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Effects of Early and Late Skip-a-Day Feeding on the Growth Performance of Male Hybro Broiler Chickens

[1]K. Benyi, [1]O. Acheampong-Boateng, [2]D. Norris and [1]M.S. Mikasi
[1]Department of Animal Science, University of Venda, Thohoyandou 0950, South Africa
[2]Department of Animal Production, University of Limpopo, Sovenga 0727, South Africa

Abstract: Four hundred and eighty 7-days old Hybro broiler chicks were fed *ad libitum*, or every other day for 14 days during the starter or grower period or for 28 days during the starter and grower periods followed by full feeding to 49 days of age to examine the effects of the different treatments on growth performance. During the feed restriction period the *ad libitum* birds consumed more feed, gained more weight and were heavier than all the feed- restricted birds. Also, the 14 day feed-restricted birds consumed more feed, gained more weight and were heavier than the 28 day restricted birds and there were no differences between the two 14 day restricted groups except in feed intake. At the end of the realimentation period, the control birds were still heavier than all the restricted birds though the restricted birds consumed similar quantities of feed, gained more weight and utilized their feed more efficiently and the 14 day restricted birds gained more weight and were heavier than the 28 day feed restricted birds. Overall, feed restriction resulted in reduced feed intake, weight gain, body weight and mortality rate but had no effects on feed efficiency and percentage of abdominal fat.

Key words: Broilers chickens, growth performance, skip-a-day feeding

INTRODUCTION

Poultry producers have, over several years, selected intensively for lines of chicken and turkey that grow faster, convert food more efficiently and produce more meat than the previous generation. Unfortunately, along with these improvements have come unintended detrimental changes. For example, the selection for increased growth in broilers has led to an increase in appetite, resulting in modern commercial strains of broiler chickens that tend to overeat when given free access to feed (Richards *et al*., 2003). The energy intake in excess of the requirements for maintenance and production is converted into fat.(Summers and Spratt, 2000; Cuddington, 2004) which can lead to obesity, various leg disorders, contact dermatitis, incidence of ascites, heart disease, impaired immune function and sudden death syndrome in growing birds if the birds are not restricted in their access to food (Appleby *et al*., 1992; Mattocks, 2002). In addition, feed cost accounts for about 70% of the cost of broiler production (Smith, 2001) and this high cost emphasizes the need to improve efficiency of feed utilization. Furthermore, it has become apparent over the past several years that a significant percentage of the improved body weight in broilers consists of carcass fat. Also, the consumer is becoming increasingly conscious of the implications of high dietary fat as it relates to human health problems and therefore there is an increasing movement to purchase meat products low in fat. Excessive fat therefore is one of the main problems faced by the poultry industry these days since it not only reduces carcass yield and feed efficiency but also causes rejection of the meat by consumers and causes difficulties in processing. Therefore, the need to reduce broiler carcass fat cannot be overemphasized.

Corresponding Author: K. Benyi, Department of Animal Science, University of Venda, Thohoyandou 0950, South Africa Tel: +27 15 962 8372

Several approaches, both quantitative and qualitative, have therefore been employed in an attempt to restrict nutrient or caloric intake of broilers in order to reduce feeding cost, improve feed efficiency, reduce abdominal and carcass fat and lessen the detrimental impact of the other problems associated with *ad libitum* feeding. Several studies have shown that early feed restriction followed by full feeding to market age has the potential to reduce the above-mentioned problems. During the period of feed restriction, growth is slower than that of birds given free access to feed but when free access to feed is restored the birds exhibit compensatory growth (Plavnik and Hurwitz, 1991; Lee and Leeson, 2001; Yousefi *et al*., 2001; Oyedeji and Atteh, 2003, 2005). Other researchers have, however, not been able to demonstrate the broiler's ability to completely compensate for growth reduction induced during a period of feed restriction (Robinson *et al*., 1992; Zubair and Leeson, 1996; Safaloah, 1999; Saleh *et al*., 2004). The nature, severity and duration of restriction, state of development of the bird relative to maturity during restriction, level of feeding during re-alimentation, period of re-feeding, diet nutrient content during re-feeding and sex and genotype of the population have been suggested as factors that influence the subsequent ability of the bird to recover from growth deficit (Summers and Spratt, 2000; Doyle and Leeson, 2003).

