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The Effects of Removal Mineral Premix at Different Periods of Rearing on Performance, Carcass Yield and Tibia Bone of Broiler Chicks

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Abstract: This experiment was conducted to evaluate the effects of mineral premix removal from diet during different period (starter, 1-21 d; grower, 22-42 d and finisher, 43-49 d) on the performance of broilers. From the days of old, chicks a diet containing two levels of supplementary minerals premix (0 and 0.25%) received. The results showed that, between experimental groups in terms of feed intake during various periods were not differences. In the starter and grower periods weight gain among all treatments were not significantly, but during finisher period of experimental weight gain of remove mineral premix of starter and grower periods and remove mineral premix of all rearing periods treatments were significantly lower than other treatments ($p<0.01$). Remove mineral premix during starter and grower periods significantly increased feed conversion ratio among treatments ($p<0.05$) and in the finisher period was significant ($p<0.01$). Remove mineral premix during different growth on carcass, abdominal fat, liver, breast, leg and tibia bone ash were not significant. Removal mineral premix on leg bone density ($p<0.05$) and bone strength ($p<0.01$) were different.

Key words: Mineral premix, performance, bone, broiler

INTRODUCTION

Although most mineral elements in animal tissue are found, but it seems many of its only because part of the animal feed are the body exist and may have not a function essential in metabolism. Although dietary vitamin and mineral requirements for birds have been periodically re-established (NRC, 1984 and 1994), some aspects of these requirements are continuously questioned (Maiorka *et al*., 2002). The requirements are normally determined in young birds by using highly purified diets and in thermo neutral conditions; however, the actual requirement can be quite different in poultry production systems. Vitamins and minerals are important ingredients used to formulate poultry diets. These nutrients are included as supplement in appropriate amounts to satisfy the nutrient requirements for a healthy and productive performance of birds as meat or egg producer animals. The need for vitamin and minerals, however, may be more crucial at certain stages of body development than others (Zapata *et al*., 1996). Because the deficiency of minerals and vitamins requires long periods to demonstrate clinical signs (Lesson and Summers, 1997), also food manufacturers, nutritionists and producers use twice to 10 times more of these nutrients than stated requirements (Inal *et al*., 2001); Thus, the withdrawal of vitamin or mineral supplements in grower diets has been evaluated in the last few years as a way to reduce the costs of broiler chicken production. In this way, some authors tend to agree that a short period of vitamin and mineral restriction during the growing phase of broilers may not affect the performance characteristics of birds with consequent saving in ration costs (Teeter and Deyhim, 1994).

Research has indicated that the trace mineral premix could be removed from the diet of growing and finishing pigs with no negative effects on growth performance (Kim *et al*., 1997; Mavromichalis *et al*., 1999; Shelton *et al*., 2004). Nilipour *et al*. (1994), in a study used mineral and vitamin premixes at 0, 25, 50, 75 and 100% of recommended level and concluded that reduction of this premixes up to 50%, didn't have any adverse effect on broiler chickens. In broilers, removal of the trace mineral premix during the finisher week resulted in no negative effects on growth performance, bone variables, or carcass traits (Skinner *et al*., 1992; Deyhim and Teeter, 1993; Christmas *et al*., 1995; Maiorka *et al*., 2002). In an experiment, Shelton and Southern (2006) removal of the trace mineral premix from broiler diets from 1 to 43 d had no effect on growth performance but decreased bone strength during the grower and finisher periods. Patel *et al*. (1997) reported that with simple corn-soybean meal diets, 7-day removal of supplemental vitamins and trace minerals from broiler diets during the period 35-42 d post hatching decreased daily weight gain in three different broiler strains (Avian x Avian, New Hampshire x Columbian and Ross x Hubbard).

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This study was carried out to evaluate the effects of removal mineral premix recommended on performance, carcass yield and some leg bones characteristics of broiler chicks at three rearing periods (starter, grower and finisher).

