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Effect of Zinc Proteinate Supplementation to Corn-soybean Meal-based Chukar Partridge (*Alectoris chukar*) Diets on Growth Performance and Zinc Concentration of Some Tissues

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Abstract: The objective of the present study was to determine the effects of based corn-soybean diets containing different levels of organic zinc (Zn) from zinc proteinate (ZP) on performance, some carcass parameters and Zn concentrations of serum, liver and pancreas in chukar partridges. Total 240 1-d-old chukar partridges were divided into five experiment groups of 48 birds each and each treatment was replicated four times with 12 birds per replicate pen. The five treatments included: 1) Control, with supplemental Zn (inorganic source) coming only from ingredients; 2) Control + ZP (25 ppm Zn in diet); 3) Control + ZP (50 ppm Zn in diet); 4) Control + ZP (75 ppm Zn in diet); 5) Control + ZP (100 ppm Zn in diet). Supplemental Zn from ZP effected BW at 8 weeks and BWG at 0-8 weeks of age ($p<0.05$). Mean BWs and BWGs values were significantly smaller at 8 weeks and 0-8 weeks of age for chukar fed diet having 0 ppm added Zn than the other groups. Supplementation Zn from ZP effected FI at 0-8 and 0-16 weeks of age($p<0.05$). Mean FIs values were significantly lower at 0-8 weeks of age for chukar fed diet having 75 ppm added Zn than the other groups. Supplemental Zn from ZP effected FCR at 0-8 weeks of age ($p<0.05$). There were significant difference between 0 and 50 ppm added Zn with 75 ppm added Zn groups for FCR at 0-8 weeks of age. There were significant difference between 0 ppm added Zn with the other groups for liver Zn concentration. Mean liver Zn concentrations values were significantly lower for chukar fed diet having 0 ppm added Zn than the other groups. It concluded that a corn-soybean meal chukar partridges diet supplemented with 25 ppm Bioplex zinc is adequate on performance during the starter period, but Zn supplementation is not necessary during the growth period in this study.

Key words: Partridge, organic zinc, performance, tissue zinc

INTRODUCTION

There are many reasons for participating in game bird farming. It can be an enjoyable hobby, a way to fulfill a 4-H project requirement, a means of establishing or increasing local game bird populations, or a business venture (Woodard *et al*., 1978). Chukar partridges are raised for meat as are broilers, or may be destined to be shot by enthusiastic hunters. Initially introduced into many countries in the early 1930s to help supply birds hunting recreation, the chukar partridge in recent years has gained popularity as a gourmet food. They are still wild birds compared with other domesticated poultry although partridges have been raised domestically for many years in Türkiye.

Zinc (Zn) is essential trace element that is required for growth, bone development, feathering, enzyme structure and function and appetite for all avian species. Zinc is commonly added as a supplement to all formulated poultry diets. Currently, poultry nutritionists have a number of mineral forms to choose from: inorganic oxide forms, inorganic sulfate forms and complexed (organic) mineral forms. It is believed that organic mineral forms provide a source of Zn with greater biological availability than Zn from inorganic sources such as zinc oxide and zinc carbonate (Wedekind and Baker, 1990; Kidd *et al*., 1992a;b). Kidd *et al*. (1996) also reported that Zn-methionine (ZnMet) has better Zn bioavailability than from inorganic sources because it is not subject to chelation by phytic acid and fiber in the lumen of the gut. After absorption, Zn from ZnMet may be metabolized differently than inorganic sources. In the poultry industry at present it is of importance to formulate diets for optimal utilization of nutrients. However, commonly used grains may reduce the availability of certain minerals. Corn and soybean meal, the major constituents of poultry rations, are relatively low in Zn. Furthermore, phytic acid inhibits absorption of Zn. Reabsorption of both endogenously

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secreted Zn and dietary Zn are impaired by the presence of phytic acid (Kidd *et al*., 1993). Dietary organic Zn supplementation of different avian species diets has been the focus of many scientific investigations (Hempe and Savage, 1990; Deyhim *et al*., 1991; McNaughton and Schugel, 1991; Pimental *et al*., 1991; Kidd *et al*., 1992; Wedekind *et al*., 1992; Aoyagi and Baker, 1993).

