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Effect of Dietary Calcium on the Performance of Commercial Chicken

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ABSTRACT

Calcium (Ca) is an important chemical element, essential for mineralization of bones and shells in poultry. The present study investigated the effect of supplementing calcium on the growth performance in broiler chickens. Broiler chicks (n = 60) were divided into three groups A, B and C (n = 20 birds/group) reared as 1%, 2% and 3% Ca supplemented groups. The parameters studied were feed intake, water intake, live body weight, carcass weight, dressing percentage and weights of different internal visceral organs. Feed intake ($p < 0.05$), water intake ($p < 0.01$) and dressing percentage ($p < 0.05$) were higher in the group supplemented with 1% calcium. Body, carcass, liver, heart, spleen, gizzard and intestine weighed greatest in 3% calcium-supplemented group. The mortality observed was 5% in each group and net profit in Pakistani rupees (Rs.) was 56.4, 59.4 and 70.2 per bird for group A, B and C, respectively. The dietary Ca showed positive impacts on commercial chicken and 3% Ca supplemented ration earned more profit in terms of better growth performance.

Key Words: Commercial chicken; performance; dietary calcium.

INTRODUCTION

Broiler production plays a major role in food security for the rapidly increasing human population. Their short production cycle, high feed efficiency and high biomass per unit of agricultural land are particularly attractive for the production systems. However, compared to other domestic animals, broiler chickens are more susceptible to changing environmental conditions. Improved efficiency and implementation of quality control in the broiler production chain has been constant in the broiler industry (Ansar et al., 2004).

Mineral imbalance, particularly of calcium (Ca) is one of the problems responsible for economic losses to poultry industry. Maintenance of calcium and phosphorus (P) ratio at 1.0:0.5 is essential for performing various functions in the body (Angel et al., 2005).

Ca is important for bone development, blood-clot formation, muscle contraction and eggshell quality. Dietary Ca and P have no effect on weight gain and feed efficiency but increased bone ash Ca level at third week of age (Scheideler et al., 2008). Addition of vitamin D_3 in maize-soybean meal diets indicated a potential improvement by increasing Ca and P retention in about 5 to 12% birds, leading to an increase in toe ash P content without added phytase (Qyan et al., 1997). The phytase, vitamin D_3 and total P are important factors together with utilization of phytate P and Ca in broilers. Phytate P inclusion at the level of 0.30% in starter and grower diets decreased tibial ash content, live weight gain and feed conversion ratio (Mohamed, 1998). Higher live weights have been reported in broilers fed a low Ca level compared to high dietary Ca inclusion (Karamuftuoolu and Kocabaoly, 2001). Rossi et al. (1994) reported that tibial ash content was

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significantly lower with diets low in Ca and P or low in cholecalciferol. Diets low in cholecalciferol increased the severity of tibial TD and reduced body weight. Keeping in view the potential role of dietary Ca, the present study was carried out to examine the effect of dietary calcium on the performance and growth of commercial chicks.

MATERIALS AND METHODS

Experimental Birds

Sixty day-old broiler birds were purchased from a local hatchery. The chicks, on deep litter system, were reared under standard hygienic conditions at the Sindh Agriculture University, Tandojam, Pakistan. The birds were fed ad libitum a commercially diet free of antibiotics and coccidiostat. The birds were vaccinated according to given schedule. On day 2, ND+IB vaccine, day 10 was followed by IBD vaccine, on day 17 HPS vaccine, on day 22 IBD was repeated and on day 28 ND were administrated.

Experimental Design

Birds were initially weighed and randomly divided into three groups (A, B and C), each containing 20 birds. The group A was kept as control and given 1.0 percent Ca, while group B and C were supplemented with 2 and 3 percent calcium respectively. Parameters were studied: live body weight (initial and weekly), feed intake, water intake, final weight, mortality, carcass weight, weight of internal edible/non edible parts and economics.

Statistical Analysis

The data were analyzed by using the Minitab Statistical package (MTB 2000) under General Linear Model by using Randomize Complete Block Design test. The probability was determined at $p < 0.05$.

