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The Effect of Different Levels of Diet Protein on Broilers Performance in *Ad libitum* and Feed Restriction Methods

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Abstract: The effect of different levels of diet protein and feed restriction was studied in broiler chicken. A total of 240 (Ros-308) day-old broiler chickens were randomly assigned to nine treatments each in 3 replicates of 10 birds per pen. The 2 protein level, 4 feed restriction level were used in 2×4 factorial arrangements in isoenergitic diets. The experiments lasted for 6 weeks. The feed consumption, body weight gain and Feed Conversion Ratio (FCR) were measured weekly. At the end experiment tow chickens from per pen were randomly selected, weighted, slaughtered and used to determine body parameters and data analysed. Feed restriction reduced significantly ($p<0.05$) body weight gain and feed consumption. Feed restriction had no significant effect on FCR. Diet protein level had no significant effect on performace. Feed restriction reduced carcass weight, breast weight and tigh weight.

Key words: Broiler, performance, feed restriction, protein level, feed conversion ratio, feed consumption

INTRODUCTION

Continuous genetic selection and improvement in nutrition have led to a very fast growth rate in modern strains. The early-life fast growth rate is accompanied by a number of problems, namely increased body fat deposition, high incidence of metabolic disorders, high mortality and high incidence of skeletal diseases. Qualitative and quantitative feed restriction of broilers might reduce the amount of fat or abdominal fat in carcasses. Qualitative restriction is related to nutrient dilution in the diet, whereas quantitative restriction to limiting the amount of feed daily given to the animals (Leeson and Zubair, 1997). Birds subjected to feed restriction for short periods during the early growth phase show improvement of feed efficiency and reach a weight similar to that of birds fed ad libitum at the time of slaughter (Auckland and Morris, 1971). The improvement in feed efficiency observed in feed restricted chickens has been attributed to reduced overall maintenance requirements caused by a transient decrease in basal metabolic rate (Rincon and Leeson, 2002). However, the improved feed efficiency can also be related to higher feed intake and to the hypertrophy of the gastrointestinal tract that occurs after the restriction (Rincon and Leeson, 2002).

Corn soybean meal diets commonly used in broiler nutrition are often first limiting in sulfur amino acids but contain other essential amino acids in 105-176% of the requirements (Khajali and Moghaddam, 2006). The potential to reduce excess dietary amino acids becomes a reality and allows the opportunity to meet the amino acid requirements of birds more accurately. An oversupply of amino acids can not be converted to body proteins and may depress performance leading to inefficient and uneconomical meat production (Blair *et al*., 1999). Feed grade forms of several essential amino acids are currently available to feed manufacturers. Poultry diets that are composed of natural feedstutts can therefore be supplemented with small amounts of synthetic amino acids to meet the bird's requirements for the most limiting amino acids. Synthetic amino acids are highly available and this may be possible to obtain equal response with lesser amounts of supplementation.

This study was conducted to investigate the effect of early-life feed restriction and levels of diet protein on growth performance.

MATERIALS AND METHODS

Commercial day-old broiler chickens (ROSS 308) were assigned into 24 separate floor pens with 10 birds per pen. The experiment was split into 8 groups, each group include 3 replication. The experiment was terminated at 42 days of chicken age. Treatments were two CP levels: P_1 (recommended by the NRC), P_2 (85% recommended by the NRC) and four feed restriction group: T_1 (without feed restriction), T_2 (6 times feeding), T_3 (3 times feeding) and

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Table 1: Ingredient compositoin (as percent of dry matter) and calculated analysis of the basal diets

	Starter (0-21 days)		Grower (22-42 days)	
Ingredients	P_1	P_2	P_1	P_2
Corn	50.67	59.10	58.38	62.17
Soybean meal	33.00	26.72	30.00	25.60
Fish meal	6.65	5.00	3.86	2.00
D.C.P	0.86	1.11	1.08	1.23
Oyster shell	1.21	1.26	1.20	1.23
Salt	0.21	0.22	0.16	0.17
Sodium bicarbonate	0.23	0.22	0.19	0.20
Oil	6.65	5.50	5.57	2.76
DL-Methionin	0.16	0.26	0.05	0.12
L-Lysine	0.00	0.07	0.00	0.02
Vitamin and mineral permix	0.50	0.50	0.50	0.50
Coccidiostat	0.00	0.00	0.05	0.05
Total	100.00	100.00	100.00	100.00
Nutrient content				
ME (kcal kg)$^{-1}$	3200.00	3200.00	3200.00	3200.00
CP	23.00	20.00	20.00	18.00