Many investigators have also reported more efficient feed conversion and reduced mortality (Kasim and Leeson, 1992; Lee and Leeson, 2001; Oyedeji and Atteh, 2003; Saleh *et al*., 2004) and reduced carcass and abdominal fat content at market age in feed-restricted birds than in birds fed *ad libitum* (Plavnik and Hurwitz, 1991; Zhong *et al*., 1995). Other reports (Robinson *et al*., 1992; Yousefi *et al*., 2001; Houshmand *et al*., 2003; Oyedeji and Atteh, 2005), however, indicate that even though feed-restricted birds had lower fat content, their feed efficiency was similar to that of birds fed *ad libitum*. Fontana *et al*. (1993) and Saleh *et al*. (2004) observed no effect of feed restriction on carcass and abdominal fat content. Most of the earlier studies on feed restriction have involved imposing the restriction for six to seven days during the first three weeks of the bird's life followed by full feeding to six, seven or eight weeks of age. In an attempt to further explore the effects of skip-a-day feeding on the growth performance of broiler chickens, this experiment was conducted to examine the effects of skip-a-day feeding during the starter period, grower period or starter and grower periods, followed by full-feeding to market age on the growth performance of a strain of commercial broiler chickens.

MATERIALS AND METHODS

Experimental Procedure

The study was conducted at the poultry facility of the experimental farm of the School of Agriculture, Rural Development and Forestry at the University of Venda, Thohoyandou, South Africa in June and July, 2006. Four hundred and eighty day-old male Hybro commercial broiler chicks were raised on a commercial broiler starter diet to 21 days, grower diet to 35 days and finisher diet to 49 days of age (Table 1). All chicks were fed *ad libitum* to 7 days of age. At 8 days of age, a random sample of 40 chicks were placed in each of 12 pens each measuring 300×287 cm and were assigned at random to the following 4 treatments:

- *Ad libitum* feeding during the starter and grower periods (8-35 days of age)
- Skip-a-day feeding during the starter period (8-21 days of age) and *ad libitum* feeding during the grower period (22-35 days of age)
- *Ad libitum* feeding during the starter period and skip-a-day feeding during the grower period
- Skip-a-day feeding during both periods

These treatments are hereafter called Control, early skip-a-day (ESAD) late skip-a-day (LSAD) and early and late skip-a-day (ELSAD), respectively. All the birds were fed *ad libitum* during the

Table 1: Chemical composition (Label values) of commercial broiler starter, grower and finisher feeds used in the study[A]

Composition (g/kg except ME and ME/CP ratios)	Starter	Grower	Finisher
Crude protein	200.00	180.00	160.00
ME (MJ g^{-1})	12.76	13.00	13.20
ME/CP ratios (MJ g^{-1})	0.06	0.07	0.08
Fat	25.00	25.00	25.00
Fibre	50.00	60.00	70.00
Moisture	120.00	120.00	120.00
Calcium	12.00	12.00	120.00
Phosphorus	6.00	5.50	5.00
Lysine	12.00	10.00	9.00

[A]: Supplied by meadow feeds, randfontein, South Africa

finisher period (36-49 days). The birds had 24 h light per day and water was available all the time. Heat was provided from day-old to 4 weeks of age by 75 watt infrared bulbs. The birds were individually weighed at 8, 35 and 49 days of age, the birds having been fasted overnight prior to each weighing. Feed consumption per bird was calculated from the records of feed intake of birds in each pen and feed efficiency was calculated as weight gained per gram of feed consumed. After weighing at 49 days of age, 5 birds were randomly sampled from each pen. After desanguination and defeathering, the head and shanks were removed and each bird was placed in a polythene bag and chilled for 48 h after which the carcass was thawed. Each carcass was then placed on its back, the thighs were separated and a slanted cut about 45° was made just under the keel to the backbone. Abdominal fat around the rectum and gizzard was removed and weighed.

The carcass was then eviscerated and weighed. From these weights, abdominal fat expressed as percentage of liveweight was calculated.

Statistical Analysis

A total of 480 observations were made on initial weight and 464 on weight at 35 days of age and weight gain from 8 to 35 days of age. There were also 373 observations each on final body weight (weight at 49 days of age) and weight gain from 36 to 49 days of age (final body weight), 12 each on feed consumption, feed efficiency and mortality rate and 60 on abdominal fat percentage. Pen means were used for body weights, weight gain, feed intake, feed efficiency and mortality. The data were analyzed by analysis of variance for a completely randomized design using the GLM procedure of SAS version 6 (SAS, 1999). The following predetermined orthogonal linear contrasts were used to compare the treatment means:

$$L_1: 3\mu_1 - \mu_2 - \mu_3 - \mu_4$$
$$L_2: \mu_2 + \mu_3 - 2\mu_4$$
$$L_3: \mu_2 - \mu_3$$

Where:

L_1, L_2 and L_3	=	Contrasts
μ_1, μ_2, μ_3 and μ_4	=	Means for control, ESAD, LSAD and ELSAD treatments, respectively.