The objective of the present study was to determine the effects of based on corn-soybean meal diets containing different levels of organic Zn from Bioplex zinc on performance, some carcass parameters and Zn concentration of serum, liver and pancreas in chukar partridges.

MATERIAL AND METHODS

This study was conducted with 240 chukar chicks (*Alectoris chukar*), at 1-d of age, housed in cages as a random production flock kept at University of Selçuk, Department of Animal Science. The birds were placed battery brooders at density of 250 cm^2/bird (from hatch to 8 weeks age) and 700cm^2/bird (from 9 to 16 weeks age). The chukar chicks were randomly divided into five experiment groups of 48 birds each and each treatment was replicated four times with twelve birds *per* replicate pen. House temperatures, maintained by whole house brooding, were controlled at 32°C the first week and reduced 2°C each week until room temperature was reached. All birds received feed and water *ad libitum* and lighting was 23 hours from 0 to 16 weeks of age.

In this study, starter diets (24.37% CP, 0.60% methionine, 1.73% lysine, 3019 kcal ME/kg and 28.35 ppm Zn) were fed from hatch to 8 weeks and grower diets (20.05% crude protein, 0.53% methionine, 1.39% lysine, 3200 kcal ME/kg and 25.24 ppm Zn) from 9 to 16 weeks. The five treatments included: 1) Control, with supplemental Zn (inorganic source) coming only from ingredients; 2) Control + ZP (25 ppm Zn in diet); 3) Control + ZP (50 ppm Zn in diet); 4) Control + ZP (75 ppm Zn in diet); 5) Control + ZP (100 ppm Zn in diet). Zinc proteinate (Bioplex zinc) is mineral chelate supplied by the Alltech Inc. Synthetic methionine and lysine were used to balance the methionine and lysine contents of the diets. Composition and nutrient analysis for each dietary treatment are included in Table 1.

Initial weights of the birds were recorded at the beginning of the study. Body weight (BW) and feed intake (FI) were measured weekly, for each cage and then body weight gain (BWG) *per* cage was calculated from BW. Feed conversion ratio (FCR) was also calculated weekly as kg of FI for kg of BWG. On the last day of the trial, ten mixed sex birds chosen from each treatments and then blood samples were obtained by heart puncture for serum concentration of Zn. Blood serum were separated by centrifugation of blood at 2500 rpm for 10 min and was then frozen (-20°C) for analysis. Also ten mixed sex birds in each replicate were slaughtered for determination of carcass, liver and pancreas weights at the end of the trial. Zinc in serum samples was determined by atomic absorption spectrophotometry (Model GBC 902). The

Table 1: Composition of experimental diets

Ingredients (%)	Starter[1]					Grower[2]				
	Control	Control+zinc	Control+zinc	Control+zinc	Control+zinc	Control	Control+zinc	Control+zinc	Control+zinc	Control+zinc
Yellow corn	46.75	46.75	46.75	46.75	46.75	57.00	57.00	57.00	57.00	57.00
Soybean meal[3]	44.35	44.35	44.35	44.35	44.35	32.60	32.60	32.60	32.60	32.60
Dicalcium phosphate	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Limestone	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Vegetable oil	4.60	4.60	4.60	4.60	4.60	6.00	6.00	6.00	6.00	6.00
Salt	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Vitamin-mineral premix[4]	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
DL-methionine	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21	0.21
L-lysine HCl	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24	0.24
Bioplex zinc, ppm	-	25	50	75	100	-	25	50	70	100
Calculated analysis										
Crude protein, %	24.37	24.37	24.37	24.37	24.37	20.05	20.05	20.05	20.05	20.05
ME, kcal/kg	3019	3019	3019	3019	3019	3201	3201	3201	3201	3201
Crude fat, %	6.61	6.61	6.61	6.61	6.61	8.24	8.24	8.24	8.24	8.24
Calcium, %	1.00	1.00	1.00	1.00	1.00	0.98	0.98	0.98	0.98	0.98
Total phosphorus, %	0.68	0.68	0.68	0.68	0.68	0.62	0.62	0.62	0.62	0.62
Available phosphorus, %	0.40	0.40	0.40	0.40	0.40	0.38	0.38	0.38	0.38	0.38
Zinc, ppm	28.90	53.90	78.90	103.90	128.90	23.37	48.37	73.37	98.37	123.37
Zinc, ppm[5]	28.35	61.42	84.25	106.19	135.61	25.24	52.45	80.53	101.22	127.32
Methionine, %	0.60	0.60	0.60	0.60	0.60	0.53	0.53	0.53	0.53	0.53
Lysine, %	1.73	1.73	1.73	1.73	1.73	1.39	1.39	1.39	1.39	1.39

