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REGULAR ARTICLE

CONTENT OF POTASSIUM AND MAGNESIUM IN THE MUSCLE TISSUE OF FEMALE RABBITS AFTER NICKEL AND ZINC PERORAL ADMINISTRATION

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ABSTRACT

The aim of our study was to determine the effect of single nickel administration as well as co–administration with zinc on distribution of potassium and magnesium in the muscle tissue (*musculus longissimus dorsi, musculus biceps femoris*) of rabbits. In the experiment 25 female rabbits of broiler line Californian were involved. Animals were divided to three groups: K (n=5) – control; P1 (n=5) – received 17.5 g $NiCl_2$.100 kg^{-1} of feed mixture, P2 (n=5) – received 35 g $NiCl_2$.100 kg^{-1} of feed mixture (FM), P3 (n = 5) – received 17.5 g $NiCl_2$.100 kg^{-1} and 30 g $ZnCl_2$.100 kg^{-1} of feed mixture and P4 (n = 5) – received 35 g $NiCl_2$.100 kg^{-1} and 30 g $ZnCl_2$.100 kg^{-1} of feed mixture. Animals were fed *ad libitum* using KKV1 feeding mixture with or without nickel and zinc addition for 90 days. For analysis of the content of these trace elements in 50 samples of animals an atomic absorption spectrophotometry method was used. The significant higher value ($p<0.05$) of potassium in *musculus longissimus dorsi* in group P2 was detected (17141.70±3702.40 $\mu g.g^{-1}$) in comparison with group P3 (9594.39±2205.10 $\mu g.g^{-1}$). The significant higher value ($p<0.05$) of potassium in *musculus biceps femoris* in group P3 (24489.78±3977.98 $\mu g.g^{-1}$) in comparison with group P4 (14986.14±3530.84 $\mu g.g^{-1}$) and group K (13100.24±2597.61 $\mu g.g^{-1}$) was measured. The average concentration of magnesium in *musculus longissimus dorsi* was

significantly higher ($P<0.05$) in P2 (1434.10±172.49 $\mu g.g^{-1}$) group than those in group P1 (802.50±209.98 $\mu g.g^{-1}$). Other differences remained insignificant ($P>0.05$).

Keywords: nickel, zinc, potassium, magnesium, rabbit, muscle tissue

INTRODUCTION

Nowadays, consumers are increasingly interested in a healthy lifestyle, e.g. energy and nutritional values of foods, which are rich in protein and low in cholesterol and lipid contents. From the nutritional point of view, rabbit meat is flavourful and easily digested, with high nutritional and dietetic properties: this meat contains 20–21% of proteins, unsaturated fatty acids (oleic and linoleic; 60% of all fatty acids), potassium, phosphorus, and magnesium, it has low concentrations of fat, cholesterol, and sodium (**Bielanski *et al.*, 2000**; **Dalle Zotte, 2002**; **Dalle Zotte *et al.*, 2005**; **Hermida *et al.*, 2006**). That is why the rabbit meat is better digested as compared to other kinds of meat (beef, lamb, or pork; **Enser *et al.*, 1996**) and is recommended for consumption e.g. for persons with cardiovascular illnesses (**Hu & Willett, 2002**). Nickel (Ni) is a metallic element that is naturally present in the earth's crust. Due to unique physical and chemical properties, metallic Ni and its compounds are widely used in modern industry. Exposure of animals and humans to different metal components through contaminated drinking water can result in a wide range of adverse clinical conditions **(Jadhav *et al.*, 2007**). Zinc (Zn) is an essential trace element which stimulates the activity of many enzymes. Among other effects, Zn supports the immune system (**Solomons, 1998**) is needed for wound healing (**Heyneman, 1996**) and for DNA synthesis (**Lukáč and Massányi, 2007**). *In vitro* studies suggest that Ni and Zn behave similar at certain sites in biological systems. Ni and Zn are consistently found in high concentrations together with RNA and DNA and may stabilize their structure. Ni and Zn also contribute to ribosomal conformation **(Spears *et al.*, 1978**) and serve as enzyme activators, e.g., arginase can be activated by either Zn or Ni (**Parisi and Vallee, 1969**). Studies used rabbits as model animal **Kalafová *et al.* (2008, 2009)** showed that addition of Ni in food is associated with depressed growth, reduced fertility and changes in serum lipids and glucose. **Capcarová *et al.* (2008)** reported a significant decrease in calcium, phosphorus, magnesium and potassium in the blood serum of laying hens after Ni treatment. No significant changes in the assessment of biochemical parameters, energy and enzymatic profile recorded (**Kolesárová *et al.*, 2008**) in similar study with hens.

Martiniaková *et al.* (2009) after analysing of data of rabbit treated with Ni and Zn from demonstrated no significant differences in femoral length and femoral weight. The highest values in the bone length and bone weight were recorded in rabbits from the group fed the diet with a combination of Ni and Zn followed by rabbits from the control group and those from the group with Ni supplementation. **Sidhu *et al.* (2004)** concluded that Zn has the ability to maintain the levels of hepatic elements and has bearing in regulating the liver functions by maintaining the activities of marker enzymes in conditions of Ni toxicity. Considering that meat is an important source of metals to humans it is important to analyse the mineral element concentrations in different types of muscles.

The aim of our study was to determine the effect of single nickel administration as well as co–administration with zinc on distribution of potassium (K) and magnesium (Mg) in the muscle tissue (*musculus longissimus dorsi, musculus biceps femoris*).

MATERIAL AND METHODS

Adult male rabbits (n=25) of meat line M91, maternal albinotic line, crossbreed (New Zealand white) were used in experiments. Rabbits were healthy and their condition was judged as good at the commencement of the experiment.