The significance of each contrast was determined by the student t-statistic, where $t = L/[\Sigma a_i^2(MSE/n)]^{0.5}$, a_i is the coefficient of a treatment mean, MSE is the error mean square from analysis of variance and n is the sample size (Dowdy and Wearden, 1991; Freund and Wilson, 1997).

RESULTS AND DISCUSSION

The initial body weight, body weight at 35 days of age and weight gain, feed intake and feed efficiency during the restriction period (8 to 35 days of age) together with the results of the significant

Table 2: Performance of full-fed and feed-restricted broiler chickens during the period of restriction period (1-5: weeks of age)

	Traits				
Treatments	Ibw (g)	W35 (g)	Wg (g)	Fi (g/bird/day)	Fe (g gain/g feed)
Control	186.10	1943.10	1732.30	106.70	0.580
ESAD	186.40	1490.60	1304.00	82.90	0.560
LSAD	177.00	1497.00	1320.10	88.10	0.540
ELSAD	185.30	1187.90	1002.10	66.30	0.540
SEM	4.93	45.49	43.64	1.73	0.018
Treatment^{+}		**	**	**	
$L_1$$^{++}$	0.56	10.47**	10.02**	13.82**	1.670
L_2	-0.60	5.48**	5.59**	9.08**	0.500
L_3	1.35	-0.10	-0.25	-2.13*	0.800

Ibw: Initial body weight, W35: Weight at 35 days of age, Wg: Weight gain, Fi: Feed intake, Fe: Feed efficiency, $^{+}$: Overall treatment effect, $^{++}$: L_1 compares the performance of the control birds and feed-restricted birds, L_2: Compares the performance of early-restricted and late-restricted birds with that of the early-and-late restricted birds, L_3: Compares the early-restricted and late-restricted birds, *: p<0.05, **: p<0.01

tests of the orthogonal linear contrasts are shown in Table 2. The control birds gained more weight (p<0.01) and were heavier (p<0.01) at the end of the restriction period than birds on the various skip-a-day feeding regimes Also, though birds on the ESAD and LSAD regimes did not differ (p>0.05) in weight gain and body weight, birds on both regimes gained more weight (p<0.01) and were heavier (p<0.01) at the end of the period than their contemporaries on the ELSAD regime. These results indicated that skip a-day feeding resulted in reduced weight gain and lower body weight at the end of the feed restriction period, the extent of reduction depending on the duration of restriction. These results agree with some of the earlier reports on the effects of feed restriction on weight gain and body weight at the end of the restriction period (Yousefi *et al*., 2001; Lee and Leeson, 2001; Uedaneta-Rincon and Leeson, 2002; Dozier *et al*., 2002). The lack of any differences (p>0.05) in feed efficiency among birds on the different treatments despite the differences in feed consumption is contrary to some earlier reports that feed efficiency of birds on skip-a-day feeding regime was worse than (Yousefi *et al*., 2001) or better than (Deaton, 1995; Zubair and Leeson, 1996) that of controls during the feed restriction period and suggests that though birds on all the skip-a-day treatments gained less weight than the control birds, birds on all the 4 treatments utilized feed with the same degree of efficiency One possible explanation for this is that feed restriction induces reduced energy requirement (Marks, 1991; Zubair and Leeson, 1994). The insignificant differences (p>0.05) between birds on the ESAD and LSAD regimes in weight gain and body weight despite the higher feed consumption (p<0.05) of birds on the LSAD regime suggests that birds that were on the skip-a-day regime for 14 days during the starter period utilized feed more efficiently than their counterparts that were on the same regime for the same duration during the grower period though the difference was not statistically significant (p>0.05) and suggests that imposing skip-a-day feeding for 14 days during the starter period might be more economical than imposing it for the same duration during the grower period or for the same period during the grower period. This observation contradicts those of McMurtry *et al*. (1988) and Zubair and Leeson (1994) that imposing feed restriction earlier in life is more detrimental to the animal than imposing it at a later stage but agrees with the report by Oyedeji and Atteh (2003) that imposing feed restriction beyond two weeks of age resulted in poorer performance. As expected, skip-a-day feeding for 14 days either during the starter or grower period was less detrimental to the bird than skip-a-day feeding for 28 days during the starter and grower periods.

