EFFECT OF NICKEL AND ZINC PERORAL ADMINISTRATION ON SERUM CALCIUM, PHOSPHORUS AND MAGNESIUM OF RABBIT FEMALE

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ABSTRACT

In this work the effects of nickel and zinc addition on serum calcium (Ca), phosphorus (P) and magnesium (Mg) of rabbit females were analyzed. Animals were divided into 5 groups: control group (K) and four experimental groups (n=5; P1, P2, P3 and P4). Experimental animals received nickel or nickel+zinc to the feed mixture for 98 days at followed amounts: 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 $ZnCl_2.kg^{-1}$. The higher values of serum calcium were recorded in groups with zinc supplementation (3.32±0.35 $mmol.l^{-1}$ and 3.49±0.30 $mmol.l^{-1}$). In other groups gradual growth was noted when compared to the control group (3.14±0.35 $mmol.l^{-1}$). The higher average concentrations of phosphorus in groups with zinc supplementation were recorded (2.30±0.40 $mmol.l^{-1}$, 2.04±0.30 $mmol.l^{-1}$). In the control group the lowest value (1.04±0.14 $mmol.l^{-1}$) and in the P4 group the highest value (1.17±0.24 $mmol.l^{-1}$) of magnesium was found, though without significant differences.

Key words: nickel, zinc, blood biochemistry, rabbits

INTRODUCTION

Nickel is a ubiquitous and virtually unavoidable environmental pollutant and occupational hazard, but its molecular and cellular effects are not well understood **(Gazel et al., 2008)**. Nickel is also essential element for at least several animal species. Animal studies associate nickel deprivations with depressed growth, reduced reproductive rates, and alterations of serum lipids and glucose. Drinking water and food are the main sources of exposure for the general population. Nickel is highly mobile in the soil, particularly in acid soils. It is not cumulative toxin in animals or in human **(Barceloux and Barceloux, 1999).**

Chronic exposure to nickel has long been known to increase cancer incidence among affected individuals **(Salnikow and Zhitkovich, 2008).** Both water soluble and insoluble nickel compounds have been implicated in the aetiology of human lung and nasal cancers. Water insoluble nickel compounds have been shown to enter cells by phagocytosis and are contained in cytoplasmic vacuoles, which are acidified thus accelerating the dissolution of soluble nickel from the particles **(Costa et al., 2005)**.

Zinc deficiency may be associated with a variety of clinical features such as hypogeusia, hyposmia, growth retardation, dermatitis, alopecia, gonadal hypofunction, abnormal pregnancy, susceptibility to infections, delayed wound healing, impaired glucose tolerance, and increased carcinogenesis **(Yanagisawa, 2008).** *In vivo*, zinc reduced enteropathogenic *Escherichia coli*-induced fluid secretion into ligated rabbit ileal loops, decreased the adherence of enteropathogenic *Escherichia coli* to rabbit ileum, and reduced histopathological damage such as villus blunting **(Crane et al., 2007).** Administration of zinc to nickel treated rats resulted in marked improvement in the structure of hepatocytes, thus emphasizing the protective potential of zinc in restoring the altered hepatic histoarchitecture close to the histoarchitecture of normal animals **(Sidhu et al., 2006)**. Zinc 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 nickel toxicity **(Sidhu et al., 2004).**

MATERIAL AND METHODS

The effect of nickel and nickel with zinc supplementation on selected serum mineral parameters as calcium (Ca), phosphorus (P) and magnesium (Mg) of rabbits was analyzed. 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 in followed amounts: 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 98 days. Blood of rabbits was acquired from *vena auricularis* by macromethod. The blood serum was separated from whole blood by centrifugation at 3000 rpm for 30 minutes. Serum mineral parameters were measured by semi–automated clinical chemistry analyser Microlab 300 (Vilat Scientific, Dieren, The Netherlands).
To compare the results the analysis of variance, t-test and Duncan's test were used to calculate basic statistic characteristics and to determine significant differences among experimental and control groups. Presented results are mean ± SD (standard deviation). Differences were compared for statistical significance at the levels $P<0.05$, $P<0.01$ and $P<0.001$.

