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Influence of Feed Withdrawal for Three Hour Time Period on Growth Performance and Carcass Parameters of Later Stage of Male Broiler Chickens

Research Article

P.H.G.J. De Silva[1*] and A. Kalubowila[2]

[1] Department of Agricultural Systems, University of Rajarata, Puliyankulama, Sri Lanka
[2] Purchasing Manager, Keells Food Products PLC, 16, Minuwangoda Road, Ekala, Ja-Ela, Sri Lanka

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*Correspondence E-mail: jayaminiganiesha@yahoo.com

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ABSTRACT

Feed restriction strategies are proven to be effective in increasing the growth performance and carcass parameters of broiler chickens. The objective of the present experiment was to evaluate the effects of feed removal for three hour time period on growth performance and carcass parameters of relatively older male broiler chickens. Twenty days old male broiler chickens (n=80) were allocated into 16 floor pens. Birds in eight pens were fed *ad libitum* while those in other eight pens were fasted for 3 hours per day (13.00-16.00) during 21-42 d experimental period. There was a slight feed intake reduction (P<0.01) due to feed restriction during 21-25 d, but not thereafter. When feed was offered after three hours of deprivation, birds consumed significantly (P<0.01) higher amount of feed within first two hours, compared to the feed intake of *ad libitum* group during the same time period. Birds fed *ad libitum* were heavier (P<0.05) on day 42 but not on days 25, 30 and 35. Feed restriction significantly reduced the weight gain between 35-42 d (P <0.01) and the total weight gain (P<0.05) from day 21-42. Feed conversion ratio (FCR) between 30-42 d was significantly (P<0.05) lower under *ad libitum* feeding, and also overall FCR from 21-42 d was affected by the feeding regimes. Restricted feeding increased the total giblet weight (liver+heart+gizzard) (P<0.10), the carcass weight (P<0.01) and dressing percentage (P<0.05) while reduced (P<0.01) the length of the small intestine relative to carcass weight. Restricted feeding tended to reduce (P<0.10) the percentage of abdominal fat. The results conclude that feed restriction for three hours per day from days 21-42 increased dressing percentage while reducing abdominal fat content of matured male broiler chicken.

KEY WORDS broiler, carcass, feed restriction, growth.

INTRODUCTION

A profitable broiler feeding strategy should maximize final body weight and lean tissue production using minimum amount of feed. Studies of Plavnik and Hurwitz (1985, 1988 and 1991) proposed that early feed restriction strategies increased the growth and feed efficiency with reduced carcass fat. Those studies showed that early growth retardation resulting from feed restriction in broiler chicks induced an accelerated growth termed as compensatory growth, when feed was given *ad libitum* after a period of restriction. However, later studies have shown that though in general growth was compensated, final body weight of the restricted birds could be low (Leterrier *et al*. 1988; Cabel and Waldroup, 1990; Ballay *et al*. 1992; Bruno *et al*. 2000) or similar (Calvert *et al*. 1987; Summers *et al*. 1990; Pinchasov and Jensen, 1989) or even higher (Cherry *et al*. 1978) compared to *ad libitum* fed counterparts. Similar

inconsistencies have been reported in relation to feed efficiency (Palo and Sell 1995; Cabel and Woldroup, 1990) and carcass or abdominal fat (Cabel and Woldroup, 1990; Santoso *et al*. 1995; Plavnik and Hurtwitz, 1985). A number of recent studies have attempted to use restricted feeding strategies to reduce the metabolic disorders such as ascites (Acar *et al*. 1995; Buys *et al*. 1998; Balog *et al*. 2000) and leg weaknesses (Su *et al*. 1999; Carter *et al*. 1994; Robinson *et al*. 1992).

Except for the study of Balog *et al*. (2000) all other studies restricted the feed or nutrient intake of broilers during early ages and then offered *ad libitum* allowing compensatory growth. Balog *et al*. (2000) deprived feed for broiler chickens for 16 hours up to day 42. Final weight and the breast meat yield of the broilers on restricted feeding regimen were lower than *ad libitum* fed counterparts. Proudfoot *et al*. (1983) also reported similar adverse effects due to feed deprivation for 8 or 12 hours. Possibly, mild feed restriction strategies are more appropriate to achieve the beneficial effects of feed restriction without the reduction of final body weight. Also, severe restrictions for longer durations can be criticized as for being unethical and affecting animal welfare. Sudden death of heavy broilers during hot-humid hours of the day due to heat stress is common in broiler flocks reared under hot-humid conditions. Metabolic heat production associated with feeding and digestion can be a significant contributor for the heat stress of broilers, particularly during hot hours of the day. Denial of feed during hot hours of the day may be helpful to reduce the metabolic heat production and thus may be an animal welfare promoting practice at least under hot humid rearing conditions. Therefore, in this study feed was restricted for three hours from 13:00 to 16:00 h; i.e., the hottest hours of the day. Since the temperature reduces after 16:00 h, increase in feed intake was assumed to have less pronounced effect on heat stress. The objective of the present study was to determine the effects of three hours of feed restriction during later stage of male broiler chickens on growth performance, carcass traits and abdominal fat content.