[1]: Starter fed from hatch to 8 week, [2]: Growers fed from 9 to 16 weeks, [3]: 46% crude protein., [4]: Supplied per kilogram of diet: 11,000 IU vitamin A (retinyl acetate + retinyl palmitate), 2,200 IU vitamin D3, 30 IU vitamin E (dl-á-tocopheryl acetate), 2.0 mg menadione, 1.5 mg thiamine, 6.0 mg riboflavin, 60 mg niacin, 4 mg pyridoxine, 0.02 mg vitamin B12, 10.0 mg pantothenic acid, 6.0 mg folic acid, 0.15 mg biotin, 0.625 mg ethoxyquin, 500 mg calcium carbonate, 80 mg Fe, 80 mg Mn, 10 mg Cu, 0.8 mg I and 0.3 mg Se, [5] :Analyzed

Table 2: Effect of supplemental Bioplex zinc on body weight, body weight gain, feed intake and feed conversion ratio of chukar partridge(Means±Sx)

Zn added, ppm	Initial	8 weeks	16 weeks	0-8 weeks	9-16 weeks	0-16 weeks
	Body weight, g			Body weight gain, g		
0	12.42±0.25	236.91±6.45^b	462.75±14.24	224.50±7.45^b	225.84±10.14	450.33±8.21
25	12.71±0.26	252.71±7.13^a	461.94±13.71	240.00±9.22^a	209.23±9.04	449.23±13.45
50	12.63±0.42	254.06±10.58^a	458.23±14.60	241.44±5.78^a	204.17±11.23	445.60±11.43
75	12.08±0.16	262.73±11.67^a	472.88±18.52	250.65±7.14^a	210.15±12.38	460.79±10.51
100	12.02±0.36	259.19±11.78^a	460.42±12.51	247.17±7.35^a	201.24±15.29	448.40±12.68
P values	0.262	0.015	0.706	0.033	0.828	0.580
	0-8 weeks	9-16 weeks	0-16 weeks	0-8 weeks	9-16 weeks	0-16 weeks
Zn added, ppm	Feed intake, g			Feed conversion ratio, g feed/g weight gain		
0	720.16±12.45^a	1510.88±35.24	2231.04±19.21^b	3.21±0.20^a	6.69±0.44	4.95±0.19
25	692.64±18.13^a	1540.56±42.71	2233.20±31.45^b	2.89±0.14^{ab}	7.36±0.70	4.97±0.31
50	730.12±12.58^a	1570.40±38.60	2300.96±22.43^a	3.02±0.24^a	7.69±0.35	5.16±0.22
75	652.96±11.67^b	1503.04±29.52	2156.00±26.51^{ab}	2.61±0.14^b	7.15±0.55	4.68±0.26
100	719.04±11.78^a	1582.72±32.51	2301.20±23.68^a	2.91±0.16^{ab}	7.87±0.49	5.14±0.23
P values	0.041	0.495	0.018	0.025	0.652	0.898