RESULTS

Growth Performance:

The feed intake of broilers was significantly ($p < 0.05$) higher (3879.7 g/bird) in the group A (1% Ca) than the birds in the groups C (3% Ca) and group B (2% Ca) with average feed consumption of 3800.3 g and 3788.5 g/bird, respectively (Table 1). The chicken reared on 2% dietary Ca consumed lesser feed than those reared under 3% and 1% dietary Ca. The results further showed that irrespective of chicken dietary Ca levels, the weekly feed consumption was increased with the development of age. The statistical analysis suggested that the results for groups, weeks as well as interaction between groups and weeks were highly significant ($p < 0.01$).

Table 2 indicated that water intake of birds was significantly ($p < 0.01$) higher in the group A compared with the groups C and B. The statistical analysis illustrated interaction between groups and weeks were highly significant ($p < 0.01$).

The effect of different dietary calcium levels on the live body weight was more ($p < 0.05$) in the group C than in the groups B and A (Table 3).

The carcass weight was obtained on the basis of three birds slaughtered from each group. The carcass weight was significantly higher ($p < 0.01$) in the group C than in the groups B and A (Table 4). The carcass weight in commercial chicken was better under 3% dietary calcium supplementation.

The dressing percentage was calculated on the basis of carcass weight from the total live body weight of the slaughtered birds. The dressing percentage was higher ($p < 0.01$) in the 1% Ca-supplemented group compared with the other groups (Table 4).

Weights of the Visceral Organs

Data indicated that the weights of liver and heart of birds kept in the group C (3% Ca)

were higher ($p < 0.05$) than in the groups B (2% Ca) and A (1% Ca) (Table 4). Similar outcomes were observed for other variables where weights of spleen, gizzard and intestine were more ($p < 0.05$) in the group C compared with the other groups (Table 4).

Table 1 Weekly feed consumption (g/bird) of commercial fed different levels of dietary calcium

Week	Group		
	A	B	C
W1	117.8	107.95	92.6
W2	292.4	335	289
W3	585.3	598	541.5
W4	817.9	791	800.7
W5	846.5	805	907
W6	1102	1151	1169.5
Total	3879.7[a]	3788.5[c]	3800.3[b]

Table 2 Weekly water intake (ml/b) of commercial fed different levels of dietary calcium

Weeks	Groups		
	A	B	C
W1	332.5	301	298.5
W2	678	690	615
W3	1270	1252.5	1249.5
W4	1856	1855	2035
W5	3046	2393.5	2439
W6	3415	3229.5	3433
Total	10597[a]	9720[c]	10069[b]

Table 3 Weekly live body weight (g/bird) of commercial fed different levels of dietary calcium

Week	Group		
	A	B	C
W1	37.69	38.86	37.3
W2	161.86	156.10	154.5
W3	339.7	356.60	380
W4	711.7	744.60	827.1
W5	1253.6	1275.00	1316
W6	1876.6	1878.55	1911
Total	2054.7[c]	2100[b]	2200[a]

Economics

Economic analysis of dietary Ca supplemented ration at different levels was worked out (Table 5) and found positive effect on the net profit due with higher levels of dietary Ca. The total cost (Rs.) of production per bird in groups A, B and C were 100.8, 98.4 and 98.8, respectively. After fetching the market price Rs. 120/kg live weight, the total income received from commercial chicken in group A, B and C were Rs. 246.5, 252.1 and 264.0. After deduction of production costs, the net profit received in groups A, B and C was Rs. 56.4, 59.4 and 70.2.The 3% dietary Ca level earned more net profit compared with 2% and 1% dietary Ca levels.

Table 4 Average weights of carcass, visceral organs and dressing percentage of broilers

Group	Carcass weight (g)	Dressing percentage	Weight (g)				
			Liver	Heart	Spleen	Gizzard	Intestine
A	1231.67[b]	62.41[a]	43.70[c]	9.01[b]	1.97[b]	32.10[b]	130.67[b]
B	1227.00[b]	60.58[c]	48.54[b]	10.17[a]	1.68[b]	31.57[b]	127.33[b]
C	1390.67[a]	61.38[b]	52.83[a]	10.80[a]	2.20[a]	34.50[a]	132.33[a]

[abc]Means with different superscript in a same row differs significantly ($p < 0.05$)

