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Production performance of broiler chickens influenced by feed restriction systems

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The rapid growth rate of the modern broiler chicken is associated with a number of management and welfare problems. These include impaired reproductive performance (Robinson *et al*. 1993), muscular, skeletal and metabolic disorders, excessive body fat and high mortality (Zubair and Leeson 1996). However, superior management practices are an important trigger of some metabolic disorder. Fast growing birds were found to be more susceptible to the metabolic disorder, ascities than slower growing birds and there is evidence that the leg abnormalities are more prevalent in high performance flock. Several management practices are developed to reduce losses from skeletal problems without any reduction in broiler performance. One of these practices is early feed restriction or feed removal with compensatory growth, generally successful in reducing these adverse effects (Hocking *et al*. 1996). Earlier studies showed that broiler chickens subjected early feed restriction utilized their feed more efficiently and accumulated less abdominal fat compared to broilers fed *ad lib*.

Various methods of feed restriction such as intermittent feeding, skip-a-day feeding, appetite suppression with glycolic acid (Pinchasov and Jensen 1989), time of restriction (Samara *et al*. 1996) and quantitative feed restriction (Lee and Leeson 2001) are used in broilers to improve their efficiency of feed utilization and weight gain. The feed restriction for suitable periods may prove an effective method to achieve the benefits of compensatory growth through a change over to normal feeding. In many physical feed restriction or diet dilution studies, there are reports of body fat deposition, although this effect seems variable (Zhong *et al.* 1995). However, the optimum period of feed restriction has received little attention. The present project therefore, was planned to investigate the effect of different durations of feed restriction on growth performance and dressing percentage of broilers.

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This research was conducted at the experimental farm of the Department of Livestock Production and Management of West Bengal University of Animal and Fishery Sciences, Kolkata. Day old Hubbard broiler chicks (152) were purchased from a local hatchery. Glucose and electrolyte solutions were offered to the birds upon arrival, which was followed by weighing and random distribution of the chicks into 4 treatment groups, each consisting of 2 replicates with 19 birds per replicate. The chicks in a replicate were placed in litter in individual pens (0.5m × 0.5 m). The litter was composed of fresh wood shavings. The pens were separated with plastic wire netting and contained plastic feeder and water troughs. The temperature inside the poultry house was maintained at 35°C during the first 2 weeks, between 28° and 30°C during the subsequent couple of weeks and about 25°C in the last week of the study. Continuous light was provided during the first 2 weeks of brooding. Exhaust fans were fitted in the broiler house to ensure adequate ventilation. The birds were vaccinated against Newcastle and Infectious Bursal diseases on d 7, 14 and 21 and provided antibiotic for the first 5 days.

The experimental birds were divided randomly into four groups. After 2 weeks, one group was kept as control and given feed *ad lib* for 24 h while the other groups were restricted to feed for 4 h (from 10 AM - 2 PM), 6h (from 10 AM - 4 PM), 8 h (from 10 AM - 6 PM). Lighting was also provided up to 24 h. Fresh and potable water was given *ad lib.* throughout the experimental period. But feed was given *ad lib.* up to 14 days of age and thereafter 4h (T_1), 6 h (T_2), 8 h (T_3) restriction followed up to 42 days except control group. The experimental period was divided into 2 phases, starter (1 to 28 d) and the finisher (29 to 42 d). The experimental diets were formulated to meet the Bureau of Indian Standard (1992) nutritional requirement of broiler chicken. Ingredients and chemical composition of basal diet were presented in Table 1. Total amount of feed offered during 24 h to a replicate under a specific treatment group was divided into 2 equal proportions. The amount and timing of

Table 1. Ingredients and chemical composition of the basal diet

Ingredients	Starter[a]	Finisher[b]
Ingredients, air dry basis (g/kg)		
Maize	550	600
Till cake (red)	40	30
Rice polish	30	30
Soybean meal	300	250
Fish meal	25	25
Oil	25	35
Calcite	9.5	12
Di-calcium phosphate	13	12
Sodium chloride	3	2.5
DL-methionine	1.8	1.5
L-Lysine	1.5	0.7
Vitamin premix[c]	0.2	0.3
Trace mineral mixture[d]	1	1
Chemical composition (calculated, DM basis)		
ME (MJ/kg)†	12.45	12.86
CP (g/kg)	202.2	189.7
Calcium (g/kg)	8.7	9.1
Available phosphorus (g/kg)†	4.5	4.0
Methionine (g/kg)†	5.4	4.8
Lysine (g/kg)†	12	10.3

