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# THE EFFECT OF SINGLE NICKEL AND COMBINED NICKEL AND ZINC PERORAL ADMINISTRATION ON GROWTH, TOTAL PROTEIN AND CHOLESTEROL CONCENTRATIONS IN RABBIT FEMALES

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## ABSTRACT

In this study the effects of nickel and nickel with zinc supplementation on growth, total proteins and cholesterol concentration in rabbit females were analyzed. Animals were divided into 5 groups: control group K and 4 experimental groups P1, P2, P3 and P4 (n=5). Experimental animals received nickel or nickel+zinc to the feed mixture for 90 days in following amounts: P1 group - 17.5 mg $NiCl_2$/kg, P2 group - 35.0 mg $NiCl_2$/kg, P3 group - 17.5 mg $NiCl_2$/kg + 30 mg $ZnCl_2$/kg and P4 group - 35 mg $NiCl_2$/kg + 30 mg $ZnCl_2$/kg. During this period animals were weighted every week (Day 0 – 90) and the blood was collected every month (Day 0, 30, 60, 90). Insignificant reduce of daily weight gain was found in P3 group. Interesting results were observed in P4 group, where the highest daily weight gain was found. The higher average concentrations of total proteins were measured in groups with zinc supplementation. The highest concentration of cholesterol was recorded in P1 group (1.58±0.49 mmol.l$^{-1}$) and the lowest one in control group. Our study did not found any significant effect of nickel or zinc on the growth of rabbits as well as on total protein and cholesterol concentration.

**Keywords**: nickel, zinc, blood biochemistry, rabbits, growth

## INTRODUCTION

The vast industrial use of nickel has led to environmental pollution by the metal and its by-products during production, recycling, and disposal. Nickel is a known hematotoxic, immunotoxic, hepatotoxic, pulmotoxic, and nephrotoxic agent (Das and Buchner, 2007). Human epidermal keratinocytes are the sentinel and the primary target for nickel (Gazel et al., 2008). Nickel is also essential element for at least several animal species. 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 a cumulative toxin in animals or in human (Barceloux and Barceloux, 1999). Nickel-treated rats showed significant reductions in the body weight and hepatic protein contents as compared to normal control rats (Sidhu et al., 2005). Chronic exposure to nickel has long been known to increase cancer incidence among affected individuals (Salnikow and Zhitkovich, 2008). Nickel deficiency caused a significant triacylglycerol accumulation in liver, with greater concentrations of saturated fatty acids, monounsaturated fatty acids and polyunsaturated fatty acids (Stangl and Kirchgessner, 1996). Bersényi et al. (2004) stated that supplementation of the diet with 50 mg Ni.kg$^{-1}$ had slight but non-significant beneficial effects on the growth performance of broiler chickens.

Zinc is an essential trace element and serves as the active centre of approximately 300 enzymes. Therefore, zinc deficiency may be associated with a variety of clinical features such as hypogeusia, hyposmia, growth retardation, dermatitis, alopecia, gonadal hypofunction,

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abnormal pregnancy, susceptibility to infections, delayed wound healing, impaired glucose tolerance, and increased carcinogenesis (Yanagisawa, 2008).

The aim of this study was to analyze possible effects of single nickel administration as well as combined administration of nickel with zinc on growth of rabbits and subsequently on the concentration of total proteins and cholesterol in blood serum.

## MATERIAL AND METHODS

The effect of nickel and nickel with zinc supplementation on growth and some biochemical parameters, as total proteins and cholesterol, 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 groups received nickel and animals of P3 and P4 groups received nickel+zinc supplement to the feed mixture for 90 days in following 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 $ZnCl_2.kg^{-1}$. Blood was collected from *v. auricularis*. The blood serum was separated from whole blood by centrifugation at 3000 rpm for 30 minutes and samples were stored at -18°C. Biochemical parameters were measured by semi–automated clinical chemistry analyser Microlab 300 (Vilat Scientific, Dieren, The Netherlands). Animals were weighted weekly and weight gain was recorded.

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.

## RESULTS AND DISCUSSION

Insignificant reduce of daily weight gain was found in P3 group with addition of 17.5 mg $NiCl_2.kg^{-1}$ + 30 mg $ZnCl_2.kg^{-1}$. Interesting results were observed in P4 group (35 mg $NiCl_2.kg^{-1}$ + 30 mg $ZnCl_2.kg^{-1}$), where the highest daily weights gain was found (Figure 1).

Concentrations of monitored biochemical parameters are summarized in Tables 1 and 2.

The higher average concentrations of total proteins were recorded in groups with zinc supplementation; in P4 group it was 66.16±6.03 mmol.$l^{-1}$ and in P3 group - 66.05±8.43 mmol.$l^{-1}$. The lowest value (59.98 mmol.$l^{-1}$) was recorded in the control group. The results in other groups were: 63.05±7.77 mmol.$l^{-1}$ in P1 group and 62.00±6.16 mmol.$l^{-1}$ in P2 group. Evaluation of this parameter detected no any significant differences among the groups (P>0.05).

