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Effect of Zinc Picolinate on the Quality of Japanese Quail Eggs

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Abstract: This work was carried out to investigate the effect of zinc picolinate on quality of eggs from Japanese quails. Ninety, 55-day-old Japanese quail (Coturnix coturnix Japonica) were randomly assigned to 3 treatment groups consisting of 6 replicates of 5 birds. Birds were fed either a control diet or a control diet (C group) supplemented with 30 (Z1 group) or 60 (Z2 group) mg Zn kg^{-1} of diet. Eggs yielded from the birds were analyzed for quality. Supplementation with zinc picolinate to Japanese quail resulted in significant improvements of egg weight, eggshell weight, shell thickness and of egg yolk color and yolk indexes ($p<0.01$). As a result, egg breakage is reduced due to increased strength of eggshell. Results showed that zinc supplementation improve the egg shell quality.

Key words: Zinc picolinate, quail, egg quality

INTRODUCTION

Egg breakage is a severe problem that affects profits of commercial egg producers. To minimize this problem, increased of eggshell quality should be aimed. Bone fragility also often occurs in caged layers in the modern poultry industry. About 10% of eggs are cracked from farm to the retail sale. Many factors such as genetics, feed quality, environment and age are involved in egg shell formation and its quality.

Minerals play an important metabolic role in poultry and the bioavailability of minerals depends on chemical form, feed composition, age and physiological state of bird and mineral interactions. Zinc is absorbed at the rate of 14-67% depending on chemical form and concentrations of elements acting antagonistically such as Cd, Cu, S, P, Mg[1]. Zinc acts as cofactor for several enzymes and thus has significant roles in the organism. One of the most significant functions of zinc is related to its antioxidant role and its participation in the antioxidant defense system[2]. Zinc deficiency provokes oxidative damage through the effects of free radical action[3-5] and alters the status of antioxidant enzymes and substances[7]. The mechanism by which Zn exerts its antioxidant action is not well defined. However, it has been suggested that it increases the synthesis of metallothionein, a cysteine-rich protein, which acts as a free radical scavenger[6,7]. Zinc is required for activity of alkalin phosphatase which is involved in calcium storage in bone and zinc deficiency causes a decreased level of alkaline phosphatase, resulting in depression in bone and egg shell formation[8-10].

Currently, there are two feed-grade Zn sources commonly used by the animal feed industry: ZnO (72% Zn) and $ZnSO_4.H_2O$ (36% Zn). Of the supplemental Zn fed, 80 to 90% is ZnO, which is less bioavailable for poultry than reagent-grade or feed-grade $ZnSO_4.H_2O$[11-13]. Organic zinc sources such as zinc methionine or zinc propionate have been clearly demonstrated to be significantly more bioavailable than inorganic Zn sources such as ZnO or $ZnSO_4.H_2O$ [14] and consequently, organic forms of the element have been used with increasing frequency by the feed industry. A variety of Zn chelates and complexes are available as supplements to the poultry industry. Zinc picolinate (ZnPic) is an excellent form of zinc that is effectively absorbed from the gastrointestinal tract. The aim of the study was to determine the effect of Zn Pic on the egg quality and egg shell strength in laying quail.

MATERIALS AND METHODS

Ninety 55-day-old Japanese quails (Coturnix coturnix Japonica) were used in the study. The birds were randomly assigned to 3 treatment groups consisting of 6 replicates of 5 birds. Birds were kept in cages in

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temperature-controlled rooms at 22°C for 24 h per day. Main effect was the level of supplementation of Zin Pic to the diet 0 (C group), 30 (Z1 group) or 60 (Z2 group) mg Zn kg^{-1} of diet). Ingredients and chemical composition of the basal diet are shown in Table 1. The basal diet contained 16.8 g protein 100 g^{-1} with 2700 kcal ME kg^{-1} diet. Water and diets were offered ad libitum throughout the experiment. The experimental period lasted 90 d with a 17L: 9D light: Dark photo schedule.

The egg weights were recorded and the shape index was measured by an instrument (BV. Apparatenfabreik Van Doorn, Holland). The specific gravity of a whole egg was measured by Archimedes method with an instrument designed for the measurement of egg weight in air (Wa) and in Water (Ww) which was at 15.6°C and specific gravity was calculated on the same day of egg collection with the following formula: [Specific gravity = Wa/(Wa-Ww)]. Shell thickness was a mean value of measurements at three locations on the egg (air cell, equator and sharp end) by using a dial pipe gauge. Albumen height (H) was measured by a tripod micrometer (Mitutoyo, 0.01 mm, Japan), albumen Length (L) and width (W) by a compass (Swordfish, 0.02 mm, China) and then the albumen index was calculated with the following formula: [Albumen index = H/{(L+W)/2}x100]. Yolk Height (H) and yolk diameter were measured by the same instruments mentioned above and the yolk index was calculated with the following formula [Yolk index = (H/D)x100]. Haugh units were calculated using the HU formula [Haugh Unit = 100 Log. $(H+7.57-1.7G^{0.37})$], (H = Height of Albumen, G .= Egg Weight).

Eisen *et al.*,[15] based on the height of albumen determined by a micrometer and egg weight.