Table 3 shows body weight, weight gain, feed intake, feed efficiency and abdominal fat percentage during the realimentation period (36-49 days of age) together with the results of significance tests of the orthogonal contrasts. During this period, the previously-restricted birds gained more weight (p<0.01) than the control birds. Also, though birds on the LSAD treatment gained more weight than those on the ESAD treatment, birds on both treatments did not differ (p>0.05) from birds on the

Table 3: Performance of full-fed and feed-restricted broiler chickens during the realimentation period (36-49 days of age)

	Traits				
Treatments	W49 (g)	Wg (g)	Fi (g/bird/day)	Fe (g gain/g feed)	AF (%)
Control	3188.80	1260.30	187.00	0.480	2.40
ESAD	2819.60	1304.40	182.70	0.510	2.80
LSAD	2947.30	1444.40	196.40	0.530	2.70
ELSAD	2561.70	1366.50	178.20	0.550	2.60
SEM	54.72	24.91	3.87	0.011	0.22
Treatment^{+}	**	**	*	**	
L_1^{++}	5.58**	-3.87**	0.30	-3.750**	-1.49
L_2	4.44**	0.26	2.39*	-2.140*	0.94
L_3	-1.25	-3.98**	-2.50*	-1.250	0.03

W49: Weight at 49 days of age, Wg: Weight gain, Fi: Feed intake, Fe: Feed efficiency, AF: Abdominal fat, $^{+}$: Overall treatment effect, $^{++}$: L_1 compares the performance of the control birds and feed-restricted birds, L_2: Compares the performance of early-restricted and late-restricted birds with that of the early-and-late restricted birds, L_3: Compares the early-restricted and late-restricted birds, *: $p<0.05$, **: $p<0.01$,

ELSAD regime. In spite of the higher weight gains of the previously-restricted birds than the control birds during the period, the previously-restricted birds were still lighter (p<0.01) than the control birds at the end of the period. Also, birds on the ELSAD treatment were lighter than those on the ESAD and LSAD treatments (p<0.01) in spite of insignificant difference in weight gains between birds on the ESAD and LSAD regimes and those on the ELSAD regime. Furthermore there was no difference (p>0.05) in body weight between birds on the ESAD and LSAD treatments though the LSAD birds gained more weight during the period than the ESAD birds. The lighter body weights of the previously-restricted birds than the control birds at the end of post-restriction period despite the greater weight gains of the restricted group shows that though the previously-restricted birds exhibited accelerated growth during the this period, they were unable to recover fully from the effect of the slow growth during the feed restriction period. These results agree with some of the earlier reports (Safaloah, 1999; Uedaneta-Rincon and Leeson, 2002; Dozier *et al*., 2002; Saleh *et al*., 2004) that though previously-restricted birds showed accelerated growth during *ad libitum* feeding in the post-restriction period, they were unable to recover fully from the effect of feed restriction imposed earlier but contradict those of other workers (Plavnik and Hurwitz, 1991; Plavnik and Balnave, 1992; Altan *et al*., 1998; Yousefi *et al*., 2001) that early feed restriction resulted in complete compensatory growth and insignificant difference in body weight between previously-restricted and control birds at market age.

The vast differences in results on compensatory growth from feed restriction experiments have been caused by several factors including type and severity of restriction, duration of restriction, maturity of the birds during restriction, duration of the realimentation period and composition of the realimentation diet (Doyle and Leeson, 2003). The skip-a-day method is one of severest feed restriction methods and this probably was one of the reasons why the feed-restricted birds were unable to recover fully during the refeeding period. Also, the duration of the restriction in this study (14 or 28 days) was longer than those reported in the literature. In the literature, apart from a few studies such as those of Benyi and Habi (1998), Safaloah (1999) and Oyedeji and Atteh (2003, 2005) in which the period of restriction lasted for 14 to 28 days, most of the restriction periods were short, ranging from 3 to 9 days (Altan *et al*., 1998; Lee and Leeson, 2001; Yousefi *et al*., 2001; Uedaneta-Rincon and Leeson, 2002; Dozier *et al*., 2002, 2003; Houshmand *et al*., 2003). Furthermore, in our study, the realimentation periods were 14 or 28 days compared with periods of 33 or more days reported in the literature (Summers *et al*., 1990; Plavnik and Hurwitz, 1985, 1991; Plavnik and Balnave, 1992; Fontana *et al*., 1993; Zubair and Leeson, 1996; Altan *et al*., 1998). The longer restriction periods in this study, coupled with the shorter realimentation periods probably did not allow the birds enough time to fully recover from the effects of the severe feed restriction. The composition of the realimentation diet also has an influence on the ability of the previously-restricted birds to recover fully from the effects of the feed restriction. In our trial, the 16% crude protein content of the realimentation diet was much lower than the 21 to 35% fed by some of the earlier workers (Santoso *et al*., 1995; Yousefi *et al*., 2001). Fontana *et al*. (1993) showed that protein might be a limiting factor during recovery after a period of restriction.