The highest concentration of cholesterol was in P1 group (1.58±0.49 mmol.$l^{-1}$) and the lowest - in control group (1.10±0.24 mmol.$l^{-1}$). The value 1.34±0.18 mmol.$l^{-1}$ was found in P2 group, 1.32±0.31 mmol.$l^{-1}$ in P3 group and 1.47±0.32 mmol.$l^{-1}$ in P4 group. The differences were not significant (P>0.05).

Nickel is an essential mineral element that may accumulate to toxic levels in soils due to anthropogenic activities. Zinc is essential dietary nutrient and is 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 some biochemical parameters following nickel and zinc administration, as well as the growth of rabbits were monitored.

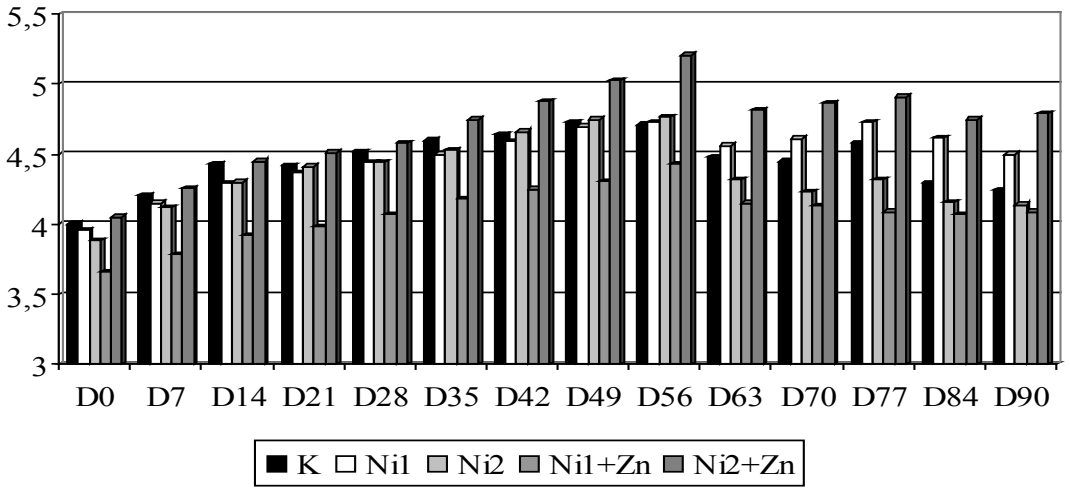


**Figure 1: Growth of rabbits after nickel and zinc administration**

**Table 1: Effect of nickel and zinc administration on total protein concentrations in blood of rabbits**

| Day of Experiment | 0 | 30 | 60 | 90 | Average |
|---|---|---|---|---|---|
| Group K (control; n=5) | | | | | |
| $\bar{x}$ | 62.71 | 58.91 | 58.91 | 59.38 | 59.98 |
| s | 2.71 | 3.15 | 5.39 | 10.84 | 5.52 |
| CV | 4.31 | 5.34 | 9.15 | 18.25 | 9.26 |
| minimum | 59.07 | 53.85 | 51.38 | 48.48 | 53.20 |
| maximum | 66.28 | 61.75 | 65.24 | 70.83 | 66.03 |
| P1 (17.5 mg $NiCl_2.kg^{-1}$) | | | | | |
| $\bar{x}$ | 60.63 | 59.18 | 67.45 | 64.94 | 63.05 |
| s | 5.25 | 3.89 | 6.81 | 15.11 | 7.77 |
| CV | 8.74 | 6.58 | 10.10 | 23.26 | 12.17 |
| minimum | 54.73 | 52.96 | 61.54 | 38.20 | 51.86 |
| maximum | 66.72 | 62.69 | 77.70 | 73.81 | 70.23 |
| P2 (35.0 mg $NiCl_2.kg^{-1}$) | | | | | |
| $\bar{x}$ | 62.48 | 58.13 | 62.12 | 65.28 | 62.00 |
| s | 4.03 | 4.68 | 7.30 | 8.64 | 6.16 |
| CV | 6.45 | 8.05 | 11.75 | 13.23 | 9.87 |
| minimum | 57.86 | 52.75 | 54.81 | 55.11 | 55.13 |
| maximum | 67.89 | 65.66 | 73.55 | 75.75 | 70.71 |
| P3 (17.5 mg $NiCl_2.kg^{-1}$ + 30 mg $ZnCl_2.kg^{-1}$) | | | | | |
| $\bar{x}$ | 64.57 | 65.30 | 63.47 | 70.86 | 66.05 |
| s | 5.09 | 5.62 | 6.90 | 16.12 | 8.43 |
| CV | 7.88 | 8.61 | 10.88 | 22.75 | 12.53 |
| minimum | 56.88 | 61.11 | 57.48 | 56.21 | 57.92 |
| maximum | 69.81 | 75.00 | 72.06 | 88.13 | 76.25 |
| P4 (35 mg $NiCl_2.kg^{-1}$ + 30 mg $ZnCl_2.kg^{-1}$) | | | | | |
| $\bar{x}$ | 67.19 | 61.83 | 66.49 | 69.11 | 66.16 |
| s | 6.20 | 2.15 | 4.85 | 10.91 | 6.03 |
| CV | 9.23 | 3.48 | 7.29 | 15.79 | 8.95 |
| minimum | 60.10 | 59.12 | 59.15 | 55.72 | 58.52 |
| maximum | 76.03 | 64.47 | 72.78 | 85.05 | 74.58 |