Table 3: Effect of supplemental Bioplex zinc on carcass, liver and pancreas weights and zinc concentrations of some tissues(Means±Sx)

Zn added, ppm	Carcass weight g	Liver weight g	Pancreas weight g	Serum zinc ppm	Liver zinc ppm	Pancreas zinc ppm
0	315.50±14.53	9.12±1.39	1.32±0.07	49.02±4.67	60.27±3.40^b	74.42±14.22
25	328.00±13.86	7.69±1.41	1.20±0.08	57.12±1.40	68.65±3.36^a	90.38±16.41
50	331.00±25.05	7.86±1.56	1.23±0.08	52.37±2.21	69.72±2.27^a	105.07±8.07
75	333.00±16.10	8.35±1.18	1.27±0.06	49.24±4.02	72.03±4.14^a	125.13±13.15
100	343.00±12.97	9.59±1.43	1.32±0.03	55.37±3.01	74.27±4.18^a	109.28±10.03
P values	0.459	0.782	0.355	0.762	0.022	0.896

^{a,b}: Means in column with no common superscript differ significantly ($p<0.05$)

diets, liver and pancreas were analyzed for Zn following HNO_3 wet ashing as described by Wedekind *et al*. (1992). The Zn content was determined using a sequential ICP-AES (Varian Vista model).

Data obtained from the trial were analyzed by a one way analysis of variance for the level of supplemental Zn in the diet (Minitab, 1990). Those response variables resulting in a significant F test were further analyzed using Duncan's multiple range test (Duncan, 1955).

RESULTS

Data on BW, BWG, FI and FCR were shown in Table 2. Supplementation of Zn from ZP did not effect BW at 16 weeks and BWG at 9-16 and 0-16 weeks of age ($p>0.05$). But supplemental Zn from ZP effected BW at 8 weeks and BWG at 0-8 weeks of age ($p<0.05$). There were significant difference between 0 ppm added Zn with the other groups for BW and BWG at 8 weeks and 0-8 weeks of age, respectively. Mean BWs and BWGs values were significantly smaller at 8 weeks and 0-8 weeks of age for chukar fed diet having 0 ppm added Zn than the other groups. Supplemental Zn levels did not have a significant effect on FI at 9-16 weeks of age. But supplementation Zn from ZP effected FI at 0-8 and 0-16 weeks of age ($p<0.05$). There were significant difference between 75 ppm added Zn with the other groups for FI at 0-8 weeks of age. Mean FIs values were significantly lower at 0-8 weeks of age for chukar fed diet having 75 ppm added Zn than the other groups At the end of the study, there was a significant difference in FI groups fed diet containing 0 and 25 ppm supplemental Zn and groups fed diets containing 50 and 100 ppm supplemental Zn. Mean FIs values were significantly lower fed diets having 0 and 25 ppm added Zn than the birds fed with diets having 50 and 100 ppm added Zn. Supplementation of Zn from ZP did not effect FCR at 9-16 and 0-16 weeks of age ($p>0.05$). But supplemental Zn from ZP effected FCR at 0-8 weeks of age ($p<0.05$). There were significant difference between 0 and 50 ppm added Zn with 75 ppm added Zn groups for FCR at 0-8 weeks of age. Mean FCRs values were significantly smaller at 0-8 weeks of age for chukar fed diet having 75 ppm added Zn than the birds fed with diets having 0 and 50 ppm added Zn. Data on carcass, liver and pancreas weights and Zn concentration of serum, liver and pancreas were shown Table 3. Supplementation of Zn from ZP did not effect carcass, liver and pancreas weights with Zn concentration of serum and pancreas at the end of the study ($p>0.05$). But supplemental Zn from ZP effected liver Zn concentration ($p<0.05$). There were significant difference between 0 ppm added Zn with the other groups for liver Zn concentration. Mean liver Zn concentrations values were significantly lower for chukar fed diet having 0 ppm added Zn than the other groups. Differences in liver Zn concentration between the groupsfed diets containing 25, 50, 75 and 100 ppm supplemental Zn were not significant.

