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Effect of Different Sources and Levels of Zinc on Egg Quality and Laying Hen Performance

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Abstract: Eighty layer hens were assigned in a completely randomized design to four dietary treatments containing zinc sulphate or organic zinc as Albino-Zn in two levels of 25 or 50 ppm. Feed intake was expressed on a per hen basis. Daily egg collection was expressed on a hen-day basis. Eggs were weighed to calculate egg mass. Feed conversion ratio was calculated as feed consumed per egg mass. Also all eggs produced on days 14, 28 and 42 were collected and used for egg quality parameters. Albumen height was measured and HU was calculated. The yolk and dried shell were weighed then albumen weight was calculated. There was no effect of zinc source or zinc level on egg production, egg weight or feed conversion ratio. However, feed intake was lower in the group receiving 50 mg kg^{-1} organic zinc. There were no significant treatment differences for weight of egg components or shell thickness, but albumen height and HU were higher in the second fortnight for the groups receiving organic zinc at 25 or 50 mg kg^{-1} than in the un-supplemented group.

Key words: Organic zinc, layer performance, egg quality

INTRODUCTION

Zinc is commonly supplemented in the diets for poultry and other livestock because many natural feed ingredients are marginally Zn-deficient. Zinc is an integral part of more than 300 enzyme systems that are involved in metabolism of energy, carbohydrates, nucleic acids and protein. Moreover, zinc plays a key role in the immune system and transport and use of vitamin A (Ibs and Rink, 2003; Rahman *et al.*, 2002). Zinc functions in the formation of eggs. Zinc deficiency affects the quality of epithelium due to the role of zinc in protein synthesis. Zinc also indirectly affects epithelial secretions, by affecting the structure of epithelium or directly during the synthesis of egg shell membranes. Zinc plays a role in the magnum during the deposition of albumen and in the isthmus where egg shell membranes are produced. Further zinc is important in the uterus (Zinpro, 2002). Organic complexes of zinc have been proposed to be a more available source of zinc for layer hens (Cheng and Guo, 2004) and may be metabolized differently than inorganic forms (Spears, 1989). The main objective of the present study was to investigate the effect of levels and forms of dietary zinc on laying hen performance and egg quality.

MATERIALS AND METHODS

A total of 80 Hi-Line 36 layer hens were weighed individually and assigned to 40 pens in a completely randomized design. This study was conducted in research center of Bu-Ali Sina University, Iran in Aug, 2006. There were 5 replicates of 2 pens and each pen contained 2 birds in each treatment. Hens were maintained on a 16 h light-8 h dark schedule. Hens were 50 week-old when given the different diets for 6 weeks. The dietary treatments were: 1) basal diet (containing 29 mg kg^{-1} Zn) without additional zinc, 2) basal diet supplemented with 50 mg kg^{-1} inorganic zinc as $ZnSO_4$, 3) basal diet supplemented with 50 mg kg^{-1} organic zinc as Albino-Zn and 4) basal diet supplemented with 25 mg kg^{-1} organic zinc as Albino-Zn. The basal diet was formulated as per NRC (1994) recommendation to meet or exceed hen requirements except zinc (Table 1).

Table 1: Ingredients and nutrient composition of the basal diet

Ingredient (g kg^{-1})							
Corn grain	Soybean meal	Soybean oil	Oyster shell	Common salt	Min. premix*	Vit. Premix**	DL-Methionine
625.5	238.6	31.1	80.7	3.2	2.5	2.5	0.1
Nutrient (g kg^{-1})							
ME (MJ kg^{-1})	Protein	Calcium	Aval. Phos.	Sodium	Methionine	Lysine	Met+Cys
12.34	165.0	35.0	4.5	1.5	3.0	9.2	5.81

* Supplied per kilogram of diet: Cu: 6 mg, Fe: 55 mg, Mn: 65 mg, Se: 0.2 mg and I: 1 mg, ** Supplied per kilogram of diet: vitamin A: 10500 IU, vitamin D_3: 2200 IU, vitamin E: 15 IU, vitamin K_3:1.0 mg, riboflavin: 5 mg, niacin: 39 mg, pantothenic acid: 10 mg, folic acid: 0.4 mg, thiamin: 4 mg, pyridoxine: 8 mg, biotin: 0.15 mg, vitamin B_{12} 0.08 mg

