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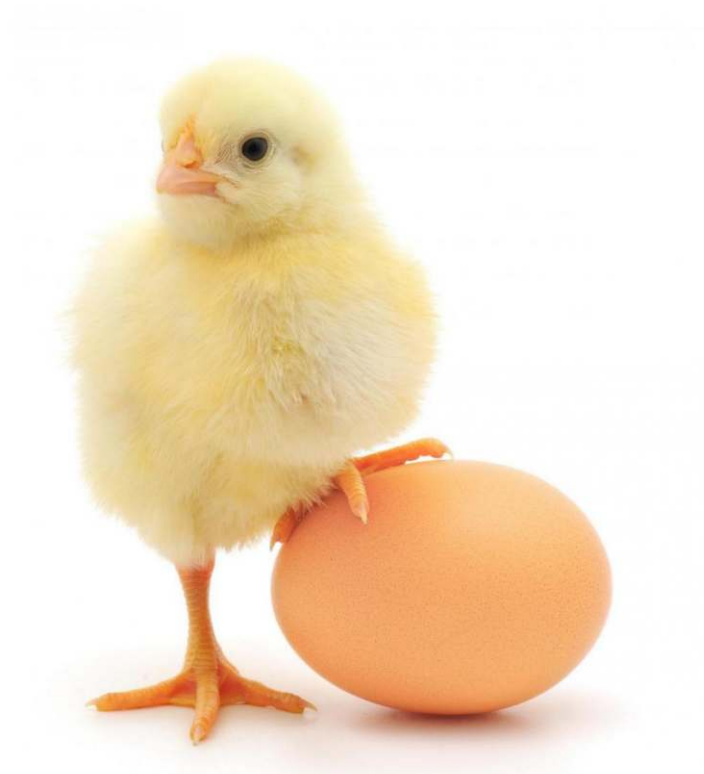

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The Effect of Reducing Calcium and Phosphorous on Broiler Performance

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Abstract: This study was conducted to evaluate different levels of calcium (Ca) and phosphorous (P) on ileum microbial content, and performance of broilers. In a completely randomized design test with four treatment diets containing; NRC level (control), 10, 20 and 30% lower than NRC level of Ca and P with four replicates and 30 Ross broiler chicken per replicate in 44 days (12-56 days of age), food consumption, feed conversion ratio (FCR), serum and tibia Ca and P, and duodenal and jejunal epithelial protein were evaluated weekly. Results indicated that serum Ca and P was not affected at all, in contrast, Ca and P content of the tibia were significantly ($p<0.05$) affected, with the lowest level in 30% reduced group. FCR was also influenced by the levels of Ca and P on the diet significantly ($p<0.05$) which reduced by decreasing their levels. Reduction of Ca and P of the ration did not affect the microbial content of the ileum but affected the protein content of the intestinal epithelium significantly ($p<0.05$) in different weeks.

Key words: Calcium, phosphorous, broiler, water

Introduction

Calcium (Ca) and phosphorous (P) are couple of essential inorganic materials which are involved in many physiological functions of the body of living animals (Hurwitz *et al.*, 1995; Underwood and Suttle, 2001). These elements take part in construction and biochemical functions of the cell (Bain and Watkins, 1993; Whitehead, 1995). Regarding the nutrients which are more considered in the diet of animals suggest particular amount of Ca and P in the ration of broilers (NRC, 1994). Most of the sources for these elements are inorganic which have high acid binding capacity, particularly the Ca which affects the pH seriously (Ferd, 1974).

On the other hand the circumstances of the poultry intestine is almost acidic than alkaline (Bronner, 1987), and in this case high levels of Ca might increase the intestinal pH and consequently the digestion and absorption of the nutrients. As some have suggested removal of Ca and P might influence the broiler performance (Skinner *et al.*, 1992a). Considerable difference in the estimated calcium requirements of hens and broilers is apparent from reports (Bond *et al.*, 1991). The strain and age of the birds; the source of the supplemental calcium; the ability of hens to raise food intake to acquire sufficient calcium; exaggerated safety; and microflora content of the intestine all affect (Bond *et al.*, 1991; Underwood and Suttle, 2001).