DISCUSSION

Dietary organic Zn supplementation has not been tested fully in chukar partridge but organic Zn supplementation of different avian species diets has been the focus of many scientific investigations. Ferket *et al.* (1992) demonstrated that turkey fed 20 and 40 g/kg ZnMet through to 126 days of age had moderately improved body weights, significantly improved feed conversion and significantly reduced mortality rates. McNaughton (1991) made similar observation with broiler. In addition to improved feed conversion, supplemental ZnMet increased breast meat yield and bone ash and reduced skin lesion score. Kidd *et al.* (1993) observed that ZnMet had the greatest effect on improving feed efficiency. Ferket and Kidd (1997) demonstrated that Zn-lysine and Zn-amino acid complexes improved the performance of broiler chickens equally as effective as ZnMet. In this study, the less expensive Zn-amino acid complex even resulted in better feed conversion and lower mortality rate than the other forms. Other organic forms of Zn may be or may not be as effective as Zn complex forms, but the value of these other organic Zn supplements is not adequately evaluated in refereed scientific journals. Ferket *et al.* (1992) observed that turkey toms fed diets supplemented with ZnMet had improved FCR without affecting BWG. McNaughton and Schugel (1991) made similar observation in broiler for FCR and breast meat yield. Pimental *et al.* (1991) reported that the source of zinc (ZnMet or ZnO) effected liver Zn concentrations, but did not effect growth in chicks. McNaughton (1991) reported that feeding a combination of ZnMet and MnMet complexes gave significantly better FCR at both 21 and 46 days of age as compared inorganic trace minerals from oxide sources in broilers. Also, feeding ZnMet and MnMet in the starter ration alone did not support improved performance at 46 days of age. Kidd *et al.* (1992b) reported that the addition of supplemental Zn in the hen or chick diets with either ZnMet or ZnO resulted in no significant differences in FCR or average BW. Because of the fact that using avian types were different in these studies, data obtained from those studies were not compared with results of the present study. But still these findings are in agreement with results of some studies. Differences in results obtained from present study and other studies may be related to the manner in which the birds were raised during the experiment, numbers of replicate pens, the number of the birds per pen, source and level of Zn.

In this study, during the starter period, BW, BWG, FI and FCR were affected by organic Zn levels of the starter diet. The BW were increased by 6.25, 6.75, 9.83 and 8.60%, respectively in chukar partridge consuming 25, 50, 75 and 100 ppm Zn diet compare to control group at 8th week of age. The BWG were also increased by 6.46, 7.02, 10.43 and 9.21%, respectively in chukar partridge consuming 25, 50, 75 and 100 ppm Zn diet compare to control group at 0-8 week of age. These data indicate that Zn supplementation in starter diets of chukar partridge should be 61.42 ppm Zn diet for BW and BWG. The FI and FCR were better for chukar fed diet having 75 ppm Zn compared to other groups. Starter diets for better FI and FCR should contain 106.19 ppm Zn. During the grower period, Zn supplementation of chukar partridge diets had no effect on BWG, FI and FCR from 9 to 16 weeks of age. These data indicate that Zn supplementation above 25.24 ppm Zn is unnecessary during the last 8 week of chukar partridge growth. The carcass, liver and pancreas weights with Zn concentration of serum and pancreas were not effected by dietary organic Zn levels. Also these data indicate that organic Zn supplementation is unnecessary for these parameters during the experimental period. The present study has shown that grower diet containing 25.24 ppm Zn was adequate for chukar partridges. Mortality was not influenced by dietary organic Zn.

CONCLUSIONS

It concluded that a corn-soybean meal chukar partridges diet supplemented with 25 ppm Bioplex zinc is adequate on performance during the starter period, but Zn supplementation is not necessary during the growth period in this study. Also, further researches for determine to optimum Zn level might be conducted in chukar partridges.

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