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Birds were allowed *ad libitum* feed and tap water that contained no detectable Zn. Feed consumption was recorded per replicate. Feed intake was expressed on a per hen basis. Daily egg collection was done and expressed on a hen-day basis. Collected eggs from each replicate were separately weighed to calculate egg mass. Feed conversion ratio was calculated as feed consumed per egg mass. Also all eggs produced on days 14, 28 and 42 were collected and used for egg quality parameters. Each egg was weighed separately then broken onto a flat surface. The thick albumen height was measured. HU also was calculated (Haugh, 1937). The yolk was separated from the albumen and weighed. Shell was washed and dried at 40°C for 24 h and then weighed. Albumen weight was calculated from the difference between egg weight and weight of yolk and shell. Before drying the shell, shell thickness was measured using a micrometer.

Data were analyzed by GLM Procedure of SAS software (SAS, 1997). Comparison between mean values was done using the Duncan's Multiple Range Test ($p<0.05$).

RESULTS

There was neither zinc source nor zinc level effect on egg weight laid during the experimental period (Table 2). Feed intake of the hens for the higher organic Zn diet was significantly lower than that of other treatments ($p<0.05$). Feed conversion ratio was not affected by dietary treatments except during the third fortnight for the higher organic Zn diet. No significant difference was observed between different treatments for percentage of egg laid (production %). Dietary treatments did not bring about any significant difference for egg mass between treatments.

Table 2: Mean values of hen's performance affected by zinc sources

Parameters	Fortnight	Treatments* 1	2	3	4	p-value	MSE**
Egg weight (g)	1	64.00^a	60.95^a	64.77^a	63.47^a	0.120	5.710
	2	59.18^a	58.56^a	59.98^a	60.36^a	0.370	2.880
	3	61.46^a	58.16^a	57.98^a	59.78^a	0.350	10.520
Feed intake	1	99.86^{ab}	101.79^a	97.82^b	100.64^a	0.047	3.630
(g hen^{-1} day^{-1})	2	102.43^a	101.50^a	92.10^b	96.96^{ab}	0.013	19.660
	3	87.80^a	87.39^a	75.18^b	91.38^a	0.005	32.900
FCR	1	2.18^a	2.23^a	2.40^a	2.18^a	0.530	0.057
	2	2.39^a	2.44^a	2.11^a	2.28^a	0.180	0.051
	3	2.05^a	2.11^a	1.69^b	2.12^a	0.043	0.051
Production (%)	1	71.79^a	75.36^a	64.73^a	72.86^a	0.200	50.410
	2	72.50^a	71.79^a	73.21^a	70.71^a	0.940	39.370
	3	67.50^a	67.14^a	61.44^a	70.63^a	0.380	57.970
Egg mass	1	45.84^a	45.82^a	41.93^a	46.23^a	0.390	16.250
(g hen^{-1} day^{-1})	2	42.90^a	42.05^a	43.92^a	42.67^a	0.910	15.520
	3	41.55^a	39.09^a	35.57^a	42.09^a	0.190	22.030

Means in the same row with different letter are significantly different ($p<0.05$), *1: Basal diet, 2: Basal diet supplemented with 50 mg kg^{-1} inorganic zinc, 3: Basal diet supplemented with 50 mg kg^{-1} organic zinc and 4: Basal diet supplemented with 25 mg kg^{-1} organic zinc, **: Mean Square of Error