MATERIALS AND METHODS

In this study, 480 male commercial broiler chicks (Ross 308 strain) used in a randomized complete block design with 8 treatments, 4 replicates per treatment and 15 chicks per replicate were divided. On 1-d-old, chicks were weighed and allotted at random to battery compartments housed within environmental chambers for a 49-d experimental period. The lighting system consisted of 10 d of 23-h light and 1 h dark, followed by 24 h of light for the remainder of the project. The temperature in the house was 31-33°C for the first week and was dropped each week until 24-27°C was reached. Chickens in all three rearing periods (starter, grower and finisher) diet based on NRC (1994) received. Experimental diets from ages 1-49 days were fed to chickens. Diets and water were supplied *ad libitum*; diet was fed in mash form. Composition of experimental diets is shown in Table 1.

Body weights were measured at 21, 42 and 49 days of age. Feed consumption were measured during the 1-21d, 22-42d and 43-49d periods and feed conversion for the periods were calculated. Mortalities and weight of dead birds were recorded daily. At the end of the 49-d growth trial, from each treatment eight broilers were randomly selected, subjected to 6 h fasting, reweighed and killed by severing the jugular vein. After slaughtered carcass the amount of carcass, abdominal fat (was defined as the fat surrounding the gizzard, extending within the ischium and surrounding the bursa of Fabricius, cloaca and adjacent abdominal muscles), liver, breast and leg (drumstick and thigh) yields were determined (as percentage of live body weight). The left tibia was removed and frozen for subsequent determination of bone density (Halliday *et al*., 2010), bone breaking strength and bone ash percentage. Bone breaking strength was determined by using a HD 250 Texture Machine (Texture Technologies Corporation, Scarsdale, NY) fitted with a 3-point bend rig with a load cell capacity of 50 kg and a crosshead speed of 100 mm/min. After determination of bone breaking strength, fat was removed from the tibias by a 36-h Soxhlet extraction in ethyl alcohol followed by a 36-h extraction with diethyl ether and then dried at 100°C for 24 h. Bone ash percentage was determined by placing the bones in a muffle furnace and ashing for 36 h at 550°C.

Data were analyzed by ANOVA procedures appropriate for a randomized complete block design using the GLM procedure of SAS (2002). Means which were found to be significantly different at the $p<0.05$ level were separated using a Duncan (1955) multiple range test.

Table 1: Composition and calculated nutrient content of broiler starter (1-21 d), grower (22-42 d) and finisher (43-49 d)

Ingredient (%)	Starter	Grower	Finisher
Yellow corn	58.67	64.44	67.45
Soybean meal (44% CP)	35.74	29.85	26.73
Soybean oil	1.44	2.00	2.76
Di calcium phosphate	2.16	1.32	1.05
$CaCO_3$	1.06	1.31	1.23
Common salt	0.25	0.25	0.25
Vitamin premix[1]	0.25	0.25	0.25
Mineral premix[2]	0-0.25[3]	0-0.25[3]	0-0.25[3]
DL-Methionine	0.22	0.11	0.03
L-Lysine (HCl)	-	0.23	-
Calculated analysis			
ME (kcal/kg)	2,900.00	3,015.00	3,100.00
Crude protein (%)	20.84	18.84	17.51
Lysine (%)	1.10	1.08	0.89
Methionine (%)	0.54	0.40	0.32
Met + Cys (%)	0.88	0.72	0.61
Calcium (%)	1.00	0.90	0.80
Available Phosphorus (%)	0.50	0.35	0.30
Sodium (%)	0.11	0.11	0.11
Potassium (%)	0.89	0.79	0.73

[1]Provided the following per kilogram of diet: vitamin A, 9000 IU; vitamin D_3, 2000 IU; vitamin E, 18 IU; vitamin K_3, 2 mg; riboflavin, 6.6 mg; pantothenic acid, 9.8 mg; niacin, 29.7 mg; vitamin B_{12}, 0.015 mg; biotin, 0.1 mg; folic acid, 1 mg; pyridoxine, 2.94 mg; thiamine, 1.75 mg; Choline chloride, 250 mg; Antioxidant, 1 mg.