Vitamin and mineral provided per kilogram of diet: vitamin A, 360,000 IU; vitamin D3, 800,000 IU; vitamin E, 7200 IU; vitamin K3, 800 mg; vitamin B1, 720 mg; vitamin B9, 400 mg; vitamin H2, 40 mg; vitamin B2, 2640 mg, vitamin B3, 4000 mg; vitamin B5, 12000 mg; vitamin B6, 1200 mg; vitamin B12, 6 mg; Choline chloraid, 200,000 mg, Manganeze, 40,000 mg, Iron, 20,000 mg; Zinc, 40,000 mg, coper, 4000 mg; Iodine, 400 mg; Selenium, 80 mg

T_4 (two every day). Chicks were exposed to feed restriction from 7-16 day of age, each chick was allowed a daily intake 12 g. Following the restriction period, the chickens were fed *ad libitum*. The chickens were weighed at week intervals. Feed intake on a group basis was also recorded at that time (Table 1).

Sample collection: Weighing of the feed and chickens were made on a weekly basis. At the end of the experiment, two birds from each replicate of treatments were slaughtered for separation of carcasses.

Statistical analysis: All data were analyzed using the One-Way Anova procedure of SAS for analysis of variance. Significant differences among treatments were identified at 5% level by Duncan's multiple range tests.

RESULTS AND DISCUSSION

Growth performance: The effect of feed restriction on the performance of broiler chickens is given in Table 2. Chicks were exposed to feed restriction were significantly lighter in body weight gain after the restriction period compared to the full fed birds. On 0-21, 21-42 and 0-42 days, T_2, T_3 and T_4, birds had similar body weight gain. The present study confirm previous observation (Saleh *et al*., 2004) that the Feed restriction from 7-14 days reduced body weight significantly at 63, 70 and 77 days of age. Therefore, birds were not able to totally compensate for the weight lost during the restriction program even after extended feeding. Conversely, Novel *et al*. (2009) that in the mildest regimens, body weights reached slightly higher values than those of the ad libitum fed chickens. Lee and Leeson (2001) also considered that full body weight recovery could be realised more consistently if a number of short restriction periods were used instead of the long ones. In severe feed restrictions, birds maybe unable to reach an acceptable body weight at the end of raring period.

Such finding achieved by Novel *et al*. (2009). When the time allowed for refeeding extended beyond the period of fast growth in control birds, delayed fast growth enabled the restricted birds to catch up (Yu and Robinson, 1992). The feed intake for *ad libitum* fed birds were higher than feed-restricted birds ($p<0.05$). On 0-21 days, the feed intake for T_4 birds were higher than T_2 and T_3 birds but had similar feed intake in other days.

The response observed in present study partially agree with those reported by Zhan *et al*. (2007) and Camacho *et al*. (2004). Conversely, Hassanabadi and Moghaddam (2006) and Sahraei and Shariatmadari (2007) that the feed restriction increase feed intake. The higher feed intake can be related to the hypertrophy of the gastrointestinal tract that occurs after the restriction period, when the birds are fed *ad libitum*. Feed Conversion (FC) reflected weight gain and feed intake results, suggesting that feed conversion was impaired during the restriction period ($p<0.05$). However, this effect was not observed on the 22-42 and 0-42 days of age. The expected improvement in feed conversion subsequent re-feeding is likely due to a drop in maintenance requirements or basic metabolism because of a smaller body size (Rincon and Leeson, 2002). The effect of protein levels on the performance of broiler chickens is given in Table 3.

Comparing body weight gain and feed intake at 0-21 days, birds fed the low protein diet were significantly lower than other group but in 22-42 days, were significantly higher than other group. The feed conversion had no significant difference in 0-21, 22-42 and 0-42 days. This observation was in agreement with Kerr and Kidd (1999) and disagree with Cheng *et al*. (1997), Hussein *et al*. (2001) and Kamran *et al*. (2008).