RESULTS

The concentrations of monitored serum mineral parameters are summarized in Tables 1-3.
When compared control group with other groups gradual growth of serum calcium was noted. The higher values were in groups with zinc supplement, but differences among the groups remained insignificant ($P>0.05$).
The higher average concentrations of phosphorus in P4 and P3 groups were recorded, what were groups with zinc supplement. Lower values of observed parameter were in groups without zinc supplement. Statistical evaluation showed increasing tendency in content of serum phosphorus according to increasing days of administration. As it is shown in Table 2, increases were observed in P2, P3 and P4 group. Significant increase ($P<0.05$) of serum phosphorus at Day 90 between P1 and P3 group (zinc addition) was recorded.
In control group the lowest value and in P4 group the highest value of magnesium was found. Significant differences ($P<0.05$, 0.01) among individual blood taking within the groups are shown in Table 3. In total average values higher concentration of magnesium in experimental groups in comparison with control group was observed and P4 group significantly ($P<0.05$) differed from control group.

Table 1 Calcium concentration during the experiment with nickel administration

Blood taking (days)	0	30	60	90	Average
Group K (control)					
x	3.06	3.14	2.93	3.41	3.14
s	0.29	0.33	0.39	0.38	0.35
CV	9.46	10.48	13.21	11.03	11.05
P1 Ni (17.5 mg $NiCl_2.kg^{-1}$)					
x	3.22	3.36	3.16	3.16	3.23
s	0.49	0.19	0.12	0.63	0.36
CV	15.30	5.51	3.93	19.77	11.13
P2 Ni (35.0 mg $NiCl_2.kg^{-1}$)					
x	3.26	3.31	2.94	3.47	3.25
s	0.35	0.21	0.19	0.38	0.28
CV	10.73	6.23	6.41	10.86	8.56
P3 Ni + Zn (17.5 mg $NiCl_2.kg^{-1}$+ 30 mg $ZnCl_2.kg^{-1}$)					
x	3.46	3.22	3.08	3.52	3.32
s	0.85	0.21	0.11	0.21	0.35
CV	24.43	6.47	3.58	5.97	10.11
P4 Ni + Zn (35 mg $NiCl_2.kg^{-1}$+ 30 mg $ZnCl_2.kg^{-1}$)					
x	3.78	3.32	3.22	3.65	3.49
s	0.40	0.35	0.25	0.21	0.30
CV	10.60	10.43	7.66	5.75	8.61

x – mean; SD – standard deviation; CV – coefficient of variation
differences among the groups were not significant (P>0.05)

Table 2 Phosphorus concentration during the experiment with nickel administration

Blood taking (days)	0	30	60	90	Average
Group K (control)					
x	1.53	1.49	2.37	2.40	1.95
s	0.07	0.18	0.82	0.32	0.35
CV	4.43	11.89	34.64	13.29	16.06
P1 Ni (17.5 mg $NiCl_2.kg^{-1}$)					
x	1.66	1.67	2.31	1.87	1.88
s	0.27	0.24	0.22	0.30	0.26
CV	16.48	14.49	10.41	16.13	14.38
P2 Ni (35.0 mg $NiCl_2.kg^{-1}$)					
x	1.58	1.63	2.30	2.46	1.99
s	0.22	0.13	0.24	0.23	0.21
CV	14.12	7.84	10.53	9.52	10.50
P3 Ni + Zn (17.5 mg $NiCl_2.kg^{-1}$+ 30 mg $ZnCl_2.kg^{-1}$)					
x	1.52	1.67	2.42	2.56	2.04
s	0.18	0.19	0.66	0.17	0.30
CV	11.74	11.30	27.22	6.50	14.19
P4 Ni + Zn (35 mg $NiCl_2.kg^{-1}$+ 30 mg $ZnCl_2.kg^{-1}$)					
x	1.95	1.62	2.94	2.68	2.30
s	0.39	0.10	1.00	0.10	0.40
CV	20.16	6.01	34.11	3.80	16.02
minimum	1.51	1.48	2.34	2.55	1.97
maximum	2.45	1.72	4.73	2.80	2.93

