Asian Journal of

Poultry Science

ISSN 1819-3609

Academic
Journals Inc.

www.academicjournals.com

Asian Journal of Poultry Science 5 (1): 21-27, 2011
ISSN 1819-3609 / DOI: 10.3923/ajpsaj.2011.21.27

Productive Performance of Broiler Chickens as Affected by Feed Restriction Systems

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ABSTRACT

The study was conducted to evaluate the effect of feed restriction on body weight, body weight gain, feed intake and feed conversion ratio and carcass traits of broilers. Two hundred forty, one day old, Hubbard broiler chicks were randomly distributed into five treatments. Each treatment included six replicates each with 8 birds. The five treatments were as follows: T_1: Birds were fed *ad libitum*, T_2 (feed removed from 11 p.m. to 7 a.m. during a day), T_3 (feed removed from 8.00 a.m. to 12.00 p.m. and from 7.00 to 11.00 p.m. during a day), T_4 (removed feed from 12.00 to 6.00 p.m. during a day), T_5 birds were fed from 8.00 to 11.00 a.m. and from 8.00 to 11.00 p.m. during a day) except these hours feed was ad libitum during a day. The results indicated that feed restriction systems did significantly affect live body weight, body weight gain and feed conversion at starter period. Feed restriction significantly reduced feed consumption and at the same time improving economic efficiency.

Key words: Broiler chickens, feed restriction systems, feed conversion ratio, body weight gain, feed intake

INTRODUCTION

Quantative and qualitative feed restriction are procedures that can be applied to manipulate the feeding strategies of poultry in order to decrease growth and metabolic rate to some extent and so alleviate the incidence of some metabolic diseases as will as improving feed conversion and reducing feed cost. Birds selected for carly-life fast growth (commercial broilers) suffer from leg disorders, organ failure and heart disease. At six weeks of age, broiler chickens have much difficulty supporting their abnormality heavy bodies as that they spend 76 to 86% of their time laying down (Weeks *et al.*, 2000). They may suffer from respiratory diseases, big liver and spleen disease, sudden death syndrome and ascites (Lippens *et al.*, 2000; Demir *et al.*, 2004).

Young chicks exposed to a minor change in the physical structure of their feed transiently disrupted the organisation of feed pecking. Martaresche *et al.* (2000) and Merlet *et al.* (2005) showed the number of transitions between various activities was increased in restricted compared with growing broiler breeders fed *ad libitum*.

Recently, an experimental dwarf heavy broiler breeder type selected for better viability and reproductive traits at the partial expense of growth is capable of being fed *ad libitum* with relatively little effect on reproductive performance (Heck *et al.*, 2004). The time-budget of these birds showed a consistent trend to rest longer than a standard heavy broiler breeder fed *ad libitum* or restricted (Puterflam *et al*., 2006). Most studies have been conducted on feed restriction a long with genotype, behavioral change, environmental conditions or insulin receptors of broiler breeders (Merlet *et al*., 2005; Puterflam *et al*., 2006; Hocking *et al*., 2007; Bruno *et al*., 2007) but insufficient information has been conducted on feed intake, growth performance and economic efficiency of broiler chicks. Moreover, in animal production most studies in catch-up growth have been concerned with lying hens (Tesfaye *et al*., 2009). Information on catch-up growth in broiler chickens is very limited. It is necessary to examine the phenomenon of catch-up growth and some of the factors that influence the response of broiler chickens to a short term feed restriction and refeeding. So this study was conducted to evaluate the effect of different feed restriction systems on productive performance of broiler chickens.