MATERIALS AND METHODS

Day old male broiler chicks were obtained from a local hatchery. Chicks were reared on an electric brooder until they were 14 days old. A commercial broiler starter diet (CIC Feeds, Sri Lanka, Table 1) was fed until 20 days. On day 20, chicks were weighed and eighty chicks were allocated into 16 deep litter floor pens so that variation between pen weights was minimum. Cages were randomly assigned into two treatments so that each treatment had eight replicates with five birds in each pen. Each pen had a feeder and a bell shape drinker. Lighting schedule included 12 h natural day light and 9 h artificial light during night time.

Chicken were given 1 ft^2 of floor space per chick. From days 21 to 42 all the birds were fed a commercial broiler finisher diet (CIC Feed, Sri Lanka, Table 1).

Table 1 Nutrient composition of the experimental diets

Nutrients	Composition (%)	
	Starter	Finisher
Protein	22	20
Fat	6	7.5
Ash	6.5	6.5
Fibre (Max)	4.5	4.5
Moisture (Max)	12	12
Calcium (Min)	1.0	0.9
Available phosphorus (Min)	0.45	0.4
Metabolizable energy (Min)	2950 kcal/kg	3050 kcal/kg
Methionine + Cysteine	0.93	0.93

Birds in eight pens were fed *ad libitum* while those in other eight pens were deprived of feeds for three hours daily from 21-42 days. In the restricted feeding regimen, feeders were withdrawn from the pens at 13:00 and reintroduced at 16:00 h. For both groups, water was given *ad libitum* throughout the experiment. Cage-wise daily feed and water intakes were recorded. Birds were weighed on days 25, 30, 35 and 42. One randomly selected chicken from each pen was sacrificed and dissected on days 25, 30, 35 and 42. The de-feather carcass, eviscerated carcass and total giblet (liver+heart+gizzard) weights were recorded. Abdominal fat was manually separated from carcasses and weighed. Length of the intestine from the junction between gizzard and jejunum to the cloaca was washed, blotted dry, residual fecal material removed and measured. Data were analyzed using GLM procedure of SAS V6.12 (SAS Institute, 2001). For growth performance data including feed and water intake, weight gains, live weights and FCR analysis, pen means served as replicates. For carcass parameter data analysis, an individual chicken served as replicates. Effects were considered as significant when $P<0.05$ while P values between 0.05 and 0.1 were conceded as having a statistical trend.

RESULTS AND DISCUSSION

Feed and water intake, growth and FCR

Effects of three hour feed restriction on feed and water intakes, growth performance and FCR are shown in Table 2. There was a statistical trend ($P<0.10$) to reduce the feed intake when birds were deprived of feed for three hours per day during 21-25 d. Thereafter, feed intake values of two feeding regimes were not different. The total feed intake from 21-42 d was also not significantly different between two feeding regimens. When feed was offered after three hours of deprivation, broilers consumed significantly ($P<0.01$) higher amounts of feed (compensatory feed intake) within two hours (from 16:00 to 18:00 h), compared

to the feed intake of *ad libitum* group during the same time period.

Feed restriction did not significantly affect the live weight up to days 25, 30 and 35. However, there was a significant reduction in the live weight ($P<0.05$) on day 42 due to feed restriction. Feed restriction had no significant effect on weight gain until day 30. However, the live weight gain of birds subjected to feed restriction was numerically higher during days 21-25 and 25-30. During the next six days (from 30-35), the effect reversed and birds fed *ad libitum* gained a significantly higher live weight. The positive effect of *ad libitum* feeding on weight gain became highly significant ($P<0.01$) during the last six days. The total live weight gain during 21-42 d was significantly higher ($P<0.05$) when birds were fed *ad libitum* compared to feed restriction. Feed conversion ratio also followed a similar trend. However, in contrast to total weight gain, the total FCR from days 21-42 was significantly lower ($P<0.05$) in *ad libitum* fed broiler males than those on restricted feeding.