x – mean; SD – standard deviation; CV – coefficient of variation
$p<0.05$ [P4 (Day 30 - 60); P1 – P3 (Day 90); P1 – P2 (Day 90)]; $p<0.01$ [P2 (Day 0 – 30, 0 – 90, 30 - 60); P3 (Day 30 - 60); P1 – P4 (Day]; $p<0.001$ [P2 (Day 30 - 90); P3 (Day 0 - 90)]

Table 3 Magnesium concentration during the experiment with nickel administration

Blood taking (days)	0	30	60	90	Average
Group K (control)					
x	0.97	1.06	0.92	1.20	1.04
s	0.13	0.13	0.18	0.12	0.14
CV	13.75	11.83	19.80	10.30	13.92
P1 Ni (17.5 mg $NiCl_2.kg^{-1}$)					
x	1.29	1.12	0.72	1.48	1.15
s	0.28	0.24	0.08	0.23	0.21
CV	21.95	21.10	10.41	15.36	17.21
P2 Ni (35.0 mg $NiCl_2.kg^{-1}$)					
x	1.19	1.09	0.71	1.53	1.13
s	0.15	0.34	0.16	0.35	0.25
CV	14.82	27.16	22.97	22.62	21.89
P3 Ni + Zn (17.5 mg $NiCl_2.kg^{-1}$+ 30 mg $ZnCl_2.kg^{-1}$)					
x	1.01	1.08	0.93	1.34	1.09
s	0.02	0.17	0.27	0.37	0.21
CV	2.20	15.57	28.94	27.49	18.55
P4 Ni + Zn (35 mg $NiCl_2.kg^{-1}$+ 30 mg $ZnCl_2.kg^{-1}$)					
x	1.51	0.99	0.92	1.26	1.17
s	0.38	0.17	0.25	0.16	0.24
CV	24.91	17.07	26.86	12.99	20.46

x – mean; SD – standard deviation; CV – coefficient of variation
$p<0.05$ [P1 (Day 60 - 90); P4 (Day 0 – 30, 0 - 60); P3 – P4 (Day 0); K – P4 (Day 0)]; $p<0.01$ [P2 (Day 60 - 90)]

DISCUSSION

Nickel is an essential mineral element that may accumulate to toxic levels in soils due to anthropogenic activities. Zinc is essential dietary nutrients **(Linder, 1991)** involved in numerous metabolic reactions, forming part of the functional groups of several key enzymes **(Ferns et al., 1997).** In our experiment the concentrations of serum calcium, phosphorus and magnesium after nickel and zinc administration to the feed mixture for rabbits were monitored.

In the case of calcium, nickel did not significantly influence it's concentration in blood serum of rabbits; even through we obtained increase of this parameter in each experimental group in comparison with control group. **Hiramo et al. (1994)** observed increase of calcium in rats at 2-3 days post-instillation of nickel.

When zinc was given to nickel-treated rats, the concentration of phosphorus was significantly different from that of normal controls and among the groups what corresponded with **Sidhu et al. (2004)**. **Kucuk et al. (2008)** found that dietary zinc and pyridoxine supplementations together increased plasma calcium and phosphorous concentrations in hens.

Nielsen et al. (1993) reported that nickel affected growth of rats and number of variables associated with calcium and magnesium metabolism. Our differences were not significant even though the level of this parameter was higher in each group with nickel supplement versus control group.

In our experiment nickel or zinc did not promote adverse biological effects in rabbits what correspondent with experiment with rats **(Pereira et al., 2008)**.

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