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SUPPLEMENTATION OF ZINC AND CADMIUM ON EGG QUALITY OF JAPANESE QUAILS

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Introduction

Zinc is an essential trace element in the animal body. It is involved in a variety of biochemical reactions. The zinc ion is a cofactor of many enzymes and a component of matalloenzymes that participate in a number of metabolic processes (Zowczak-Drabarczyk et al., 2004). Coturnix coturnix japonica - Japanese quail are quite sensitive to a dietary deficiency of zinc. Zinc deficiency in quails was characterised by slow growth, abnormal feathering, labored respiration and an uncoordinated gait, low tibia ash, and a low concentration of zinc in liver and tibias. Cadmium is a relatively volatile element and is not essential for animals. Cadmium is chemically similar to zinc and occurs naturally with zinc and lead in sulphide ores. Cadmium commonly occurs in zinc minerals such as zinc blended (ZnS) with cadmium contents from 0.1- to 0.5%, and galmei ($ZnCO_3$) with cadmium contents up to a maximum of 5%. Higher doses of cadmium can lead to toxic effects (Massanyi et al., 1999). Japanese quail are produced mainly for their eggs and meat. The objectives of this study were to evaluate the effect of zinc and cadmium on quality of Japanese quail eggs, - weight of Japanese quail eggs, solidity and thickness of eggshells.

Material and methods

Sixty Japanese quails, (40-days-old) were included in the experiment. Quails were divided into 3 groups. Each group consisted of 20 birds. In the experimental group G2, zinc ($ZnSO_4.6H_2O$; Merck, Germany) was administered daily in the form of water solution at a dose of 12 mg of Zn for one quail. In the experimental group G3, combination of cadmium ($CdCl_2.2\ H_20$) and zinc ($ZnSO_4.6H_2O$; Merck, Germany) was administered daily in the form of water solution at a dose of 12 mg of Zn and 0.12 mg of Cd for one quail. Group 1 was the control group. Birds were fed by complete feed mixture HYD-10, set as full–value feed for the whole experiment. Feed mixture and water were provided *ad libitum.* The composition of the feed was in accordance with Decree of the Ministry of Agriculture of the Slovak Republic No. 149/2, 100, 2003.

Feed composition	Minerals	Vitamins

Crude protein	l53.0 $g.kg^{-1}$	Zn	60 $mg.kg^{-1}$	A	8 000 IU. kg^{-1}
Metabolizable energy	11.5 $MJ.kg^{-1}$	Ca	28-45$g.kg^{-1}$	D_3	1 600 IU. kg^{-1}
Ash	160.0 $g.kg^{-1}$	P	5 $g.kg^{-1}$	E	10 mg. kg^{-1}
Fiber	60.0 $g.kg^{-1}$	Na	2,2-2,5 $g.kg^{-1}$	B_2	4 mg. kg^{-1}
Lysine	7.0 $g.kg^{-1}$	Mn	40 $mg.kg^{-1}$	B_{12}	10 $\mu g.kg^{-1}$
Methionine + cystine	6.0 $g.kg^{-1}$	Fe	40 $mg.kg^{-1}$		
Methione	3.5 $g.kg^{-1}$	Cu	4 $mg.kg^{-1}$		
Linoleic acid	15.0 $g.kg^{-1}$				

Composition of complete feed mixture (HYD-l0):

The experimental condition complied with the requirements for ethical standards and under favourable microclimatic conditions for growing of welfare and animal treatment. The Japanese quails were kept in cages. The biological trial lasted 58 days. The weight of eggs, strength and thickness of eggshell were determined on 35 and 58 day of experiment.

Throughout the experiment, the resistance of the eggshell against breaking was observed. The solidity was evaluated as the force or work needed to break the eggshell, expressed in units of force or work. The strength of the eggshell was determined by a method established by Marcinka and Gažo (1964). The force needed to break eggshell was developed under the pressure of a spring by means of manual tightening of the screw. The force was read from scale of values. The values characterizing the eggshell were expressed in N/cm^2.

Results were statistically analyzed (ANOVA) using Student's *t*-test at significance levels of $P \leq 0.05$, $P \leq 0.01$ $P \leq 0.001$. Data are presented as mean and standard deviations. Coefficient of variation (V %) was calculated by dividing the standard deviations by the mean, multiplied by 100.

Results and discussion

In the present study relatively lower mean level weight of eggs was observed in experimental group (with Zn supplementation) in comparison to control group on 35 day of experiment (10.38 g; 10.79g)respectively. As shown in Table 1, minimal differences in weight of eggs were found in the control and experimental group on 58 day of experiment (Table 1). It was obtained the coefficient of variation 17.26%; 11.76%, respectively. The average egg from mature female weights about 10g, about 8%of the body weight of the quail hen as compared to 3% for chicken eggs. The egg of Japanese quails contains 158 cal. of energy, 76.4% water, 13.1% protein, 11.29% fat, and 1.1% total ash. (Koréneková, et al. 2004).