[2]Provided the following per kilogram of diet: Mn, 99.2 mg; Fe, 50 mg; Zn, 84.7 mg; Cu, 10 mg; I, 0.99 mg; Se, 0.2 mg; Choline chloride, 250 mg.

[3]Based on treatment as follows: T1) complete diet in all period (control) T2) remove mineral premix from starter diet T3) remove mineral premix from grower diet T4) remove mineral premix from finisher diet T5) remove mineral premix from starter and grower diets T6) remove mineral premix from starter and finisher diets T7) remove mineral premix from grower and finisher diets T8) remove mineral premix of all rearing diets

RESULTS AND DISCUSSION

The effects of removal mineral premix on performance broilers at different periods are shown in Table 2. Removal of mineral premix from the diet during different periods had no significant ($p>0.05$) effect on feed intake. Removal of mineral premix from the broilers during starter and grower periods did not affect weight gain ($p>0.05$), but in the finishing period of rearing (42-49 d) treatment removing mineral premix of all rearing periods (T8) and treatment removing mineral premix of starter and grower periods (T5) body weight gain was less than other treatments ($p<0.01$). Feed conversion in treatments which mineral premix from the diets of had been removed compared to broilers fed diets with complete mineral premix, were high feed conversion ($p<0.05$). However, in grower and finisher periods, treatment removing mineral premix of starter and grower periods (T5) and treatment removing mineral premix of all rearing periods (T8), feed conversion were higher than other treatments ($p<0.05$) and ($p<0.01$) respectively. Waldroup *et al*. (1968) reported that the presence or

Table 2: Effect of removal mineral premix during different period (starter, grower and finisher) on performance in broilers

	Feed intake (g)			Weight gain (g)			Feed conversion ratio (g/g)		
	Period								
Treatment[1]	Starter (1-21 d)	Grower (22-42 d)	Finisher (43-49 d)	Starter (1-21 d)	Grower (22-42 d)	Finisher (43-49 d)	Starter (1-21 d)	Grower (22-42 d)	Finisher (43-49 d)
T1	568.7	2,816.5	1,032.3	407.3	1,490.3	535.1[a]	1.39[b]	1.89[b]	1.93[b]
T2	601.2	2,804.9	1,018.1	384.2	1,483.0	530.5[a]	1.56[a]	1.89[b]	1.92[b]
T3	590.2	2,826.2	1,028.2	418.9	1,467.4	523.9[a]	1.41[b]	1.92[b]	1.96[b]
T4	580.0	2,811.2	1,028.6	413.8	1,488.9	533.5[a]	1.40[b]	1.89[b]	1.93[b]
T5	592.3	2,878.4	965.2	380.0	1,398.3	431.7[b]	1.55[a]	2.06[a]	2.24[a]
T6	589.4	2,815.3	1,019.9	382.9	1,480.9	533.8[a]	1.54[a]	1.90[b]	1.91[b]
T7	582.1	2,824.1	1,024.9	416.0	1,463.9	518.1[a]	1.40[b]	1.93[b]	1.98[b]
T8	595.9	2,829.3	969.9	381.4	1,388.8	431.2[b]	1.56[a]	2.05[a]	2.26[a]
SEM	9.8	19.2	8.1	6.7	18.3	9.4	0.02	0.02	0.03
p-value	0.97	0.99	0.14	0.11	0.63	<0.0001	0.01	0.01	<0.0001

[a-b]Means in a column with no common superscripts differ significantly (p<0.05).