Table 5 Economics of experimental ration

Economic parameter	Group		
	A	B	C
Cost of day old chick (Rs./bird)	65.0	65.0	65.0
Total feed intake (kg./bird)	3.9	3.8	3.8
Total cost of feed (Rs./bird)	100.8	98.4	98.8
Misc. Expenditure (Rs./bird)	25.0	25.0	25.0
Cost of calcium	0.0	4.3	5.0
Final live body weight (kg./bird)	2.1	2.1	2.2
Total cost of production (Rs./bird)	190.0	192.7	193.8
Broiler sale rate (Rs./kg.)	120.0	120.0	120.0
Total income (Rs./bird)	246.5	252.1	264.0
Net profit (Rs./bird)	56.4	59.4	70.2

DISCUSSION

Ca is a major element in poultry nutrition and higher Ca level is required, particularly in the finisher periods (Zyla et al., 2000). Ca is important for bone development, blood-clot formation, and muscle contraction and to provide good eggshell quality and dietary Ca is effective in feed efficiency, bone ash and legs problems (Scheideler et al., 2008). The results showed that in commercial chicken groups A (1% Ca), B (2% Ca) and C (3% Ca), the feed intake was 3879.7, 3788.5, 3800.3 g/bird, water intake 10597, 9720, 10069 ml/b, live body weight 2054.7, 2100, 2200 g/bird, FCR 1.8, 1.7 and 2.0, carcass weight 1231.67, 1227 and 1390.67 g/bird, dressing percentage 62.41, 60.58 and 61.38, respectively. These results are in concurrence with those of Ramazan et al. (2007) who investigated the addition of varying dietary calcium (1.2, 1.4 and 1.6%) levels on growth performance, feed intake, some organ weights and tibia ash parameters in broiler. Results showed that there was no adverse effect on broiler performance when Ca was included up to 1.6% levels. Leytem et al. (2007) evaluated the effects of different dietary Ca levels (0.47, 0.70, 0.93, and 1.16%) and reported that there was a linear relationship between dietary Ca and production performance. Similar results have also been reported by Bintvihok and Kositcharoenkul (2006) who examined the effects of calcium on performance of broilers and indicated that addition of dietary calcium had positive effects on body weight gain. Driver et al. (2006) reported that poultry diet containing 0.80% Ca improved carcass quantity and quality of the bird. Tibia ash, traditionally used as an indicator of bone strength, was better correlated to the incidence of bloody breasts. In another study, Manangi and Coon (2007) investigated the effect of dietary Ca on broilers and concluded that broilers fed 0.9% dietary Ca had a greater P physiological threshold before a loss in retention compared with broilers fed lower (0.5%) dietary Ca concentrations.

The dietary Ca showed positive impacts on commercial chicken and 3% Ca-supplemented ration earned profit of Rs.70.20/bird compared with 59.4 and 59.4/bird under 2% and 1% Ca and 5 percent mortality in each group was noted. These results are further supported by the findings of Doan (2000) who suggested that the diet containing 1.1% Ca supplemented is good for increased survivability and reduced mortality. Shivazad et al. (2005) found that pronounced effect on bone ash was obtained in hens fed the high Ca diet; at day 14, the high Ca diets decreased phytate P retention while at day 28 the high P diets decreased phytate P retention.

Leytema et al. (2007), reported positive effects on the survivability of birds and reduced mortality alongwith higher growth in Ca-included diet. Likewise, Letourneau et al. (2008) measured the impact of dietary Ca and found highest growth rate when chicks were fed with 0.9 % Ca. Scheideler et al. (2008) determined the effect of dietary Ca on growth, feed conversion and mortality and indicated that even slight deviations in dietary Ca beyond the NRC recommendations can create a metabolic imbalance in certain strains of broilers (Ross x Ross), which possibly increases susceptibility to mortality. In another similar study, Xie et al. (2009) examined five Ca levels (4.0, 6.0, 8.0, 10.0, 12.0 g/kg) on growth performance and bone ash in White Pekin ducklings and found that weight gain, feed intake and tibia ash were decreased as dietary Ca increased from 4.0 to 12.0 g/kg at the lowest NPP level (2.0 g/kg) but these adverse effects could be alleviated or reversed at other dietary P from 3.0 to 5.0 g/kg. The effect of dietary calcium on the poultry production suggested that for improving the performance of commercial poultry, the inclusion of calcium through various dietary sources may be balanced, so that not only feed conversion efficiency of the poultry is improved, but by ensuring survivability and mortality may also be minimized.

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