The higher weight gains and heavier body weights of the birds that were restricted for 14 days compared with those that were restricted for 28 days shows that imposing skip-a-day restriction for 28 days was more detrimental to the birds than imposing it for 14 days. This result agrees with those of Pokniak *et al*. (1984) and Plavnik and Hurwitz (1991) that showed that birds that were restricted for 6 or 14 days recovered completely whilst those that were restricted for 28 days could not. It however contradicts reports by Balay *et al*. (1992), Dozier *et al*. (2002) and Dozier *et al*. (2003) that broilers subjected to 24 h feed removal for 5 or 6 days could not recover from the weight loss and were lighter than their full-fed counterparts at 42 and 56 days of age.

Though there was no difference ($p>0.05$) in feed intake between the restricted and control birds, birds on the ESAD and LSAD regimes consumed more feed than those on the ELSAD regime ($p<0.05$) and birds on the LSAD treatment consumed more feed ($p<0.05$) than those on the ESAD treatment. The better efficiency of feed utilization of the restricted birds than the controls ($p<0.01$) during the realimentation period despite the lack of a difference in feed consumption ($p>0.05$) between the two groups agrees with earlier reports by several authors (Plavnik and Hurwitz, 1991; Plavnik and Balnave, 1992; Altan *et al*., 1998; Safaloah, 1999; Yousefi *et al*., 2001; Dozier *et al*., 2003; Onderka and Hanson, 2006) but contradicts those of Summers *et al*. (1990), Zubair and Leeson (1996), Dozier *et al*. (2002) and Uedaneta-Rincon and Leeson (2002) that feed restriction has no effect on efficiency of feed utilization. This result agrees with the suggestion by Zubair and Leeson (1994) that feed restriction induces reduced energy requirement. According to these authors, the improvement in feed efficiency noted with the use of feed restriction programmes is due to reduced overall maintenance requirements. This reduction seems to be due to a transient decrease in basic metabolic rate of feed-restricted birds and is linked with a smaller body weight during early growth, leading to less energy needed for maintenance (Marks, 1991). Also, the better feed efficiency of ELSAD birds than the ESAD and LSAD birds despite the higher feed consumption of the two latter groups suggests that the longer duration of restriction improved efficiency of feed utilization. The lack of differences in feed efficiency and body weight at 49 days of age between birds that were fed every other day for 14 days during the starter period and those that had the same treatment during the grower period despite the higher feed consumption and weight gain of the LSAD than the ESAD birds, suggests that skip-a-day feeding during the starter period was more economical than restriction during the grower period and directly contradicts a report by McMurtry *et al*. (1988) and Zubair and Leeson (1994) that undernutrition in the early stages of growth is more detrimental to an animal than restriction at a later stage. The absence of any significant differences in abdominal fat percentage among birds on the various treatments agrees with some reports that feed restriction did not influence abdominal fat deposition (Deaton, 1995; Zubair and Leeson, 1996; Altan *et al*., 1998; Dozier *et al*., 2002; Uedaneta-Rincon and Leeson, 2002; Saleh *et al*., 2004) but contradicts other reports that indicate that feed restriction lowered abdominal fat deposition (Plavnik and Hurwitz, 1991; Plavnik and Balnave, 1992). The fact that there were no significant differences in abdominal fat deposition in this study suggests that even feed-restricted broiler chickens are still overeating and that the level of feed intake may control de novo lipogenesis (Rosebrough and McMurtry, 1993).

Table 4 shows final body weight, weight gain, feed intake, feed efficiency and mortality rate during the entire experimental period (8 to 49 days of age). The overall results are similar to those obtained at the end of the restriction period. The control birds gained more weight and were heavier than the feed-restricted birds. Also birds on the ESAD and LSAD treatments did not differ in weight gain and body weight but birds on both treatments gained more weight and were heavier than those on the ELSAD treatment.