Animals were divided into five groups: control group K and 4 experimental groups P1, P2, P3 and P4 (5 animals in each group). Experimental animals of P1 and P2 group received nickel and animals of P3 and P4 group nickel+zinc supplement to the feed mixture ($mg.kg^{-1}$) in followed doses: P1 group 17.5 mg $NiCl_2.kg^{-1}$, P2 group 35.0 mg $NiCl_2.kg^{-1}$, P3 group 17.5 mg $NiCl_2.kg^{-1}$ + 30 mg $ZnCl_2.kg^{-1}$ and P4 group 35 mg $NiCl_2.kg^{-1}$ + 30 mg $ZnCl_2.kg^{-1}$ for 90 days. Samples were analysed for concentration of K and Mg using atomic absorption spectrophotometry method (wavelength for K - 766 nm, Mg – 285,2 nm). Biological material (*musculus longissimus dorsi, musculus biceps femoris*) was taken from animal organisms with chromo-nickel surgical instruments. Preparation samples were dried until dry mass was obtained. In order to obtain the dry mass, small pieces of tissue with the weight of between 0.050 to about 1.000 g were placed on the Petri's dish and put into the thermostat regulated dryer at 60°C for 24 hours; next the dryer temperature was set to 105°C. The samples were regularly weighted day by day until the loss of their mass was unnoticeable. Dried samples were mineralized by wet mineralization. In the process of wet mineralization all dry material of each sample was placed in separate mineralization tubes, dissolved by adding 2 mL of concentrated HNO3-HClO4 mixture in the proportion 4:1 and heated in a thermostat digestion

block at 120°C for 90 minutes. The resulting solution was diluted to 10 mL with demineralised water. All element concentrations are expressed on wet-weight basis in $\mu g.kg^{-1}$. The recovery of the methods was 96-98% and reproducibility was better than 1%. To compare the results the analysis of variance, one-way ANOVA test were applied to calculate basic statistic characteristics and to determine significant differences between experimental and control groups. Statistical software Sigma Plot 11.0 (Jandel, Corte Madera, USA) was used. Differences were compared for statistical significance at the level $P<0.05$.

RESULTS AND DISCUSSION

The concentrations of K and Mg in the selected muscle tissue (*musculus longissimus dorsi, musculus biceps femoris*) are summarized in Tables 1. In the present study a significant decrease ($p<0.05$) of K in P3 group (9594.39±2205.10 $\mu g.g^{-1}$) when compared with P2 group (17141.70±3702.40 $\mu g.g^{-1}$) was measured. In P3 group (24489.78±3977.98 $\mu g.g^{-1}$) a significant higher value ($p<0.05$) of K in *musculus biceps femoris* in comparison with P4 (14986.14±3530.84 $\mu g.g^{-1}$) and K (13100.24±2597.61 $\mu g.g^{-1}$) was found. The average concentration of Mg in *musculus longissimus dorsi* was significantly higher ($P<0.05$) in P2 group (1434.10±172.49 $\mu g.g^{-1}$) against P1 group (802.50±209.98 $\mu g.g^{-1}$). Differences in average concentration of Mg in *musculus biceps femoris* were not significant ($p>0.05$). **Sidhu *et al.* (2004)** found that zinc treatment alone did not cause any appreciable change in the concentration of these elements. When zinc was given to nickel-treated rats, the concentrations of Zn, copper, K, and phosphorus were not significantly different from that of normal controls, whereas the levels of iron, selenium, and sulphur were improved in comparison to Ni-treated rats but were not within the normal limits. Zn had the ability to maintain the levels of hepatic elements and has bearing in regulating the liver functions by maintaining the activities of marker enzymes in conditions of Ni toxicity. The heavy metals are known to adopt different ways that can change the function of some mineral elements (**Falandysz *et al.*, 1994; Kimáková, 2000; Massányi *et al.*, 2001; Toman *et al.*, 2004; Kolesárová *et al.*, 2008; Koréneková *et al.*, 2008).**

Table 1 Concentration of K and Mg in the muscle tissue of rabbits

muscle	mineral element	K	P1 (17.5 g $NiCl_2$)	P2 (35g $NiCl_2$)	P3 (17.5g $NiCl_2$ and 30g $ZnCl_2$)	P4 (35g $NiCl_2$ and 30g $ZnCl_2$)
musculus longissimus dorsi (µg.g^{-1})	K	*12671.98 ±3618.96*	*10157.99 ±4515.05*	***17141.70***^{a} *±3702.40*	***9594.39***^{a} *±2205.10*	*14390.77 ±4917.41*
	Mg	*1019.95 ±422.67*	***802.50***^{a} *±209.98*	***1434.10.39***^{a} *±172.49*	*1139.84 ±194.34*	*1208.14 ±200.23*
musculus biceps femoris (µg.g^{-1})	K	***13100.24***^{a} *±2597.61*	*15666.44 ±7802.19*	*17000.82 ±2347.14*	***24489.78***^{ab} *±3977.98*	***14986.14***^{b} *±3530.84*
	Mg	*1019.95 ±422.67*	*802.50 ±209.98*	*1434.10 ±172.49*	*1139.84 ±194.34*	*1208.14 ±200.23*

Legend: K - control group; P1, P2, P3, P4 - experimental groups with various doses of Ni and Zn, x – mean, SD – standard deviation, a-a, b-b the same letters within the rows mean significant differences between groups

CONCLUSION

;There is a great variability in mineral element content of rabbit meat among the different studies. This fact could be related to the mineral distribution in the carcass, so further studies are needed in order to evaluate the distribution of mineral elements in rabbit meat. In our experiment inclusion of Ni to the feed mixture caused higher accumulation of K and Mg in the muscle tissue of experimental animals. Some investigators have confirmed, but others have not, the Ni-induced disturbances in the level of mineral elements.

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