Table 3: Effect of different sources of zinc on egg quality parameters

Parameters	Fortnight	Treatments 1	2	3	4	p-value	MSE**
Egg weight (g)	1	57.78^a	58.33^a	59.99^a	58.98^a	0.1456	16.4100
	2	61.35^a	60.54^a	61.31^a	62.40^a	0.4147	19.3000
	3	61.75^a	59.08^a	59.21^a	59.61^a	0.2183	20.3000
Albumen weight (g)	1	36.27^a	36.76^a	38.40^a	37.35^a	0.0602	10.7700
	2	38.89^a	38.09^a	39.08^a	39.89^a	0.2090	11.2200
	3	39.80^a	36.59^a	37.46^a	37.07^a	0.2790	13.3600
Yolk weight (g)	1	16.20^a	15.90^a	16.26^a	16.30^a	0.4904	1.2800
	2	17.03^a	17.11^a	16.93^a	17.37^a	0.5777	1.5900
	3	17.73^a	17.46^a	16.74^a	17.45^a	0.3456	2.7200
Shell weight (g)	1	5.31^a	5.19^a	5.42^a	5.33^a	0.2269	0.2000
	2	5.43^a	5.33^a	5.30^a	5.36^a	0.7218	0.2100
	3	5.15^a	5.04^a	5.01^a	5.09^a	0.8371	0.2800
Shell thickness (mm)	1	0.412^a	0.397^a	0.394^a	0.398^a	0.1450	0.0012
	2	0.393^a	0.398^a	0.388^a	0.387^a	0.2122	0.0006
	3	0.376^a	0.379^a	0.373^a	0.375^a	0.9661	0.0010
Albumen height (mm)	1	7.45^a	7.31^a	7.43^a	7.50^a	0.8068	0.6600
	2	6.96^c	7.20^{bc}	7.58^{ab}	7.87^a	0.0001	0.6400
	3	7.17^a	7.25^a	7.43^a	7.29^a	0.8226	0.6900
HU	1	86.67^a	85.73^a	85.87^a	86.63^a	0.8133	24.5800
	2	82.62^c	84.48^{bc}	86.29^{ab}	87.73^a	0.0003	23.8400
	3	83.67^a	85.19^a	86.09^a	85.12^a	0.5628	26.6700

Means in the same row with different letter are significantly different ($p<0.05$), *1: basal diet, 2: basal diet supplemented with 50 mg kg^{-1} inorganic zinc, 3: Basal diet supplemented with 50 mg kg^{-1} organic zinc and 4: Basal diet supplemented with 25 mg kg^{-1} organic zinc, **: Mean Square of Error

As it can be seen from the Table 3, zinc supplementation, regardless of its source and level, had no effect on egg weight. However albumen weight in treatment three where 50 mg kg^{-1} organic zinc was supplemented in the first fortnight tended to increase ($p<0.06$). Similar results were observed for yolk and shell weights. We did not observe any significant difference in shell thickness between dietary treatments. In the first fortnight albumen height was similar for all the treatments but in the second fortnight significant differences were observed between treatments ($p<0.001$). In the second fortnight, HU also differed significantly ($p<0.001$).

DISCUSSION

However zinc should be supplemented to the diets of layer hen for the optimal egg production, in the present study, zinc supplementation, regardless of its source had no effect on egg weight. Cheng and Guo (2004) also reported that different sources of zinc had no effect on egg production and egg weight. However, Khajaren *et al.* (2006) observed improvements in egg production, egg and egg shell quality for layers fed organic zinc. There was a significantly lower feed intake for the higher organic Zn diet in present study, but we could not find any reason for this apart from chance variation. The first sign of zinc deficiency is usually reduction in feed intake but in the present study the basal diet contained enough zinc (29 mg kg^{-1}) to prevent decrease in feed intake.

Zinc deficiency lowers the rate of growth, feed efficiency and egg production (McDowell, 1992). However Stahl *et al.* (1986) found that supplementing different amounts of zinc to layer diets did not alter the performance parameters of laying hens. Carbonic anhydrase is a zinc dependent enzyme that plays a role in converting calcium into calcium carbonate which is needed for egg shell formation (Keshavarz, 2001).

The increased albumen quality in the present study, as measured by increased albumen height and HU in the second fortnight is in agreement with the report of Sahin and Kucuk (2003) who reported that zinc supplementation positively affected HU. Apart from this effect, there were minimal differences in egg quality parameters between the treatments. This may be due to the level of zinc in the basal diet (29 mg kg^{-1}) which possibly was sufficient for normal activity of carbonic anhydrase. Alternatively, the feeding period of 42 days may have been too short to allow the effects of zinc deficiency on other egg quality parameters to be expressed.

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