević *et al.*, 2006). There were determined that  $^{137}\text{Cs}$  binding efficiency of natural zeolite ranged from 50.0 % to 70.0 % (Lonin, 2009). Modified clinoptilolite (Poschl and Øezàè, 2003) also showed significant efficiency in reducing  $^{137}\text{Cs}$  transfer from feed to chicken meat.

Sepiolite is naturally occurring clay mineral of sedimentary origin. It is porous clay with a large specific surface area and with high ability to adsorb inorganic as well as organic compounds and radionuclides (Lazarević *et al.*, 2007; Lazarević *et al.* 2009). Sepiolite additives provide viscous fluids when they are dispersed in water or other liquid systems. These properties make it a valuable material for wide range of applications such as pet litters, absorbents and animal feed additives. In a practice, sepiolite used as a pellet binders for improving pellet quality (Angulo *et al.*, 1995). Addition in broiler chicken diets, sepiolite increase the nutritive value of diets by retaining digesta longer in the gastrointestinal tract. This could increase the ability of the digestive tract to hydrolyze enzymatically dietary polymers, especially in growing broilers which have faster transit times than adults (Ouhida *et al.*, 2000).

There is low information about sepiolite efficiency in radiocaesium sorption in contaminated broiler chickens.

The objectives of the present study were to examine the level of radiocaesium deposit in meat and edible organs of broiler chickens as well as to investigate efficiency of natural sepiolite in reducing  $^{137}\text{Cs}$  deposition in meat, liver and gizzard of alimentary contaminated broiler chickens.

## Materials and Methods

In this experiment 42 days of age male Hubbard broiler chickens were used. The birds were divided into two groups (10 birds per group) and reared in the cages. Body weights of broilers were uniform (2.0 – 2.2 kg). Food and water intake was ad libitum. The birds in all groups were orally contaminated (using gastric tube) receiving a single dose of 3 ml CsCl solution activity of 1250 Bq/ml (total 3750 Bq/bird). The broiler in the group 2, simultaneously with the  $^{137}\text{Cs}$  was applied, received 5 ml natural sepiolite solution, using gastric tube (2 g sepiolite per bird). After 24 hours, the broilers from each group were stunned and killed by cervical dislocation. The samples of meat (breast and legs muscles), liver and gizzard were taken from each broiler. The samples were homogenized and placed in the counting vessels of defined geometry and kept frozen at the temperature of  $-18^{\circ}\text{C}$ . The  $^{137}\text{Cs}$  activity was determined in the thawed samples using gamma spectrometry system (HPGe, ORTEC) with pure germanium vertical gamma detector with 30.3% efficiency. The measurement time was 12000 s. For each broiler, level of radiocaesium deposit was determined in samples of meat (breast and legs), liver and gizzard and expressed in Bq/sample and in percents of ingested (given)  $^{137}\text{Cs}$  activity (%). For examination the effectiveness of sepiolite,  $^{137}\text{Cs}$

activity concentration (Bq/kg fresh weight) was determined and reduction of  $^{137}\text{Cs}$  deposition in the breast meat, liver and gizzard of broiler chicks was calculated in relation to the group 1 (control) expressed in percents (decreasing percentage relative to control).

The experimental data were subjected to the analysis of variance using the STATISTICA for Windows Software (Stat Soft Inc. version 6). The significance of differences between means was tested using Tuckey's Honestly Significant Test.

## Results and Discussion

After oral contamination, radiocesium be deposited in soft tissues. The level of deposition in meat (breast and legs muscle), liver and gizzard of chickens, after 24 hours of contamination is shown in Table 1.