MATERIALS AND METHODS

This study was carried out at the poultry farm, Department of animal production, Faculty of agriculture, South Valley University 2009. Two hundred and forty, one day old, Hubbard broiler chicks were used in this experiment. All birds were weighed and randomly distributed into five experimental treatments. Each treatment included six replicates each with eight birds. The five treatments were as follows:

- $\mathbf{T_1}$: control: Birds were fed *ad libitum* during the experimental period
- $\mathbf{T_2}$: Birds were fed *ad libitum* during the day except from 11.00 p.m. to 7.00 am which the feed was removed (8 h fasting per day during the experimental period)
- $\mathbf{T_3}$: Birds were fed *ad libitum* during the day except from 8.00 a.m. to 12.00 p.m. and from 7.00 to 11.00 pm (8 h separately fasting per day during the experimental period).
- $\mathbf{T_4}$: Birds were fed *ad libitum* during the day except from 12.00 to 6.00 p.m. in which the feed was removed (6 h fasting per day during the experimental period)
- $\mathbf{T_5}$: Birds were fed *ad libitum* during the day except from 8.00 to 11.00 a.m and from 8.00 to 11.00 p.m. (6 h separately fasting per day during the experimental period)

The experimental period was divided into two feeding phases, starter period (from 0-3 weeks of age) and grower period (from 4-7 weeks of age). The experimental diets had 24.19 and 21.65% crude protein, 12.6 and 13.17 MJ kg^{-1} diet for the starter and the grower diet, respectively (Table 1). Chicks were reared in two-tier wire floor battery in a windowless house. The chicks of each replicate were allocated in a cage with slatted floor of iron. The diameters of the cage were 97×50×45 cm for length, width and height, respectively.

Chicks had full access to water during the experimental period. The environmental temperature was kept about 32°C during the first week and then gradually reduced by 2°C weekly to reach about 24°C during fourth week and at termination of the experiment (6 weeks of age). The chicks were maintained on a 23 h constant light schedule and 1h darkness and had free access to feed and water during entire experimental period.

Traits under study during the experimental period (7 weeks) were live body weight, daily body weight gain, feed consumption and feed conversion ratio. At 49 days of age (end of experimental period), five birds from each treatment were taken; as representative sample around the average weight of treatment. Birds were weighed individually and then slaughtered for carcass evaluation. Carcass characteristics (abdominal fat, head, liver, empty gizzard, giblets, feather, legs and dressing percentage) were measured. All traits were expressed as percentage of live weight.

Table 1: Composition and calculated analysis of the experimental diets

Items	Starter diets (0-3 weeks)	Grower diets (4-6 weeks)
Ingredients (g kg^{-1})		
Yellow corn, ground	531.7	565.2
Soybean meal (44% CP)	320	300
Corn gluten meal (60% CP)	90	60
Vit and Min. Premix*	3	3
Sunflower oil	20	40
Dicalcium phosphate	20	18
Limestone	10	10
Salt	3.8	3.8
DL-methionine	0.5	---
L- lysine	1	---
Total	1000	1000
Calculated analysis		
ME (MJ Kg^{-1})	12.6	13.17
Crude protein (%)	24.19	21.65
Crude fiber (%)	3.16	3.05
Crude fat (%)	4.62	6.65
Ca (%)	0.93	0.88
P (Available %)	0.52	0.48
Lysine (%)	1.27	1.04
Methionine (%)	0.62	0.41
Price of ton diet (LE) 2009	2600	2400

USD = 5.5 LE. *Each diet was supplied with 2.5 kg^{-1} ton Vit. and Min. Mix (commercial source B. p. Max) Each 2.5 kg contains, Vit. A: 10,000,000 MIU, Vit: D 2,000,000 MIU, Vit: E 10000 mg, Vit: K3 1000 mg, Vit: B1 1000 mg, Vit: B2 5000 mg, Vit: B6 1500 mg, Biotin 50 mg, BHT: 10000 mg, Pantothenic: 10000 mg, folic acid: 1000 m, Nicotinic acid: 30000 m, Mn: 60 g, Zinc: 50 g, Fe: 30 g, Cu: 4 g, I 3 g, Selenium: 0.1 g, Co: 0.1 g

Economic parameters of production including feeding cost (starter and grower) income and returns per birds were calculated. The other productive costs were disregarded since they were constant. Economic Efficiency (EE) is defined as the net revenue (total revenue per chick (L.E)-total feed cost (starter and grower) per chick (L.E)). Relative economical efficiency (REE) = assuming control treatment 100%.