Cheng *et al*. (1997) suggest at temperatures below 25.3°C, weight gain was responsive to increasing dietary CP until it reached a plateau at 22.4% CP. Feed conversion improved with increasing dietary CP at low temperatures. Hussein *et al*. (2001) observed body weight of chicks fed the low CP diet were significantly lower than the respective values for chicks fed the positive control high CP diet. Using a low CP diet depressed BW gain and GFR by 8-11%, compared with results from the high CP diet, whereas feed intake was unaffected. Kerr and Kidd (1999) suggest Reduction of CP by two percentage units had no impact on daily BW gain or feed conversion compared to birds fed the positive control diet. since this level of CP reduction results in amino acid levels being relatively close to current recommendations

In 22-42 days, the T_1P_2 treatment had higher bodyweight gain ($p<0.05$). Numerically, In feed restriction group, birds that consume low protein diet had higher body weight gain. A significant interaction was not observed between protein level and feed restriction for feed conversion (Table 4).

Carcass composition: The effect of experimental treatments on the composition of the bird carcasses (grams) and the carcass efficiency (%) are given in Table 5 and 6. Carcass yield and breast muscle were significantly lower in restricted broilers at 42 days of age ($p<0.05$). Howevere, no statistical difference in abdominal fat was noted at 42 days of age.

The protein level had no significant effect on carcass yield, breast muscle and abdominal fat. Kerr and Kidd (1999) suggest that percentage abdominal fat was unaffected when dietary CP levels were reduced by two percentage units, regardless of amino acid supplementation. This might be expected because dietary amino acid levels were near recommended levels.

Table 2: The effects of feed restriction on performance of broiler chickens (Mean±SE)

	Body weight gain (g)			Feed consumption (g)			Feed conversion ratio (g g^{-1})		
Treatments	0-21	22-42	0-42	0-21	22-42	0-42	0-21	22-42	0-42
T_1	467.87±1.52^{a}	1405.48±39.31^{a}	1873.35±40.06^{a}	826.15±4.56^{a}	2545.37±43.18^{a}	3371.52±41.57^{a}	1.76±0.01^{ab}	1.81±0.02^{a}	1.80±0.01^{a}
T_2	292.43±9.81^{b}	1222.97±26.66^{b}	1515.40±27.28^{b}	477.32±5.74^{c}	2249.65±75.26^{b}	2726.98±78.31^{b}	1.63±0.04^{c}	1.83±0.03^{a}	1.79±0.02^{a}
T_3	283.21±6.61^{b}	1222.67±25.98^{b}	1505.88±28.14^{b}	481.40±6.00^{c}	2302.51±62.54^{b}	2783.92±57.39^{b}	1.70±0.03^{bc}	1.88±0.02^{a}	1.84±0.02^{a}
T_4	285.93±10.56^{b}	1252.79±26.38^{b}	1538.72±32.36^{b}	519.55±6.05^{b}	2332.72±48.45^{b}	2852.27±51.50^{b}	1.82±0.04^{a}	1.86±0.01^{a}	1.85±0.01^{a}

Table 3: The effects of protein levels on performance of broiler chickens (Mean±SE)

	Body weight gain (g)			Feed consumption (g)			Feed conversion ratio (g g^{-1})		
Treatments	0-21	22-42	0-42	0-21	22-42	0-42	0-21	22-42	0-42
P_1	347.60±22.94^{a}	1242.37±22.79^{b}	1589.97±43.14^{b}	598.67±44.47^{a}	2308.43±45.29^{b}	2907.10±82.00^{a}	1.71±0.03^{a}	1.85±0.01^{a}	1.82±0.01^{a}
P_2	327.14±25.77^{b}	1323.18±34.75^{a}	1650.32±59.32^{a}	572.50±44.20^{b}	2426.44±52.67^{a}	2998.94±91.21^{a}	1.75±0.03^{a}	1.83±0.01^{a}	1.82±0.01^{a}

Table 4: The interaction effects of feed restriction and protein levels on performance of broiler chickens (Mean±SE)