Two other factors which should be considered are pH and microflora content of the intestine that are seriously pH dependent and affect the absorption of digestive system (Barrow, 1992; Wuthier, 1993), and this situation also influences the brush border and apical cell of the intestine (Bronner, 1987). In this regard to evaluate the effect of Ca and P levels on gut and body performance the present research was conducted.

Materials and Methods

In a completely randomized design test 480 one day old Ross chicken were divided into 16 cages (each 30), with 4 treatments and 4 replicates for each treatment. Treatments received a corn soybean basal diet with four different levels of Ca and P. Diets contained; NRC level (control base on NRC 1994), 10, 20 and 30% lower than NRC (Table 1). Food consumption and chicken weight were evaluated weekly and at the same time 2 chicken of each replicate were randomly selected and their blood samples were taken, killed and 1-2 g of ileum content, 1 cm of duodenum and jejunum and 2 cm of tibia were collected for microbial, protein content and Ca and P content evaluation, respectively. Method's of Lowry's *et al.* (1951) was applied to measure the protein content of the intestinal epithelium. Data processing was completed by the statistical program SAS, (1986).

Results

Results of the analyzed data for dry matter, calcium and phosphorous of tibia are shown in Table 2. Different percentages of calcium and phosphorous of the diet did not affect the dry matter and phosphorous of tibia of studied chicks. Different percentages of calcium and phosphorous of diet had significant effect on calcium level of tibia ($p<0.05$). The effects of reducing calcium and phosphorous of diet on calcium of blood is shown in Table 3. Different levels of calcium and phosphorous of the diet had no significant impression on calcium of blood. The effect of calcium and phosphorous on feed conversion ratio of different weeks is shown in Table 4.

Table 1: Composition of starter, grower and finisher diets (%)

Ingredients and compostion (%)	0-3 WK A	3-6 WK A	6-8 WK A	0-3 WK B	3-6 WK B	6-8 WK B
Corn	52.91	58	62.5	52.91	58	62.5
Soybean Meal	27.79	22.4	20.05	27.79	22.4	20.05
Wheat	10	12	12	10	12	12
Fish meal	6	5	3	6	5	3
Calcium phosphate	1.01	0.68	0.6	0.8	0.52	0.44
Oyster shell	1.15	1.3	1.25	1.03	1.16	1.13
DL-methionine	0.07	0.02	-	0.07	0.02	-
Vitamin-mineral premix	0.5	0.5	0.5	0.5	0.5	0.5
Salt (sodium chloride)	0.1	0.1	0.1	0.1	0.1	0.1
Sand	0.47	-	-	0.8	0.3	0.28
Chemical analysis						
Me (Kcal/kg)	2859	2957.9	2999.9	2859	2957.9	2999.9
Crude protein (%)	20.06	18.45	16.93	20.6	18.45	16.93
Ca (%)	0.89	0.84	0.75	0.8	0.75	0.67
P (%)	0.4	0.29	0.28	0.36	0.26	0.25
Corn	52.91	58	62.5	52.91	58	62.5
Soybean Meal	27.79	22.1	20.05	27.79	22.4	20.05
Wheat	10	12	12	10	12	12
Fish meal	6	5	3	6	5	3
Calcium phosphate	0.59	0.31	0.28	0.37	0.24	0.17
Oyster shell	0.92	1.04	1.04	0.81	0.93	0.89
DL-methionine	0.07	0.02	-	0.07	0.02	-
Vitamin-mineral premix	0.5	0.5	0.5	0.5	0.5	0.5
Salt (sodium chloride)	0.1	0.1	0.1	0.1	0.1	0.1
Sand	1.12	0.63	0.53	1.45	0.81	0.79
Chemical analysis						
Me (Kcal/kg)	2859	2957.9	29999	2859	2957.9	2999.9
Crude protein (%)	20.6	18.45	16.93	20.6	18.45	16.93
Ca (%)	0.71	0.66	0.6	0.62	0.6	0.52
P (%)	0.32	0.22	0.22	0.28	0.21	0.2

Abbreviations: A= Control group, B= 10% Ca & P lower than NRC, C= 20% Ca & P lower NRC, D= 30% Ca & P lower than NRC.