[1]Treatments as follows: T1) complete diet in all period (control) T2) remove mineral premix from starter diet T3) remove mineral premix from grower diet T4) remove mineral premix from finisher diet T5) remove mineral premix from starter and grower diets T6) remove mineral premix from starter and finisher diets T7) remove mineral premix from grower and finisher diets T8) remove mineral premix of all rearing diets

absence of a commercial trace mineral premix in a corn-soybean meal diet had no significant effect on body weight gains, feed utilization or the incidence of toe and hock deformities of broilers 0 to 28 d of age. Thomas and Twining (1971) concluded from two floor-pen trials that supplementation with vitamins and trace minerals does not appear to be necessary if broilers are not kept on withdrawal feeds for longer than 10 days.

Removal of both vitamin and trace mineral supplements from the diet fed to broilers 7, 14, or 21 days prior to processing at 49 days of age had no adverse effects on feed intake, body weight gain, feed utilization, or mortality (Skinner *et al*., 1992). Deyhim and Teeter (1993) also demonstrated that broiler chickens reared in batteries under a cycling ambient temperature (24-35°C, creating heat stress) and fed diets without vitamin and trace mineral supplements had reduced weight gain, higher mortality and poorer feed conversion as compared to birds fed normally supplemented diets. Christmas *et al*. (1995) reported that vitamins and trace minerals could be removed from broiler diets during 35-42 d without affecting weight gain or feed efficiency.

Jafari Sayadi *et al*. (2005) showed that reduction or withdrawal of mineral premix from diets in different weeks of grower period, did not affect feed intake. In weeks 4 and 5, there was no significant difference in weight gain and feed conversion ratio, but in week 6, weight gain of treatment which fed diet with 0.5% mineral premix at whole the experiment period was significantly higher and its feed conversion ratio was significantly lower than other treatments. The findings of the study Maiorka *et al*. (2002) suggest that withdrawal of vitamin premix during the final period of broiler chicken growth is more deleterious than withdrawal of mineral premix, because its affect on feed conversion. Growth performance was not affected in chicks fed diets with or without the trace minerals during starter (0-15 d), grower (15-36 d) and finisher (36-43 d) periods, but adding phytase had positive effects on growth performance (Shelton and Southern, 2006).

The effects of removal mineral premix on carcass yield and leg bone broilers at different periods are shown in Table 3 and 4. There were no adverse effects of removal of mineral premix on carcass, abdominal fat, liver, breast and leg yields (p>0.05).

Review results related to the tibia bones determine that removal mineral premix for long-term (treatments T5 and T8) significantly bone density is the left leg reduced (p<0.05). Compare treatments on bone breaking strength manifested subject that broilers fed diets with complete mineral premix for a long-time (treatments T1 and T4) and broilers that mineral premix in the grower period had received (treatments T2 and T6) high bone breaking strength shown (p<0.01). Removing mineral premix from broilers diet during different periods rearing caused no significant effect on bone ash percentage (p>0.05). Although, bone ash among treatments showed no significant effect, but numerical treatment T5 (removing mineral premix of starter and grower periods) and treatment T8 (removing mineral premix of all rearing periods), bone ash lower than the control group.

Skinner *et al*. (1992) showed that removal of vitamin and trace mineral supplements from the diet of broilers for periods up to 21 days before slaughter (49 d) had no significant effect on dressing percentage or abdominal fat content. Maiorka *et al*. (2002) vitamin and trace mineral supplements were removed from broiler diets for during from 42-49 d. Yields of broiler carcass, breast and leg were not affected by vitamin or mineral premix withdrawal from the diet at 42 d of age. However, relative liver weight was reduced when vitamin or mineral premix occurred.