**Table 1.**  $^{137}\text{Cs}$  distribution and deposition into the meat, liver and gizzard of broiler chicken

Tissue/ organs	$^{137}\text{Cs}$ activity (Bq/sample)		% of ingested $^{137}\text{Cs}$ activity	
	Group 1 ( $^{137}\text{Cs}$ )	Group 2 ( $^{137}\text{Cs}$ +sepiolite)	Group 1 ( $^{137}\text{Cs}$ )	Group 2 ( $^{137}\text{Cs}$ +sepiolite)
Meat	2090 ± 112	1660 ± 109*	56.00	44.00
Liver	36 ± 6.1	32 ± 2.1	1.0	0.85
Gizzard	92 ± 8.7	81 ± 7.7	2.4	2.16

Means ± Standard deviation;

\* Statistically significance of differences ( $p < 0.05$ )

Obtained results showed that 56 % of introduced  $^{137}\text{Cs}$  radioactivity was deposited in the muscle, 1 % in the liver and 2,4 % in the gizzard (group 1, only radiocesium ingested). In the case of oral simultaneous addition of sepiolite, 44 % of introduced  $^{137}\text{Cs}$  activity was deposited in the muscle, 0,85 % in the liver and 2,16 % in the gizzard.

The effects of the administration of sepiolite on the decreasing  $^{137}\text{Cs}$  deposition in the meat, liver and gizzard of contaminated broiler chicks were presented in Table 2.

**Table 2.**  $^{137}\text{Cs}$  activity concentration (Bq/kg) in broilers meat and edible organs and efficiency of sepiolite in reduction of  $^{137}\text{Cs}$  deposition (%)

Tissue/ organs	$^{137}\text{Cs}$ activity concentration (Bq/kg)		Decreasing percentage (%)
	Group 1 ( $^{137}\text{Cs}$ )	Group 2 ( $^{137}\text{Cs}$ +sepiolite)	
Meat	2614 ± 150	2187 ± 141*	16
Liver	939 ± 67	893 ± 55	5
Gizzard	2298 ± 161	2020 ± 174	12

Means ± Standard deviation;

\* Statistically significance of differences ( $p < 0.05$ )

Broilers in group 2, which received sepiolite, showed significantly ( $p < 0,05$ ) lower  $^{137}\text{Cs}$  activity concentration in meat when compared to the broilers in control group (group 1), those who did not received sepiolite. Percentage reduction (decreasing percentage) of  $^{137}\text{Cs}$  deposition in meat was 16 % compared to the control group. In cases of liver and gizzard there were no significant differences in  $^{137}\text{Cs}$  activity concentration between group 1 and group 2. Radiocesium decreasing percentage, relative to the control group, in liver was 5 % and in gizzard 12 %.

Obtained results showed lower degree of broilers protection compared to those achieved with clinoptilolite *Vitorović et al. (2002)*, *Poschl and Øezàè (2003)*, *Vićentijević et al. (2006)* and *Mitrović et al. (2007)*. These authors stated that  $^{137}\text{Cs}$  binding efficiency of natural and modified zeolite ranged from 50.0 % to 70.0 %.

According to the researchers from Ukraine (*Lonin, 2009*) all substances with antiradiation properties can be separated into three categories by the protective action efficiency. The first category (insufficient protective action) consists of substances with protective efficiency of 0-30 %; the second category (efficient) consists of substances with protective efficiency of 30-60 % and the third category (high-efficient) consists a substances with protective efficiency of 60-100 %. On the basis of these divisions, natural sepiolite demonstrated insufficient protective action.

## Conclusion

After 24 hours of contamination, 56 % of introduced  $^{137}\text{Cs}$  radioactivity was deposited in the meat (breast and legs muscles), 1 % in the liver and 2,4 % in the gizzard of broiler chickens 42 days of age.

Natural sepiolite demonstrated insufficient protective action. Compared to the control group, percentage reduction (decreasing percentage) of  $^{137}\text{Cs}$  deposition in meat was 16 %, in liver 5 % and in gizzard 12 %.