The statistical analysis was performed on data by operating Randomized Complete Block Design (RCBD) using General Linear Models (GLM) procedure of the SAS Institute (SAS, 1996). All statements of significance are based on the 0.05 level of probability. Significant differences among treatments were performed using Duncans multiple range test (Duncan, 1955).

RESULTS AND DISCUSSION

Table 2 shows that feed restriction decreased significantly ($p<0.05$) body weight of all treatments at 2 and 3 weeks of age as compared to the control treatment. Moreover, the highest decrease in body weight was in the treatment that fasted continuously (T_2) as compared by separated fasting treatments (T_3 and T_5) and the other continuously fasted treatment (T_4). Moreover, at fourth week of age all treated treatments were significantly ($p<0.05$) lower in body weight compared to the control treatment except for separated fasting treatment (T_3). Weeks 5, 6 and 7 the differences between control and treated treatments were not significant. From the performance of the growing period of broilers it could be adduced that feed intake of broilers in the

Table 2: Effect of feed restriction on body weight (g) of broiler chicks

Age (weeks)	T_1	T_2	T_3	T_4	T_5	p-value
0	52.00±0.77	53.17±0.91	52.67±0.61	51.67±0.67	53.5±0.67	p>0.051
1	137.9±0.91	133.8±1.58	134.6±1.52	136.50±1.75	134.8±1.78	p>0.053
2	352.25±0.8^{a}	322.7±4.16^{c}	335.4±4.28^{b}	328.42±4.41^{bc}	332.5±4.02^{bc}	p>0.001
3	654.17±6.9^{a}	585.4±6.78^{c}	615.6±11.50^{b}	630.21±10.99^{ab}	617.7±6.93^{b}	p>0.001
4	1062.88±1.25^{a}	982.2±12.2^{b}	1040.5±11.43^{a}	991.67±7.51^{b}	1004.5±12.0^{b}	p>0.001
5	1612.50±16.69	1539.5±29.2	1586.5±23.18	1539.67±14.96	1555.5±17.22	p>0.053
6	2137.79±30.74	2079±44.74	2133.0±37.19	2112.50±29.49	2144.±45.16	p>0.061
7	2425.55±28.63	2385±34.33	2419.4±35.11	2400.00±32.86	2434.7±49.18	p>0.064

Values are mentioned as Means±SE, letter(s) in the same row with different superscripts are significantly different at $p \leq 0.05$

Table 3: Effect of feed restriction on body weight gain (g/bird/day) of broiler chicks

Age (weeks)	T_1	T_2	T_3	T_4	T_5	p-value
1	12.27±0.18	11.52±0.32	11.71±0.19	12.12±0.27	11.62±0.30	p>0.051
2	30.62±0.20^{a}	26.98±0.38^{c}	28.69±0.46^{b}	27.42±0.63^{bc}	28.24±0.67^{bc}	p>0.012
3	43.13±0.95^{a}	37.53±0.62^{c}	40.03±1.16^{bc}	43.11±1.16^{a}	40.74±0.76^{ab}	p>0.042
4	58.39±0.72^{ab}	56.68±1.12^{b}	60.70±1.08^{a}	51.64±1.35^{c}	55.21±1.43^{b}	p>0.014
5	78.52±1.60	79.62±2.71	77.99±2.89	78.29±1.52	78.71±1.07	p>0.061
6	75.04±2.61	77.07±3.83	78.08±2.48	81.83±2.64	84.12±7.64	p>0.064
7	41.11±6.21	43.75±1.27	40.92±3.94	41.07±1.04	41.53±2.49	p>0.071

Values are mentioned as Means±SE, letter(s) in the same row with different superscripts are significantly different at $p \leq 0.05$

final stages of production (5 to 8 weeks) allows little or no time for catch-up growth to occur (Plavnik and Hurwitz, 1988).

These results are in agreement with those of Sandilandsa *et al.* (2006) the mean body weight of the control treatment in starter period was higher than that of the restricted feeding treatments. Scheideler and Baughman (1993) and Deaton (1995) stated that restricting feed supply was found to have no significant effect on broiler performance during growing period. On the contrary, Sandilandsa *et al.* (2006) found that the weight of birds in all restricted treatments increased faster than that of control birds in the grower period. Benyi and Habi (1998) reported that chicks fed *ad libitum* grew faster and were found to be heavier than those on restricted feeding regimes.