Table 1: Ingredients and chemical composition of diets fed to japanese quail

Ingredients	%
Corn, cracked	63.05
Soybeanmeal, 43%HP	22.75
Wheat bran	1.68
Animal fat	1.5
Limestone	8.54
Dicalcium phosphate	1.4
Vitamin premix*	0.25
Mineral premix**	0.2
DL-methionine	0.2
Sodium chloride	0.4
Total	100
Chemical Analyses (DM basis)	
ME, (kcal/kg)	2780
Crude protein, %	17.65
Calcium, %	4.15
Zinc, ppm	33

* Mix supplied per 2.5 kg: 12000 IU vitamin A; 2500 IU cholecalciferol; 15000 IU vitamin E; 3 mg menadione; 3 mg thiamin; 2 mg pyrodixine; 15 mg vitamin B_{12}; 1 mg folic acid; 25 mg niacin. ** Mix supplied per kilogram: 80 mg Mn; 35 mg Fe; 50 mg Zn; 5 mg Cu; 2 mg Iodine; 0.15 mg Se; 4 mg Choline chloride

Table 2: Effects of supplemental Zn on the egg quality parameters in japanese quail (n = 30)

	Treatment			
	C	Z1	Z2	P
Egg Weight, g	11.102±0.171^a	11.255±0.148^a	11.722±0.100^b	**
Egg Shape Index, %	75.286±0.789	75.818±0.588	76.616±0.474	-
Specific Gravity, g/cm3	1.065±0.007	1.066±0.009	1.067±0.008	-
Shell Weight, g	1.043±0.010^a	1.133±0.029^b	1.128±0.020^b	**
Shell Thickness, µm	0.202±0.005^a	0.236±0.004^b	0.267±0.003^c	***
Albumen Index, %	9.103±0.234	9.142±0.233	9.270±0.257	-
Yolk Index, %	39.458±0.957^a	38.668±0.531^a	43.375±0.661^b	***
Haugh Unit	85.553±0.532	85.182±0.477	85.165±0.532	-

*** : ($p<0.001$), ** : ($p<0.01$), - : Not significant, a, b, c : Differences between the groups on the same line bearing different letters are important ($p<0.05$).C: control, Z1: 30 mg Zn/kg diet, Z2: 60 mg Zn/kg diet

Statistical analyses were performed by using ANOVA procedures with the Statview software program[16]. When significant effects were detected by ANOVA, treatment means were compared using Duncan's multiple range test.

RESULTS

The effects of supplemental zinc for egg quality of Japanese quails are shown in Table 2. Egg shape index, egg specific gravity, albumen index and Haugh unit were not affected by different levels of zinc. However, zinc supplementation to the diet at the concentrations of 30 and 60 mg kg^{-1} of diet increased egg weight ($p<0.01$), shell weight ($p<0.01$), shell thickness ($p<0.01$) and yolk index ($p<0.01$) in quail.

DISCUSSION

In the present study, zinc supplementation at different levels (30 and 60 mg kg^{-1} of diet) had significant effects on egg quality in laying Japanese quail. In agreement with our results[17] reported that dietary zinc (47-77 ppm) increased feed intake, growth rate and feed efficiency in broiler chicks. Similarly, Roberson and Edwards[18] reported that 15-30 ppm zinc supplementation increased growth rate in broilers. Since zinc is a constituent of alkaline phosphatase, the enzyme involved in calcium storage in bone, the presence of zinc in the diet probably increased the activity of this enzyme in birds receiving supplemental zinc. Similarly, Moreng *et al.*,[19] have reported that dietary zinc supplementation significantly improved shell breaking strength, shell weight and percentage of shell defects. Similarly, Sahin *et al.*,[20] reported that zinc and chromium supplementation improved egg production and quality in laying hens under low temperature.

In the current study, egg weights in group 1, group 2 and group 3 were 11.102, 11.255 and 11.722 g, respectively and increased Zn in the diet had positive influence on egg weight. Sahin *et al.*,[20] reported that Zn supplementation affects the egg weight. In contrast, Kidd *et al.*,[21] and Kaya *et al.*,[22] did not found any effect of Zn supplementation on egg weight. There was no relation between Zn supplementation and shape index or specific gravity in the study. This result is in agreement with the findings of Kaya *et al.*,[22].

Significant relations were found between Zn supplementation and egg shell weight or egg shell thickness. These findings obviously indicate that egg shell weight and egg shell thickness increase when the amount of Zn supplementation in the ration is increased. Moreng *et al.*,[19] reported that Zn supplementation increased shell resistance, shell weight and the ratio of shell defect significantly. Although there was no difference for albumen index between control and Zn supplemented groups, a significant difference was detected for yolk index. Also, there was no difference for Haugh Unit between treatment groups and this is in agreement with the findings of Sahin and Kucuk,[23].

Supplementation with Zn improves overall health, productivity and performance of animals in poultry, swine and dairy measured as increased body weight, final body weight and feed efficiency. Although NRC recommends a minimum of 39 mg zinc kg^{-1} dry matter, clinical signs of Zn deficiency have been observed even when dietary Zn was increased above the recommended minimum levels[24]. The apparent deficiency can be explained in part by reduced bioavailability resulting from dietary antagonists and interaction with other minerals. A number of researchers reported that dietary zinc supplementation increased feed intake, growth rate and feed efficiency in broiler chicks[17,18,13].

Zinc picolinate is formed by the bonding of zinc with picolinic acid, which is the body's prime natural chelator. This special form of Zn has been used because it is better absorbed in humans than many other forms. Higher absorption of ZnPic sources allows lower inclusion rates for Zn supplementation and makes mineral balance in animals easier to maintain[14]. The ZnPic form is also more likely to satisfy these varying demands, especially when the demand is greatest[14].

The results of the present study suggest that zinc supplementation improved egg quality and this could be a protective measure to prevent egg loss during marketing.

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