	Body weight gain (g)			Feed consumption (g)			Feed conversion ratio (g g^{-1})		
Treatments	0-21	22-42	0-42	0-21	22-42	0-42	0-21	22-42	0-42
T_1P_1	465.32±1.32^{a}	1335.81±24.70^{b}	1801.14±24.70^{b}	827.62±8.30^{a}	2468.45±21.30^{ab}	3296.07±16.31^{a}	1.77±0.01^{a}	1.84±0.02^{ab}	1.83±0.02^{a}
T_1P_2	471.27±1.65^{a}	1498.38±45.24^{a}	1969.65±43.59^{a}	824.18±2.18^{a}	2647.93±54.25^{a}	3472.11±52.07^{a}	1.74±0.00^{ab}	1.76±0.01^{b}	1.76±0.01^{a}
T_2P_1	306.88±12.34^{b}	1204.27±32.27^{c}	1511.15±20.03^{c}	484.00±8.18^{c}	2177.72±90.58^{c}	2661.73±98.12^{b}	1.58±0.07^{b}	1.80±0.05^{ab}	1.76±0.05^{a}
T_2P_2	277.99±10.96^{b}	1241.67±46.50^{bc}	1519.66±57.47^{c}	470.64±7.29^{c}	2321.59±122.23^{bc}	2792.23±129.52^{b}	1.69±0.04^{ab}	1.86±0.02^{ab}	1.83±0.01^{a}
T_3P_1	287.82±7.36^{b}	1189.73±46.89^{c}	1477.55±51.88^{c}	481.11±10.36^{c}	2264.78±129.55^{bc}	2745.89±119.27^{b}	1.67±0.06^{ab}	1.90±0.04^{a}	1.85±0.02^{a}
T_3P_2	278.60±11.97^{b}	1255.61±9.58^{bc}	1534.22±21.56^{c}	481.70±8.54^{c}	2340.24±36.77^{bc}	2821.95±28.22^{b}	1.73±0.04^{ab}	1.86±0.04^{ab}	1.84±0.04^{a}
T_4P_1	291.14±5.72^{b}	1208.52±23.39^{c}	1499.66±29.11^{c}	525.63±3.07^{b}	2269.44±11.25^{bc}	2795.07±14.32^{b}	1.80±0.02^{a}	1.87±0.02^{ab}	1.86±0.02^{a}
T_4P_2	280.71±22.31^{b}	1297.06±31.20^{bc}	1577.77±53.52^{c}	513.48±11.70^{b}	2396.00±87.23^{bc}	2909.48±98.93^{b}	1.84±0.1^{a}	1.84±0.02^{ab}	1.84±0.00^{a}

Table 5: The effect of feed restriction and protein levels on carcass composition of broiler chickens

	Treatments					
	Protein levels		Feed restriction			
Variables (g)	P_1	P_2	T_1	T_2	T_3	T_4
Carcass	1522.17±45.43^{a}	1585.42±61.51^{a}	1842.50±43.68^{a}	1442.50±61.13^{b}	1382.50±44.66^{b}	1387.50±44.86^{b}
Breast	385.50±14.69^{a}	401.66±19.97^{a}	482.22±16.48^{a}	362.5±21.11^{b}	339.58±10.66^{b}	341.66±16.12^{b}
Abdominal fat	35.33±2.18^{a}	30.24±2.30^{a}	36.40±2.75^{a}	36.27±3.82^{a}	28±2.63^{a}	29.93±3.37^{a}

Table 6: The interaction effect of feed restriction and protein levels on carcass composition of broiler chickens

	Treatments							
Variables (g)	T_1P_1	T_1P_2	T_2P_1	T_2P_2	T_3P_1	T_3P_2	T_4P_1	T_4P_2
Carcass	1757.50±48.02^{b}	2012.50±25.42^{a}	1401.67±64.26^{c}	1483.33±107.94^{c}	1375.00±85.23^{c}	1390.00±38.62^{c}	1319.17±26.53^{c}	1455.83±79.27^{c}
Breast	453.33±19.39^{b}	540.00±10.64^{a}	345±31.38^{c}	380.00±29.21^{c}	351.66±17.40^{c}	327.50±11.81^{c}	324.16±12.93^{c}	359.16±29.23^{c}
Abdominal fat	38.95±3.10^{ab}	31.30±5.23^{ab}	40.54±5.49^{a}	32.00±5.20^{ab}	31.54±4.78^{ab}	24.45±1.66^{b}	26.66±3.85^{ab}	33.21±5.56^{ab}

Means in each row with different superscripts are significantly different ($p<0.05$)

CONCLUSION

A period of short-term feed restriction and subsequent refeeding in broiler chicken is sometimes but not always, marked by catch up growth. Evidence suggests that substantial catch-up growth is accompanied by a corresponding increase in feed intake. Muscle mass expressed as a percentage of body weight at market age is usually not affected by restricted feeding and refeeding.

The results of the present study suggest that supplementation of amino acids can partially correct the depression in growth performance observed with low CP diets.

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