Table 4: Performance of full-fed and feed-restricted broiler chickens during the entire experimental (8-49 days of age)

	Traits				
Treatments	Fw (g)	Wg (g/bird/day)	Fi (g gain/g feed)	Fe (%)	Mr
Control	3188.80	3005.00	129.00	0.550	15.80
ESAD	2819.60	2633.00	111.30	0.560	12.50
LSAD	2947.30	2769.90	120.30	0.550	3.30
ELSAD	2561.70	2374.80	100.30	0.560	4.20
SEM	54.72	56.14	1.86	0.011	3.17
Treatment^{+}	**	**	**	*	*
L_1^{++}	5.58**	6.36**	8.51**	-0.500	2.19*
L_2	4.44**	4.75**	6.84**	-0.350	0.85
L_3	-1.25	-1.72	-3.42**	0.630	1.84

Fw: Final weight, Wg: Weight gain, Fi: Feed intake, Fe: Feed efficiency, AF: Abdominal fat, $^{+}$: Overall treatment effect, $^{++}$: L_1 compares the performance of the control birds and feed-restricted birds, L_2 Compares the performance of early-restricted and late-restricted birds with that of the early-and-late restricted birds, L_3: Compares the early-restricted and late-restricted birds, *: p<0.05, **: p<0.01

The overall heavier final body weights of the control than the feed-restricted birds indicates that despite the accelerated growth of the feed-restricted birds during the realimentation period, they could not compensate fully from the reduced weight gains during the feed restriction period. This occurred probably because either the skip-a-day feeding was too severe, the 14 and 28 day periods were too long and/or the 14 or 28 days for realimentation were too short as mentioned earlier. These results agree with those reported by Safaloah (1999) that broilers subjected to skip-a-day feeding for 14 days during the starter or grower period could not recover fully by 49 days of age. The higher weight gains and heavier final body weights of birds that were restricted for 14 days than those that were restricted for 28 days indicates that the 28 day feed restriction was more detrimental to the bird than the 14 day restriction. This agrees, in part with the results obtained by Pokniak *et al*. (1984). These workers subjected day-old broiler chicks to skip-a-day feeding for 14 or 28 days of age followed by *ad libitum* feeding to 56 days of age. While the birds that were restricted for 14 days completely recovered from the early feed restriction by 56 days of age, the 28-day restricted birds were significantly lighter. The lack of any differences in overall feed efficiency between the control and the feed-restricted birds in spite of differences (p<0.01) in feed consumption, agrees with the finding of Yousefi *et al*. (2001) that feed restriction did not influence overall feed efficiency and is contrary to some early reports (Altan *et al*., 1998; Safaloah, 1999; Lee and Leeson, 2001; Oyedeji and Atteh, 2005) that feed restriction improved overall feed efficiency. Present result suggests that, though the feed-restricted birds gained less weight than the full-fed birds, birds on all the 4 treatments utilized feed with the same degree of efficiency. Similarly, the similar feed efficiencies of the 14 day restricted birds and the 28 day restricted birds despite the higher feed consumption of the 14 day restricted birds suggests that the 28 day restricted birds utilized feed more efficiently than the 14 day restricted ones.

The similar weight gains, final body weights and feed efficiencies of the early-restricted and late-restricted birds in spite of the higher feed consumption of the late restricted birds indicates that the early-restricted birds utilized feed more efficiently than the late-restricted ones and suggests that early skip-a-day feeding might be less harmful to the bird and more economical than late restriction. This agrees in part with the statement by Lee and Leeson (2001) that when feed restriction was applied earlier or for a shorter period growth compensation occurred but contradicts the statement by McMurtry *et al*. (1988) and Zubair and Leeson (1994) that feed restriction imposed during early growth was more detrimental than feed restriction at a later stage. The lower mortality rates in the feed-restricted birds than in the control birds agrees with several reports that feed restriction reduced mortality rate (Kasim and Leeson, 1992; Lee and Leeson, 2001; Oyedeji and Atteh, 2003; Saleh *et al*., 2004).

Doyle and Leeson (2003) stated that for feed restriction to be of economic interest, the feed-restricted animal must achieve a normal weight for age prior to market and show improved efficiency of growth and exhibit superior carcass characteristics. Overall, none of these was observed in this study though the birds on the restricted regimes grew faster and utilized feed more efficiently during the realimentation period. Doyle and Leeson (2003) also indicated that to achieve the above goals, the degree of under nutrition must not be too severe and the period of under-nutrition must not be so long that the feed-restricted animals are unable to compensate in reasonable time. McMurtry *et al*. (1988) and Plavnik and Hurwitz (1988) suggested that for male and female broilers, respectively, feed restriction of not more than 7 and 6 days, respectively starting at 6 days of age appears to allow for complete recovery of body weight. The results of this study, like those of Safaloah (1999), show that though a 14 day skip-a-day feeding imposed during early growth seems to be less detrimental to the bird and more economical than the same regime imposed for the same duration during the grower period, a 14 day skip-a-day regime, in general, is too severe and too long to allow the birds to exhibit full compensatory growth during the re-feeding period and a 28 day regime is worse.