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## **Efikasnost prirodnog sepiolita u smanjenju prelaska i deponovanja $^{137}\text{Cs}$ u meso i jestive organe brojlerskih pilića**

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### **Rezime**

Cilj ovog rada je bio da se ispita stepen deponovanja radiocezijuma u mesu i jestivim organima brojlerskih pilića, kao i da se ispita efikasnost prirodnog sepiolita u smanjenju deponovanja  $^{137}\text{Cs}$  u mesu, jetri i bubcu, alimentarno kontaminiranih pilića. U radu su korišćeni brojlerski pilići (Hubbard) uzrasta 42 dana, koji su dobili po jednu oralnu dozu  $^{137}\text{Cs}$ , ukupne aktivnosti 3750 Bq. Pilići su podeljeni u dve grupe (po 10 jedinki u grupi). Grupa 1 je bila kontrolna (dobijala je samo  $^{137}\text{Cs}$ ). Pilići grupe 2, pored radiocezijuma dobijali su, istovremeno, i rastvor sepiolita (2 g sepiolita po piletu). Posle 24 sata, izvršeno je žrtvovanje svih pilića. Uzorci celokupnog mesa (mišići grudi i nogu zajedno), jetre i bubca su uzimani od svakog pileta za gamaspektrometrijsko određivanje nivoa aktivnosti radiocezijuma. Ustanovljeno je da 24 sata posle kontaminacije, u odnosu na unetu aktivnost, u mesu se deponuje 56 % radiocezijuma, u jetri 1 % a u bubcu 2,4 %. Prirodni sepiolit ispoljio je nedovoljnu efikasnost zaštite. U odnosu na kontrolnu grupu, procenat smanjenja deponovanja  $^{137}\text{Cs}$  u mesu je bio 16 %, u jetri 5 % a u bubcu 12 %.

### **References**

- ANGULO E., BRUFAN J., ESTEVE/GARCIA E. (1995): Effects of sepiolite on pellet durability in feeds differing in fat and fibre content. *Animal Feed Science and technology*, 53, 233-241.
- LAZAREVIĆ S., JANKOVIĆ-CASTVAN I., JOVANOVIĆ D., MILONJIĆ S., JANAČKOVIĆ DJ., PETROVIĆ R. (2007): Adsorption of  $\text{Pb}^{2+}$ ,  $\text{Cd}^{2+}$  and  $\text{Sr}^{2+}$  ions onto natural and acid-activated sepiolites. *Applied Clay Science*, 37, 47-57.
- LAZAREVIĆ S., RADOVANOVIĆ Z., VELJOVIĆ DJ., JANAČKOVIĆ DJ., PETROVIĆ R. (2009): Characterization of sepiolite by inverse gas chromatography at infinite and finite surface coverage. *Applied Clay Science*, 43, 41-48.
- LONIN A. (2009): Clinoptilolite influence on the radionuclide  $^{137}\text{Cs}$  removal from the animal organism. *Problems of Atomic Science and technology*, 52, 5, 46-49.
- MITROVIĆ B., VITOROVIĆ G., VITOROVIĆ D., DAKOVIĆ A., STOJANOVIĆ M. (2007): AFCF and clinoptilolite use in reduction of  $^{137}\text{Cs}$

deposition in several days contaminated broiler chicks. *J Environ Radioactiv*, 95, 2-3, 171-177.

POSCHL M., ØEZA E. P. (2003): Comparison of three cesium binders affecting the  $^{137}\text{Cs}$  transfer from feed to meat of broiler chicken. *Acta Univ Agric et Silviculturae Mendel Brno*, 1, 127-134.

VIĆENTIJEVIĆ M., MITROVIĆ R., VITOROVIĆ G. (2006): Efikasnost klinoptilolita posle višekratne alimentarne kontaminacije fazana  $^{137}\text{Cs}$ . *Biotechnology in Animal Husbandry*, 22 (3-4), 105-114.

VITOROVIĆ G., SLAVATA B., STOŠIĆ K., MLADENOVIĆ V., VITOROVIĆ D. (2002): The effect of clinoptilolite on  $^{137}\text{Cs}$  binding in broiler chickens. *Agricultural and Food Science in Finland*, 11, 137-141.

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