†=calculated on the basis of standard values applicable under Indian condition (Singh and Panda, 1996).[a]Fed from a day old to 28 days age.[b]Fed from 29 days to 42 days age.[c]Each g contains: Vitamin A-82,500 IU; Vitamin B_2–50 mg; Vitamin D_3 -12,000 IU; Vitamin K-10 mg; Vitamin B_1-4 mg; Vitamin B_6 -8 mg; Vitamin B_{12}-40 mg; Vitamin E -40 mg; Calcium D Pantothenate-40 mg; Niacin-60 mg. [d]Provided per kg of diet: Zn, 60 mg; Mn, 90 mg; Fe, 110 mg; KI, 2.5 mg

Table 2. Performance of broiler chicken on restricted time feeding programme

Weeks	Dietary treatments				Pooled SE	P-value
	C_o	T_1	T_2	T_3		
Body weight, g						
Initial	42.50	42.13	42.13	41.75	0.533	NS
0–2 wks	382.56	380.85	384.19	379.13	3.047	NS
3 wks	678.00[a]	667.75[a]	647.25[b]	645.75[b]	5.639	0.004
4 wks	1059.86[a]	1001.50[b]	1004.00[b]	990.31[b]	6.634	0.000
5wks	1565.74[a]	1511.27[c]	1540.50[b]	1539.58[b]	2.501	0.000
6 wks	2058.50[a]	1925.00[c]	1997.25[b]	1973.72[bc]	17.194	0.001
Body weight gain, g						
0–2 wks	340.31	338.73	342.06	337.38	3.151	NS
3 wks	635.75[a]	625.63[a]	605.13[b]	604.00[b]	5.686	0.004
4 wks	1017.60[a]	959.38[b]	961.88[b]	948.56[b]	6.984	0.000
5wks	1523.49[a]	1469.14[c]	1498.38[b]	1497.83[b]	2.501	0.000
6 wks	2016.25[a]	1882.88[c]	1955.13[b]	1931.97[bc]	17.178	0.001
Feed consumption, g						
0–2 wks	469.13	462.96	462.96	463.45	2.217	NS
3 wks	953.18[a]	872.39[b]	819.22[c]	814.40[c]	2.348	0.000
4 wks	1665.42[a]	1548.84[b]	1.513[c]	1480.37[d]	4.290	0.000
5wks	2781.73[a]	2610.40[b]	2594.59[b]	2570.32[c]	5.346	0.000
6 wks	3829.29[a]	3521.35[c]	3594.28[b]	3470.99[d]	5.839	0.000
Feed conversion ratio (feed intake: body weight gain)						
0–2 wks	1.38	1.37	1.37	1.37	0.016	NS
3 wks	1.50[a]	1.39[b]	1.35[b]	1.35[b]	0.026	0.005
4 wks	1.64[a]	1.62[a]	1.57[b]	1.56[b]	0.012	0.002
5wks	1.83[a]	1.78[b]	1.73[c]	1.72[c]	0.006	0.000
6 wks	1.90[a]	1.87[a]	1.84[bc]	1.79[c]	0.015	0.002

Values bearing at least one common superscript within the same row do not defer significantly (P>0.05); NS, non-significant.

feed was adjusted in such a way that the birds consume the whole of the diet offered at any one time. As a result hardly any residue can be obtained from the replicate after a day feeding. Feed intake was recorded by replicate daily. The total body weight of a replicate was measured at weekly intervals and the mean body weight and the gain in body weight of a single bird in a replicate were calculated. Feed conversion ratio (FCR) was adjusted according to the feed consumption of the dead broilers.

On day 42, four birds from each treatment groups were weighed, fasted for 12 h (indeed drinking water was supplied *ad lib.*) and were sacrificed as per standard procedure of evaluation of carcass characteristics including the yield of breast and thigh. After removal of viscera, the abdominal fat (from proventriculus surrounding the gizzard down to the cloaca) was removed and weighed (Cahaner *et al*. 1986) which is indicative of abdominal fat content.