$\bar{x}$ – mean; SD – standard deviation; CV – coefficient of variation

**Table 2: Effect of nickel and zinc administration on cholesterol concentration in blood of rabbits**

| Day of Experiment | 0 | 30 | 60 | 90 | Average |
|---|---|---|---|---|---|
| Group K (control; n=5) | | | | | |
| $\bar{x}$ | 1.43 | 1.49 | 0.52 | 0.97 | 1.10 |
| s | 0.33 | 0.27 | 0.12 | 0.22 | 0.24 |
| CV | 23.28 | 18.15 | 24.05 | 22.70 | 22.05 |
| minimum | 1.00 | 1.18 | 0.40 | 0.67 | 0.81 |
| maximum | 1.90 | 1.89 | 0.73 | 1.20 | 1.43 |
| P1 (17.5 mg $NiCl_2.kg^{-1}$) | | | | | |
| $\bar{x}$ | 1.50 | 1.84 | 1.50 | 1.48 | 1.58 |
| s | 0.41 | 0.46 | 0.41 | 0.66 | 0.49 |
| CV | 27.01 | 24.97 | 43.78 | 44.61 | 35.09 |
| minimum | 0.98 | 1.25 | 0.98 | 0.81 | 1.01 |
| maximum | 1.99 | 2.35 | 1.99 | 2.53 | 2.22 |
| P2 (35.0 mg $NiCl_2.kg^{-1}$) | | | | | |
| $\bar{x}$ | 1.27 | 1.51 | 1.27 | 1.30 | 1.34 |
| s | 0.15 | 0.21 | 0.15 | 0.22 | 0.18 |
| CV | 11.96 | 14.03 | 55.28 | 17.12 | 24.60 |
| minimum | 1.06 | 1.29 | 1.06 | 1.04 | 1.11 |
| maximum | 1.43 | 1.84 | 1.43 | 1.55 | 1.56 |
| P3 (17.5 mg $NiCl_2.kg^{-1}$ + 30 mg $ZnCl_2.kg^{-1}$) | | | | | |
| $\bar{x}$ | 1.68 | 1.70 | 0.57 | 1.33 | 1.32 |
| s | 0.47 | 0.45 | 0.18 | 0.13 | 0.31 |
| CV | 27.81 | 28.39 | 32.21 | 9.77 | 24.55 |
| minimum | 0.90 | 0.93 | 0.41 | 1.18 | 0.86 |
| maximum | 2.16 | 2.13 | 0.88 | 1.41 | 1.65 |
| P4 (35 mg $NiCl_2.kg^{-1}$ + 30 mg $ZnCl_2.kg^{-1}$) | | | | | |
| $\bar{x}$ | 1.83 | 1.92 | 0.55 | 1.59 | 1.47 |
| s | 0.19 | 0.19 | 0.09 | 0.82 | 0.32 |
| CV | 10.20 | 9.85 | 17.21 | 51.47 | 22.18 |
| minimum | 1.69 | 1.64 | 0.47 | 1.04 | 1.21 |
| maximum | 2.12 | 2.12 | 0.71 | 3.03 | 2.00 |

$\bar{x}$– mean; SD – standard deviation; CV – coefficient of variation

Nielsen et al. (1993) reported that nickel affected growth of rats and number of variables associated with calcium and magnesium metabolism. Nickel administration at 500mg.kg$^{-1}$ insignificantly reduced the weight gain in rabbits. Nickel administration at 50 mg.kg$^{-1}$ resulted in a higher but insignificant increase in average daily weight gain (Bersényi et al., 2004). Chicks and rabbits, fed more than 250 – 300 mg.kg$^{-1}$ nickel in the diet, exhibited depressed growth and reduced feed intake, partially caused by reduced palatability. Our study did not confirm significant effect of nickel or zinc on the growth of rabbits. In our experiments, nickel or zinc did not cause adverse biological effects on rabbits, what is in agreement with observations on rats (Pereira et al., 2008).

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