CONCLUSION

The results of this study has shown that skip-a-day feed restriction for 14 or 28 days reduced weight gain and decreased body weight of the feed-restricted birds during the period of restriction, the extent of reduction depending on the duration of restriction. When the feed-restricted biers were returned to full-feeding they consumed similar quantities as the full-fed counterparts and but faster. Despite this, they were unable to recover fully from the weight loss during the period of restriction. This suggests that 14 day skip-a-day feeding is too severe and the duration is too long and did not allow the birds enough time to recover before market age and 28 day skip-a-day restriction is worse. Feed restriction neither improved feed efficiency nor reduced abdominal fat though it improved mortality rate. It also appears that imposing skip-a-day feeding for 14 days is less harmful and more economical than imposing the same treatment than 28 days. It may therefore be concluded that milder forms of feed restriction, shorter feed restriction periods and/or longer refeeding periods may be necessary to achieve full growth compensation.

REFERENCES

Altan, O., S. Ozkan and S. Yakin, 1998. Restricted growth of broilers. Effect of different restricted feeding program on broiler performance and carcass characteristics. Turk. J. Vet. Anim. Sci., 22: 321-326.

Appleby, M.C., B.O. Hughes and H.A. Elson, 1992. Poultry Production Systems. CAB International, Wallingford, UK., pp: 37-38.

Balay, M., E.A. Dunnington, W.B. Gross and P.B. Siegel, 1992. Restricted feeding and broiler performance: Age at interaction and length of restriction. Poult. Sci., 71: 440-447.

Benyi, K. and H. Habi, 1998. Effects of feed restriction during the finishing period on the performance of broiler chickens. Br. Poult. Sci., 39: 423-425.

Cuddington, S., 2004. High energy diets affect broiler chicken welfare. http://www.facs.sk.ca/pdf/animal_care_award/articles_2004/cuddington_chickens.pdf (last accessed on 17 September, 2007).

Deaton, J.W., 1995. The effect of early feed restriction on broiler performance. Poult. Sci., 74: 1280-1286.

Dowdy, S. and S. Wearden, 1991. Statistics for Research. 2nd Edn. John Wiley and Sons, New York, pp: 314-319.

Doyle, F. and S. Leeson, 2003. Compensatory growth in farm animals: Factors influencing response. http://www.novusint.com/Public/Library/TechPaper.asp? ID = 1 (last accessed on 9 January, 2007).

Dozier, W.A., R.J. Lien, J.B. Hess, S.F. Bilgili, R.W. Gordon, C.F. Laster and S.L. Vieira, 2002. Effects of early skip-a-day feed removal on broiler live performance and carcass yield. J. Applied Poult. Res., 11: 297-303.

Dozier, W.A., R.J. Lien, J.B. Hess and S.F. Bilgili, 2003. Influence of early skip-a-day feed removal on live performance and carcass yield of broilers of different sexes and strain sources. J. Applied Poult. Res., 12: 439-448.

Fontana, E.A., W.D. Weaver Jr., D.M. Denbow and B.A. Watkins, 1993. Early feed restriction of broilers: Effects on abdominal fat pad, liver and gizzard weights, fat deposition and carcass composition. Poult. Sci., 72: 1296-1305.

Freund, R.J. and W.J. Wilson, 1997. Statistical Methods. Revised Edn. Academic Press, San Diego, CA, pp: 235-242.

Houshmand, M., A. Kamyab, K. Yousefi and A.T. Farshi, 2003. The performance of broiler chickens during and following different feed restriction methods at an early age. Poult. Sci., 80 (Suppl. 1): 402.

Kasim, Z.A. and S. Leeson, 1992. Metabolizable energy utilization by broilers on different nutrient restriction programs. Poult. Sci., 71 (Suppl. 1): 114.

Lee, K.H. and S. Leeson, 2001. Performance of broilers fed limited quantities of feed or nutrients during seven to fourteen days of age. Poult. Sci., 80: 446-454.

Marks, H.L., 1991. Feed efficiency changes accompanying selection for body weight in chickens and quails. World's Poult. Sci. J., 47: 197-212.

Mattocks, J., 2002. Mortality: Common causes. http://www.apppa.org/APPPA/articles/mortality.htm (last accessed on 9 January 2007).

McMurtry, J.P.R., R.W. Rosebrough, I. Plavnik and A. Carwright, 1988. Influence of Early Plane of Nutrition on Enzyme Systems and Subsequent Tissue Deposition. In: Biomechanisms Regulating Growth and Development, Steffens, G.L. and T.S. Rumsey (Eds.). Symposia on Agricultural Research, Bestville, Klume Academic Publishers, Dordrecht, The Netherlands, pp: 329-334.