The data were statistically analyzed by SPSS version-10.0. The results were expressed as mean and pooled standard error of mean. Restricted time feeding were considered as fixed factor and body weight, body weight gain, FCR, carcass characteristics and economic performance were as dependent variable. The means were compared using Duncan·s multiple range tests.

The mean values for initial body weight, feed consumption, final body weight, weight gain and feed conversion ratio for broilers of four groups are shown in Table 2. Statistical analysis of the data revealed that there was no significant (P>0.05) difference in average body weight and body weight gain among all the groups up to 2nd week. At 3rd weeks of age, it was observed that birds of T_2 and T_3 gained significantly (P<0.01) lower weight than T_1 and control group. At 4th weeks of age, lower (P<0.01) body weight gain was observed in birds of time restricted group than *ad lib.* fed group. At 5th weeks, birds of group kept off fed for 4 hr showed lowest (P<0.01) body weight gain than those of other groups, whereas, the highest gain was observed in control group. Statistical analysis showed that control group had highest (P<0.01) body weight followed by T_2 and T_3 and T_1 groups. Birds of T_3 group gained more (P<0.05) body weight than T_1, however, between T_3 and T_1, there was no significant (P>0.05) difference.

Restricted time feeding was started after 2 weeks. So, no significant (P>0.05) difference in feed consumption (g) was

Table 3. Effect of restricted time feeding programme on the carcass traits of broiler chicken

Measurements	Dietary treatments				Pooled SE	P-value
	C_o	T_1	T_2	T_3		
Live weight (g)	2058.50[a]	1925.00[c]	1997.25[b]	1973.72[b]	12.94	0.000
Eviscerated weight (g)	1374.29[a]	1303.65[b]	1318.98[b]	1310.43[b]	7.606	0.000
Dressing percentage	66.8[b]	67.72[a]	66.04[b]	66.39[b]	0.253	0.003
Giblet %	5.68	5.79	5.81	5.9	0.079	NS
Neck %	4.53[b]	4.68[ab]	4.9[a]	4.7[ab]	0.076	0.003
Wing %	8.48	8.65	8.98	8.85	0.188	NS
Back %	22.01[b]	21.61[c]	21.49[c]	22.44[a]	0.072	0.010
Breast %	28.34[a]	27.56[b]	26.2[c]	25.22[d]	0.174	0.000
Thigh %	16.12[b]	16.17[b]	16.11[b]	16.48[a]	0.074	0.002
Drumstick %	13.53[b]	13.94[a]	13.89[a]	13.98[a]	0.115	0.006
Abdominal Fat%	5.97[a]	4.9[b]	3.98[c]	3.33[d]	0.099	0.001

Value bearing at least one common superscript within the same row do not defer significantly (P>0.05). NS,nonsignificant.

found among the different groups up to 2 weeks. After third week, birds of T_2 and T_3 consumed significantly (P<0.01) less feed than T_1 and control group. After fourth week, cumulative feed intake was highest (P<0.05) in control group (1665) followed by T_1 (1548), T_2 (1513), and T_3 (1480) groups. After fifth week 8 hr restricted birds consumed significantly (P<0.05) lowest feed, whereas, in control it was highest. However, there was no difference in feed consumption among other two feed restricted groups (T_1 and T_2). Control group birds consumed highest (P<0.05) feed compared to other treatment groups. The lowest feed consumption was observed in T_3 group which may be due to longer period of feed restriction than those of other feed restricted groups.

In this study, feeding regimes had a significant effect on average body weight of broilers. It was expected based on previously reported studies (Petek 2000, Abu-Dieyah 2006, and Mahmood *et al*. 2007) that lower body weight in the feed restricted birds may be the decrease in feed intake compared to the *ad lib.* fed birds. The result of the present study are not in accordance with findings of Saleh and Watkins (2005) who reported no effects of feed restriction on body weight whereas, Lee and Leeson (2001), Mahmood *et al*. (2005) and Sandilandsa *et al*. (2006) observed more body weight gain in feed restricted birds than those fed *ad lib*. Probable explanation of these differences may be the difference in feed restriction schedules used in these studies.

Birds subjected to longer period of feed restriction consumed less feed than those in which feed was restricted for shorter period and these findings were in agreement with Dejong *et al*. (2002) and Mahmood *et al*. (2007). However, Ohtani and Leeson (2000) reported that feed intake was higher in feed restricted birds than *ad lib.* fed birds. The difference in the results of these studies may be due to the difference in the durations of feed restriction.