In the first and second week of the experiment reduction of calcium and phosphorous of the diet had no significant effect on feed conversion. In the third week, the lowest feed conversion belongs to the fourth group (30 % less than NRC). Other groups did not show significant statistical difference with each other. In the fourth week, the lowest feed conversion assigned to the second group. In the fifth and sixth week, no significant statistical difference was observed between groups. The effect of different calcium and phosphorous percentages on protein membrane of duodenum and jejunum are shown in Table 5 and 6. The group fed based on NRC had the least duodenum protein of membrane in comparison with other groups. In the second week, the group fed 10% less than NRC had significant statistical difference ($p<0.05$) with other groups and it had the least protein of membrane. In the fourth week, no significant difference between groups was observed. In the fifth week, the group 10% less than NRC and 30% less than NRC comparing with other groups had significant statistical difference and respectively had the lowest level of protein in duodenal membrane. In the first week, the most protein of the jejunal membrane belonged to the first group and the least belonged to the third group. In other weeks, no significant difference between groups was observed.

Discussion

These results about dry matter and phosphorus of tibia are similar to what have been reported by Skinner *et al.* (1992a), Holcombe *et al.* (1977), and Whitehead (1995). Water is important nutrient to all livestock and poultry. As with feed ingredients, livestock water must be regarded as an essential nutrient, although it is not possible to state precise requirements. The amount needed will depend upon environmental temperature and relative humidity, the composition of the diet, rate of egg production. The salt content and pH of water may influence the use of the drinking water as an administration route for vitamins, minerals (calcium and phosphorus) and drugs. According to the Iran geologic survey, 85 percent of the Iran has to cope with hard water

Table 2: Different contents of dry matter calcium and phosphorous of tibia (%)

Treatment	Dry Matter (%)	Calcium (%)	Phosphorus (%)
Calcium & phosphorous based on NRC	54[a]	30.5[a]	18[a]
Calcium & phosphorous 10% less than NRC	58[a]	33[a]	18[a]
Calcium & phosphorous 20% less than NRC	56[a]	30[a]	18.5[a]
Calcium & phosphorous 30% less than NRC	53[a]	23.5[b]	19[a]

Numbers shown with common superscript letters are not difference.

Table 3: The effect of reducing calcium and phosphorous on average level of blood calcium in different weeks (mg/dl).

Treatment	First week	Second week	Third week	Fourth week	Fifth week
Calcium & phosphorous based on NRC	12.43	10	9.4	11.63	10.8
Calcium & phosphorous 10% less than NRC	11.5	11.63	9.33	11.7	10.98
Calcium & phosphorous 20% less than NRC	10.6	8.27	9.23	12.83	13.07
Calcium & phosphorous 30% less than NRC	12.65	8.15	9.67	13.7	9.87

Table 4: The effect of calcium and phosphorous on feed conversion ratio in different weeks

Treatment	First Week	Second Week	Third Week	Fourth Week	Fifth Week	Sixth Week	Total Week
Calcium & phosphorous based on NRC	2.43[a]	2.23[a]	1.90[a]	2.76[a]	2.39[a]	2.68[a]	2.39[a]
Calcium & phosphorous 10% less than NRC	2.33[a]	2.22[a]	2.17[a]	2.61[b]	2.43[a]	2.78[a]	2.33[a]
Calcium & phosphorous 20% less than NRC	2.47[a]	2.19[a]	2.06[a]	2.67[ab]	2.30[a]	2.53[a]	2.33[a]
Calcium & phosphorous 30% less than NRC	2.50[a]	2.22[a]	1.66[b]	2.8[a]	2.41[a]	2.68[a]	0.35[a]

Numbers shown with common superscript letters are not difference.

Table 5: The effect of different levels of calcium and phosphorous on the protein content of membrane of duodenum in broilers (mg/g fresh tissue)

Treatment	First Week	Second Week	Third Week	Fourth Week	Fifth Week
Calcium & phosphorous based on NRC	4.08[a]	8.04[a]	4.00[a]	6.84[a]	7.39[a]
Calcium & phosphorous 10% less than NRC	7.62[b]	4.46[b]	7.82[b]	6.65[a]	4.55[b]
Calcium & phosphorous 20% less than NRC	8.09[b]	7.06[a]	8.00[b]	7.50[a]	6.06[a]
Calcium & phosphorous 30% less than NRC	7.51[b]	8.24[a]	7.2[b]	7.47[a]	4.00[b]

Numbers shown with common superscript letters are not difference.