It has been shown that eggshell strength of eggs in experimental group with addition of Zn was lower than in control group. These changes were observed in eggs of Japanese quails on 35 day of experiment (11.49N; 12.09N) as well as on 58 day of experiment (11.50N; 13.05N).

In our study, lower mean level of eggshell thickness was recorded in experimental group in comparison to control group after zinc supplementation of Japanese quails. This phenomenon was observed on 35 day of experiment (0.240mm; 0,245mm) as well as 58 day of experiment (0.233 mm; 0.255mm).

As revealed by this study, zinc supplementation of Japanese quails influenced slightly decrease of eggshell strength of eggs, eggshell thickness and partly weight of eggs**.**

Relatively lower mean level weight of eggs was found in experimental group G3 (with Cd and Zn supplementation) in comparison to control group on 35 day of experiment (8.356 g; 10.79g), as well as 58 day of experiment (9.520g; 10.00g),.

The eggshell strength of eggs in experimental group G3 was lower than in control group on 35 day of experiment (10.63N; 12.09N) as well as on 58 day of experiment (10.49N; 13.05N).

In our study, significant decrease ($p \leq 0.05$) of mean levels of eggshell thickness was recorded in experimental group G3 in comparison to control group after Cd and Zn supplementation of Japanese quails. This phenomenon was observed on 35day of experiment (0.215mm; 0,245mm) as well as 58 day of experiment (0.215 mm; 0.255mm).

As shown in Table 1, addition of cadmium in experimental group G3 (Cd+Zn) caused an important decrease of weight of eggs, eggshell strength of eggs and eggshell thickness in comparison to group G 2 (with Zn addition) on 35 as well as 58 day of experiment.

Besides protein, carbohydrates, fats, and vitamins, many other elements form a part of the nutritional requirement of quails. The zinc requirement for normal growth, feathering, tibia length and conformation of Japanese quail is 25 $mg.kg^{-1}$ diet. Sahin and Kucuk (2003) suggest that supplementation with 60 mg of zinc /kg diet protects quail by reducing the negative effects of heat stress (high ambient temperature 34^0C).

It was observed protective effect of high zinc intake for rapid quail growing compared to a subsequently fed low zinc diet. Bone might store zinc and it might be mobilized during zinc deprivation. It is known that high levels of calcium can reduce zinc absorption in adult quail (Mbe et al., 2003). On the other hand, the first defense against orally administered excess zinc is homeostatic mechanism that limits absorption. Supplements of zinc augmented the adverse effect of cadmium on eggshell of quail eggs. Kottferová et al., (2001) observed decrease of eggshell strength in laying hens after long-term addition of cadmium. Similar decrease of eggshell strength was found by Sály et al. (2004) after addition of lead. High zinc plus high cadmium produced more severe anemia than either alone. A low iron level due to feeding high zinc was further reduced by low calcium or high vitamin D. It is possible that

decrease of eggshell strength and thickness was caused by decrease of calcium level in quail after long-term supplementation with Zn and Cd.

In conclusion, similarities in chemical reactivity of zinc and cadmium lead to similar metabolic pathways in biological systems. Whereas zinc is an important essential element, cadmium is best known for its toxicity and metabolic antagonism of zinc and other essential elements. It is thought that greater sensitivity of the quails to excess zinc with diet reflects the level of essential nutrients and may have been contributory factor.

Table 1. Effect of zinc supplementation on quality parameters of Japanese quail eggs

Analyzed Parameters		Control group		Experimental group			
		35. days	58. days	35. days		58. days	
		G1	G1	G2	G3	G2	G3
Egg weight (g)	x	10.79	10.00	10.38	8.356	10.110	9.520
	SD	1.297	1.762	0.804	1.883	1.188	1.183
	Max	12.53	12.80	12.08	10.320	12.400	10.900
	V (%)	12.01	17.26	7.75	22.53	11.760	12.430
Eggshell strength (N)	x	12.09	13.05	11.49	10.630	11.50	10.490
	SD	1.997	1.414	1.435	1.095	1.786	1.535
	Max	13.81	14.66	14.10	11.960	14.38	12.820
	V (%)	16.51	10.83	12.49	10.300	15.54	14.630
Eggshell thickness (mm)	x	0.245	0.255	0.240	0.215	0.233	0.215
	SD	0.028	0.016	0.012	0.019	0.011	0.009
	Max	0.293	0.283	0.267	0.243	0.257	0.230
	V (%)	11.660	6.470	4.850	8.710	4.670	4.390

n = 15 egg, G1 = control group, G2 = Zn, G3 = Cd+Zn

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