Table 3 revealed that, at second week of age feed restriction led to significant decrease ($p<0.05$) in body weight gain in all treatment treatments (T_2, T_3, T_4 and T_5) as compared by control (T_1). The highest decrease in body weight gain was in the treatment that fasted 8 h continuously (T_2). At the third week of age, the body weight gain decreased significantly ($p<0.05$) in the treated treatments, which fasted continuously or separately 8 h as compared to control treatmentand the remaining treated treatments. At the fourth week of age feed restriction significantly affected ($p<0.05$) body weight gain and the lowest value was in the treatment fasted continuously for 6 h as compared to all remaining treatment treatments and control treatment. The differences in body weight gain were not significant in all remaining ages (5, 6 and 7 weeks). Many studies agree with our results reported that there were occurrences of compensatory growth in broiler chickens as a result of feed restriction (Plavnik and Hurwitz, 1988, 1991; Jones and Farrel, 1992; Zubair and Leeson, 1996; Mazzuco *et al.*, 2000). The lack of significant effect of feed restriction systems the live body weight gain especially at the last weeks of age in the present study may be due to gradual physiological adaptation of the birds to the different feeding regimes and probably improving the efficiency of conversion of the feed available to them. On the contrary, Sandilandsa *et al.* (2006)

Table 4: Effect of feed restriction on feed consumption (g/bird/day) of broiler chicks

Age (weeks)	T_1	T_2	T_3	T_4	T_5	p-value
1	20.21±0.90	20.25±0.70	21.13±0.88	20.92±0.48	20.46±0.71	p>0.062
2	46.79±1.40	44.95±1.12	45.69±0.96	45.54±1.60	43.54±1.46	p>0.052
3	107.51±2.22^{a}	88.84±1.15^{b}	94.49±4.55^{b}	88.29±2.54^{b}	90.58±1.50^{b}	p>0.014
4	106.09±1.67	102.08±7.07	103.24±4.94	97.32±4.28	97.47±3.42	p>0.071
5	132.38±2.38^{a}	131.53±3.02^{a}	128.57±3.61^{ab}	118.56±2.65^{c}	120.82±3.51^{bc}	p>0.011
6	165.85±2.45^{a}	149.33±3.13^{b}	154.73±2.40^{b}	153.30±4.53^{b}	149.67±5.23^{b}	p>0.055
7	128.00±7.01	144.51±5.29	136.49±4.99	117.85±3.10	138.91±9.17	p>0.056

Values are mentioned as Means±SE, letter(s) in the same row with different superscripts are significantly different at p≤0.05

Table 5: Effect of feed restriction on feed conversion (g feed/g gain) of broiler chicks

Age (weeks)	T_1	T_2	T_3	T_4	T_5	p-value
1	1.65±0.07	1.77±0.09	1.80±0.06	1.73±0.06	1.77±0.08	p>0.52
2	1.53±0.05	1.67±0.06	1.59±0.04	1.67±0.07	1.54±0.04	p>0.54
3	2.50±0.08^{a}	2.37±0.06^{a}	2.37±0.15^{a}	2.05±0.06^{b}	2.23±0.04^{ab}	p>0.045
4	1.82±0.06	1.81±0.15	1.71±0.11	1.89±0.11	1.76±0.03	p>0.064
5	1.69±0.03	1.66±0.08	1.66±0.08	1.52±0.05	1.54±0.04	p>0.051
6	2.22±0.06	1.96±0.10	1.99±0.06	1.88±0.05	1.84±0.16	p>0.12
7	3.48±0.51	3.32±0.15	3.47±0.31	2.87±0.06	3.42±0.35	p>0.066

Values are mentioned as Means±SE, letter(s) in the same row with different superscripts are significantly different at p≤0.05

Table 6: Effect of feed restriction systems on carcass characteristics (g)