excessive levels calcium and magnesium. Total Dissolved Solid (TDS) = 1500 PPM found in water in this location. The National Research Council (1994) reports the following guidelines to this water, TDS = 1000-3000 PPM should be satisfactory for all classes of poultry (especially at the higher levels) but should not affect health or performance. TDS levels of the water consumption in this trial was high, and is relatively with different levels of calcium and phosphorous. Despite this situation the results did not show significant effect on calcium of blood and this is contrary with what has already been reported by Frost and Roland (1991), which reported reduction in calcium of blood by reduction calcium of diet. On the other hand amount of calcium levels of the tibia is a fixed, calcium deposit and levels of the water calcium does not set in calcium of tibia. Different levels of calcium and phosphorous affected the calcium levels of tibia significantly ($p<0.05$) which confirms the pervious results in this relation from Holcombe *et al.* (1977). Almost 99% of calcium exists in skeleton and teeth, by reducing calcium and phosphorous of diet and setting acidic conditions in mucous of intestine, the absorption of calcium and phosphorous increase (Bronner, 1987). Hurwitz *et al.* (1995) has shown reduction calcium and phosphorous of diet results increasing of concentration of vitamin D five times, and more absorption of calcium from mucous of intestine. When the calcium of blood decreases from 6 milligram in deciliter, Parahormone hormone motivates the transfer of calcium and phosphorous from skeleton to blood and on the other way by impression on kidneys results in producing vitamin D and cholecalciferol (vitamin D_3) affects from small intestine and in this way calcium absorption increases. Effective factors in absorption of calcium are acid of intestine, calcium concentration in intestine and vitamin D. Most of calcium in the entrance of intestine absorbs before the acid of stomach neutralizes completely (pH=2-7). Parahormone hormones, calcitonin and vitamin D are basic regulators of calcium metabolism. Parahormone motivates the transfer of calcium and phosphorous from bone to blood and by affecting on kidneys the absorption of calcium and repel of phosphorous increase. The second effect of Parahormone, on kidney from small

Table 6: The effect of different levels of calcium and phosphorous on the protein content of membrane of jejunum in broilers (mg/g fresh tissue)

Treatment	First Week	Second Week	Third Week	Fourth Week	Fifth Week
Calcium & phosphorous based on NRC	9.64[a]	8.04[a]	8.04[a]	7.57[a]	7.04[a]
Calcium & phosphorous 10% less than NRC	8.00[b]	8.04[a]	9.83[a]	7.99[a]	7.46[a]
Calcium & phosphorous 20% less than NRC	7.86[b]	7.85[a]	8.00[a]	7.98[a]	7.46[a]
Calcium & phosphorous 30% less than NRC	8.25[a]	8.41[a]	8.41[a]	7.98[a]	7.17[a]

Numbers shown with common superscript letters are not difference.

intestine, motivates the production of vitamin D and in this way the absorption of calcium increases. Birds produce Calcitonin in Ultimbranchial glands and in Hypocalcaemia birds; concentration of calcium in serum of blood can be reduced. Hypocalcaemia shock in parrots family because of repel of protein from pension (kidney illness), which results in hypoalbomini, has been reported. In intestine, acidophil bacteria (lactobacillus) results in increasing in absorption of calcium. By decreasing calcium and phosphorous of diet, pH of intestine reduces and on the other side the reduction of pH results in increasing of acidophil bacteria and decreasing pathogen bacteria (Ferd, 1974). In rat, the reduction of calcium and phosphorous of diet results increase in concentration of vitamin D five times. The effect of parathyroid hormone results in producing phosphorous in kidney, this reduces the phosphate of kidneys which motivates kidneys to produce vitamin D. Feed conversion ratio in this experiment shows this emphasized on what were found by Skinner *et al.* (1992b) compared feeding by lactobacillus and virginiamycin in broilers and found out that feeding by lactobacillus improves absorption of feed and sometimes feed conversion. (Ferd, 1974), believed that by increasing the number of lactobacillus in intestine, the absorption improves and in general feed conversion increases. By reducing pH of intestine results increase the number of lactobacillus, the length of brush border and decreasing the thickness of intestine. All of them result in improving feed absorption and conversion Dofing and Gottschal (1997). It is well established that the gastrointestinal normal micro flora plays important role in the health and well being of poultry. The pH values and hard water relate to improving feed conversion and broiler performance with decreasing levels of calcium.

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