FCR was calculated on the basis of amount of feed consumed to produce unit live weight gain in birds used for the study. Up to 2 weeks, the difference in FCR of control birds and those kept off fed was found to be non-significant. This was because of the restriction started after 2nd weeks onwards. After 3rd weeks, FCR of feed restricted groups was significantly (P<0.01) lower than control group. After fourth week, 6 and 8 h restricted groups exhibited lower FCR than control and 4 h restricted groups. After fifth weeks, among the treatment groups, T_2 and T_3 showed lower (P<0.01) FCR than T_1. At the end of experimental period, birds of T_3 group exhibited best (1.79) FCR followed by T_1 (1.87) and control (1.90) groups. Significantly (P<0.05) poor feed utilization was observed in *ad lib.* fed birds than the feed restricted groups.

Birds kept on restricted feeding showed better feed conversion values in compared to *ad lib.* fed birds. The effect of feed restriction increasing feed conversion coincides with the finding of Rincon and Leeson (2002) and Abu-Diayeh (2006). However, Scheideler and Baughman (1993) and Zhong *et al*. (1995) reported that feed efficiency was not affected in broilers maintained under restricted feeding versus *ad lib.* feeding at 42 days of age. Probable explanation for the efficient utilization of the birds kept on restricted feeding may be the reduced heat stress during hot hours of the day which lead to reduced the metabolic heat production (Zhou and Yamamoto 1997) resulting into reduced stress upon the birds. Moreover, feed restriction has been found to reduce the body temperature of broilers during summer days (Anjum 2000).

Carcass weight at the time of slaughter 42 days was highest (P<0.01) in control group in relative to restricted time feeding groups (Table 3). Statistical analysis of data revealed that significantly highest (P<0.05) dressing percentage found in 4 h restriction (T_1) group than control and other two restricted groups (T_2 and T_3). Proportion of giblets and wing were similar (P>0.05) among the treatment groups. The proportion of neck was highest (P<0.01) in 6 h restricted groups than control, T_1 and T_3 groups, whereas, proportion of back was highest (P<0.01) in T_3 groups and lowest in T_2. Proportion of breast and abdominal fat content decreased significantly (P<0.01) in time restricted groups and was lowest in T_3. The proportion of thigh and drumsticks was highest in T3 groups in relative to other groups of broiler birds.

Present findings of lower final body weight and carcass weight in feed restricted birds are comparable with the report of Dozier *et al*. (2003), Mohmoud *et al*. (2005) and Saleh and Watkins (2005). In contrast to our results, Payawal (1996) and Saleh *et al*. (1996) found that the feed removal during

the day had no effect on dressing percentage. The full fed control group had a greater percentage of abdominal fat due to having a greater body weight than the restricted group. These findings were coincided with the findings of Salim-Salem-Al-Taleb (2003). In contrast, Saleh and Watkins (2005) reported that abdominal fat, expressed either, as a percentage of carcass or absolute weight, was not significantly affected by early feed restriction.

Therefore, the results of this study suggest that the feed restriction time between 6 and 8 h can be applied in broiler management system as these restrictions though produced lower body weight and body weight gain but produced best FCR and yield more thigh %, drumstick %.

SUMMARY

An experiment was conducted to evaluate the effect of feed restriction on growth performances of broiler chicken. One hundred fifty two, day old-commercial Hubbard broilers chicks were randomly distributed into 4 treatments. Each treatment included two replicates with 19 birds per replicate. For the first two weeks of life, feed and water were provided *ad libitum*. At the age of 3 weeks, one group was kept as control (C_o) with no feed restriction while the other groups were restricted to access of feed for 4 h (T_1, from 10 AM - 2 PM), 6 h (T_2, from 10 AM–4 PM) and 8 h (T_3 from 10 AM - 6 PM) until the age of 42 days. By restricted time feeding, body weight was significantly decreased but feed conversion ratio was significantly improved in 8 h and 6 h restricted group than control and 4 h restricted group. Restricted time feeding decreased dressed carcass weight but percentage of back, thigh and drumstick yield was significantly improved. Whereas, breast yield and abdominal fat % were decreased relative to control group. It can be concluded that restricted time feeding between 6 to 8 h may be applied in broiler managemental system without a very significant reduction in performance.

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