Zapata *et al*. (1996), in a study removed mineral and vitamin supplements during 2 or 3 weeks of rearing

Table 3: Effect of removal of mineral premix during different period (starter, grower and finisher), on carcass characteristics (as percentage of live body weight) of broilers

Treatment[1]	Carcass yield (%)	Liver (%)	Abdominal fat (%)	Breast (%)	Leg (%)
T1	67.53	2.21	0.72	22.87	21.50
T2	69.55	2.24	0.74	21.87	20.70
T3	67.79	2.19	0.77	21.65	20.49
T4	67.72	2.21	0.70	22.75	21.45
T5	67.25	2.18	0.82	22.48	21.21
T6	69.85	2.23	0.83	22.10	20.83
T7	68.94	2.19	0.75	21.68	20.47
T8	67.27	2.15	0.82	22.33	21.30
SEM	0.32	0.01	0.01	0.15	0.12
p-value	0.21	0.55	0.14	0.24	0.13

[1]Treatments as follows: T1) complete diet in all period (control) T2) remove mineral premix from starter diet T3) remove mineral premix from grower diet T4) remove mineral premix from finisher diet T5) remove mineral premix from starter and grower diets T6) remove mineral premix from starter and finisher diets T7) remove mineral premix from grower and finisher diets T8) remove mineral premix of all rearing diets

Table 4: Effect of removal of mineral premix during different period (starter, grower and finisher) on tibia bone of broilers

Treatment[1]	Bone density (g/cm^3)	Bone strength (kg)	Bone ash (%)
T1	1.10[a]	32.34[a]	44.84
T2	1.08[a]	31.35[a]	42.12
T3	1.07[a]	27.81[b]	41.10
T4	1.09[a]	33.45[a]	43.90
T5	0.88[b]	26.75[b]	39.86
T6	1.09[a]	31.17[a]	43.57
T7	1.07[a]	27.61[b]	40.70
T8	0.87[b]	27.26[b]	39.78
SEM	0.02	0.39	0.65
p-value	0.03	<0.0001	0.37

[a-b]Means in a column with no common superscripts differ significantly ($p<0.05$).

[1]Treatments as follows: T1) complete diet in all period (control) T2) remove mineral premix from starter diet T3) remove mineral premix from grower diet T4) remove mineral premix from finisher diet T5) remove mineral premix from starter and grower diets T6) remove mineral premix from starter and finisher diets T7) remove mineral premix from grower and finisher diets T8) remove mineral premix of all rearing diets

period and measured mineral contents of broilers meat. They observed the levels of Ca, P, Mg and K were decreased but Na, Fe, Cu, Zn and Mn did not affect.

Shelton and Southern (2006) showed that removing the trace mineral premix from broilers diets during different period (starter, grower and finisher) on bone breaking strength was not affected by diet during the starter (1-15 d) period but was decreased during the grower (15-36 d) and finisher (36-43 d) periods. Bone ash percentage was not affected during any growth period. Bone strength has been shown to be decreased in chicks fed diets with no supplemental Zn (Shelton *et al*., 2004). Mn deficiency can have a negative effect on bone development (Liu *et al*., 1994). Thus, low Mn levels in the tibia also may have played a role in the reduced bone strength. Shelton and Southern (2004) shown that removal of Mn and Cu from the diet of chicks raised in starter batteries does not affect bone strength or bone ash percentage.

There is another point, the possibility of providing mineral from composition in the diets without mineral premix. There is ration different amounts of minerals, depending on the composition used in the ration. The drinking water of chickens is the mineral values.

Bioavailability of minerals is an important factor in this respect, for example, Mn in corn and soybean meal has a low bioavailability. In the other hand, this low-level of bioavailability is considered in estimating the birds requirements, so the actual Mn requirement of modern broiler chickens is about 14 mg/kg that with regard to natural antagonisms in feeds like phytic acid, fibre and calcium, the determined Mn requirement in a reference like NRC (1994) is 60 mg/kg (Halpin and Baker, 1986). Quantification of ingredient's minerals contents is expensive and per diet formulation often impossible, then using references like those that NRC recommends is a common procedure. There maybe high variation in mineral contents of different samples of an ingredient, for example Scott (1973) reported 0.1-0.54 mg/kg selenium in soybean meals of different geographical zones.

Overall, according to the results we can say the recommended amounts of minerals by companies producing mineral premixes usually more than need animals. Thus, the experiment results can be deduction that adding mineral premix to dietary grower period support performance of broilers.

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