Item	T_1	T_2	T_3	T_4	T_5	p-value
Live weight	2360±69.8	2332±108.27	2370.8±37.14	2276.8±68.25	2468±96.85	p>0.12
Dressing (%)	78.37±0.69	77.85±0.64	80.35±0.63	78.39±0.44	78.56±1.16	p>0.25
Liver	2.54±0.09	2.26±0.18	2.82±0.16	2.40±0.23	2.38±0.29	p>0.13
Gizzard	2.33±0.13	2.06±0.09	2.22±0.09	2.58±0.23	1.95±0.28	p>0.055
Head	2.07±0.07	2.04±0.05	1.96±0.18	1.98±0.09	2.02±0.03	p>0.09
Feathers	5.86±0.38	5.81±0.37	6.20±0.18	5.76±0.21	4.71±0.39	p>0.51
Leg	4.16±0.18	4.62±0.21	3.95±0.30	4.31±0.27	4.61±0.28	p>0.65
Giblets	4.90±0.27	4.57±0.17	5.16±0.21	5.21±0.41	4.62±0.33	p>0.84

Values are mentioned as Means±SE, letter(s) in the same row with different superscripts are significantly different at p≤0.05

found that the weight gain of birds in all restricted treatments increased faster than that of control birds in the grower period.

Table 4 showed that feed restriction decreased significantly ($p<0.05$) feed consumption in all treatments that fasted 8 or 6 h as compared by control treatment at 3 and 6 weeks of age. At the fifth week of age, treated treatments with 6 h fasting period were significantly ($p<0.05$) lower in feed consumption than the control treatment and the remaining treated treatments. Generally, the present result was agreement with Lee and Leeson (2001). They found that birds which were subjected to transient feed restriction, generally ate less feed than did full-fed (control birds).

Table 5 indicated that feed restriction significantly improved ($p<0.05$) the feed conversion ratio at the third week of age in the treated treatment, which fasted continuously 6 h as compared by control treatment and all remaining treated treatments.

Concerning the carcass (Table 6) the results indicated that different feed restriction systems did not significantly affect the relative percentages of liver, gizzard, head, feather, leg and giblets and the overall dressing percentage. This finding agreed with those reported by Palo *et al*. (1995). They

Table 7: Effect of feed restriction systems on economic efficiency of broiler chicks

Item	T_1	T_2	T_3	T_4	T_5
Starter diet cost (LE)	3.176	2.804	2.935	2.816	2.813
Grower diet cost (LE)	6.792	6.432	6.492	6.202	6.182
Total feed costs (LE)	9.968	9.236	9.427	9.018	8.995
bird weight at 6 wk (kg)	2.138	2.079	2.133	2.112	2.144
Bird price (LE)	19.24	18.711	19.197	19.012	19.296
Net revenue per bird	9.27	9.48	9.77	9.99	10.3
Economical efficiency	0.93	1.03	1.04	1.11	1.14
REE	100	102.195	105.366	107.795	111.102

Price of kg live body weight, 2009 = 7.5 L.E, LE = Egyptian pound, Net revenue per bird = Total revenue/bird (LE)-Total feed cost/bird (LE), USD = 5.5 LE

indicated that restricted feeding did not affect the carcass characteristics and the relative weights of different organs, except the relative weight of liver.

Results of Economic Efficiency (EE) from chickens fed on the different feed restriction systems are summarized in Table 7. The results indicated that all feed restriction systems (T_2, T_3, T_4 and T_5) gave better Relative Economical Efficiency (REE) than the control. These improvements relative economical efficiency due to reduced total feed costs for starter and grower. This result agree with Attia *et al*. (1991) reported that early feed restriction has been credited with improved feed efficiency in broilers.

CONCLUSION

In conclusion, the results of this study suggest that feed restriction systems in T_2 and T_4 reduced significantly live body weight, weight gainand feed conversion at starter period but it was no significantly at grower period compared to transit feed restriction in T_3 and T_4 and control T_1. Feed restriction significantly reduced feed consumption and at the same time improving economic efficiency.

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