Onderka, D.K. and J.A. Hanson, 2006. Growth performance of broiler chicks after, severe early restriction. http://www.Westvet.com/feed_restriction.htm (last accessed on 15 September 2007).

Oyedeji, J.O. and J.O. Atteh, 2003. Response of broilers to 3 weeks feed restriction initiated at different time periods. http://www.ajol.info/viewarticle.php? id = 721 and jid = 17 and layou t = abstract (last accessed on 9 January, 2007).

Oyedeji, J.O. and J.O. Atteh, 2005. Response of broilers to feeding manipulations. Int. J. Poult. Sci., 4: 91-95.

Plavnik, I. and S. Hurwitz, 1985. The performance of broiler chicks during and following severe feed restriction at an early age. Poult. Sci., 64: 348-355.

Plavnik, I. and S. Hurwitz, 1988. Early feed restrictions in chicks. Effects of age, duration and sex. Poult. Sci., 63: 384-390.

Plavnik, I. and S. Hurwitz, 1991. Response of broiler chickens and turkey poults to feed restriction of varied severity during early life. Br. Poult. Sci., 32: 343-352.

Plavnik, I. and D. Balnave, 1992. Response of different strains of Australian broiler chickens to feed restriction at an early age. Aust. J. Agric. Res., 43: 1253-1258.

Pokniak, J.A., M.S. Avarice and S.B. Cornenejo, 1984. Reproductive performance and change in carcass composition of broiler under an initial energy-protein restriction and subsequent refeeding. Nutr. Rep. Int., 30: 1377-1383.

Richards, M., S. Poch, C. Coon, R. Rosebrough, C. Ashwell and J. McMurty, 2003. Expression of selected genes related to lipid metabolism in broiler breeder chickens. J. Nutr., 133: 707-715.

Robinson, F.E., H.L. Classen, J.A. Hanson and D.K. Odenka, 1992. Growth performance, feed efficiency and incidence of skeletal and metabolic diseases in full-fed and feed restricted broiler and roaster chickens. J. Applied Poult. Res., 1: 33-41.

Rosebrough, R.W. and J.P. McMurtry, 1993. Energy repletion and lipid metabolism during compensatory gain in broiler chickens. Growth Dev. Aging, 57: 73-83.

Safaloah, A.C.L., 1999. Effect of early and late feed restriction on compensatory ability of broilers. Uniswa Res. J. Agric. Sci. Tech., 3: 69-73.

Saleh, E.A., S.E. Watkins, A.L. Waldroup and P.W. Waldroup, 2004. Comparison of energy feeding programs and early feed restriction on live performance and carcass quality of large broilers grown for further processing at 9 to 12 weeks of age. Int. J. Poult. Sci., 3: 61-69.

Santoso, U., K. Tanaka and S. Ohtani, 1995. Early skip-a-day feeding of female broiler chicks fed high-protein realimentation diets: Performance and body composition. Poult. Sci., 74: 494.

SAS Institute, 1999. SAS User's Guide, Version 6, SAS Institute Inc., Cary, NC.

Smith, A.J., 2001. Poultry. The Tropical Agriculturist, MacMillan Education Ltd., London and Oxford, UK., pp: 221.

Summers, J.D., D. Spratt and J.L. Atkinson, 1990. Restricted feeding and compensatory growth for broilers. Poult. Sci., 70: 37-43.

Summers, J.D. and D. Spratt, 2000. Compensatory growth. http://www.gov.ont.ca/OMAFRA/english/livestock/poultry/facts/compgrow.htm (last accessed on 15 September 2007).

Uedaneta-Rincon, M. and S. Leeson, 2002. Quantitative and qualitative feed restriction on growth characteristics of male broiler chickens. Poult. Sci., 81: 679-688.

Yousefi, K., A. Kamyab, M. Houshmand and A.T. Farshi, 2001. The effects of early skip-a-day feeding regimen on the performance of ross male broiler chicken. Poult. Sci., 80 (Suppl. 1): 402.

Zhong, C., H.S. Nakane, C.Y. Hu and L.W. Mirosh, 1995. Effect of full feed and early feed restriction on broiler performance, abdominal fat level, cellularity and fat metabolism in broiler chickens. Poult. Sci., 74: 1636-1643.

Zubair, A.K. and S. Leeson, 1994. Effect of early feed restriction and realimentation on Heat production and changes in sizes of digestive organs of male broilers. Poult. Sci., 73: 529-538.

Zubair, A.K. and S. Leeson, 1996. Changes in body composition and adipocyte cellularity of male broilers subjected to varying degrees early-life feed restriction. Poult. Sci., 75: 719-728.