Daily water intake and water: Feed ratios were also not significantly affected by the feed restriction. Until day 30, feeding regime had no significant effect on water intake per unit of body weight. From days 30 to 41, *ad libitum* feeding had a significantly lower level of relative values of water intake compared to the feed withdrawal group. Under both feeding strategies, water intake per 100 g of body weight decreased as the birds grew.

Carcass parameters

Effects of *ad libitum* and a daily three hour feed removal from days 21 to 42 on the carcass parameters of broiler chickens are given in Table 3. Weight of the defeathered carcass and eviscerated carcass were not significantly affected by feed restriction. There was a significant increase ($P<0.10$) in the weight of the giblets (liver+heart+gizzard) due to feed restriction. The weight of the intestine was not affected by the feeding regimen, but feed removal significantly reduced the length of the intestine when expressed as mg per 100 g of the eviscerated carcass. Interestingly, the percentage of abdominal fat was reduced ($P<0.10$) due to feed removal. The weight of the carcass ($P<0.05$) and the dressing percentage ($P<0.05$) were also significantly increased by feed withdrawal.

Methodology of the present experiment differs from many restricted feeding experiments reported elsewhere due mainly to three reasons. Firstly, three hours a day feed restriction was mild in severity compared to restrict feeding strategies such as skip a day (Ballay *et al.* 1992; Yu *et al.* 1990; Boa-Amponsem *et al.* 1991) and meal feeding (Su *et al.* 1999; Yu *et al.* 1990; Kuhn *et al.* 1996; Buys *et al.* 1998). Secondly, compared to many restricted feeding studies, this experiment used relatively mature birds from 21-42 d. Thirdly, by giving free access to feed everyday after a period of feed restriction, a kind of compensatory feed ingestion period was permitted.

Around 75% of the total feed intake by the end of the sixth week was consumed during 3 to 6 weeks of age while around 30% of the total intake was consumed during the last week (NRC, 1994). Therefore, it was expected that three hour feed restriction would result in a substantial reduction in total feed intake. Weeks and Davies (1996) found that on average broilers at the end of the production cycle spent 160 minutes per day for feeding. Assuming the feed intake is uniform throughout the day, the feeding time loss due to feed restriction is estimated to be around 20 minutes. Even though the feeds withdrawal for three hours a day reduced the time available for feeding by 12.5%, it reduced the total feed intake only by 1.25%. Therefore, it is evident that birds in restricted feeding group equated their feed intake, particularly after day 26, by consuming a higher amount of feed when feed was re-offered after a three hour feed withdrawal period.

Compensatory feed ingestion capacity of broilers could be as high as 150% of the normal intake in extreme situations. Slight feed intake reduction in feed restricted birds during days 21-25 suggests that compensatory feeding capacity became large enough to equate the feed intake of birds in *ad libitum* group, after day 25. However, it could be reasonably assumed that birds given restricted feed might have consumed higher amount of feed when offered after a period of feed restriction, compared to the birds given *ad libitum* feeding during the same period. However, capacity of the digestive tract and the bowl size might not have been large enough to compensate the amount of feed that could have been consumed had they been fed *ad libitum*. Pinchasov *et al.* (1985) concluded that feed intake of broiler chicks was reduced when fed intermittently due to the low capacity of the digestive tract.

Though the water intake was not significantly affected by the dietary regime, the values for both dietary regimes were higher than the values reported in NRC (1994). However, the water: feed ratio values were within the normal range as recommended by the NRC (1994).

On one hand, hot humid conditions might have increased the water intake. On the other hand, the use of bell shaped drinkers may have over estimated the water intake due to spillage.

Water intake was closely correlated with feed intake and factors that affect the feed intake indirectly influenced the water intake. Even in *ad libitum* group, the intake of feed during that period was around the 30% of the total daily intake. Increased feed intake and reduced water: feed ratio suggest that intake of water does not necessarily follow the

Table 2 Effects of *ad libitum* and restricted feeding on the growth performance of broiler males[1]

	Feeding regime		Level of significance
	Ad libitum feeding	Restricted feeding	
Feed intake (g/bird/d)			
21-25d	127±16	115±6	NS
25-30d	141±10	144±7	NS
30-35d	159±9	162±8	NS
35-42d	163.5±10	168.2±8	NS
Total feed intake (g/bird)	3551±61	3546±28	NS
Live weight (g)			
On day 21	684±26	682±32	NS
On day 25	1095±38	1121±45	NS
On day 30	1586±68	1599±71	NS
On day 35	2160±59	2181±53	NS
On day 42	2372±65	2301±59	*
Weight gain (g/bird)			
21-25d	412±19	437±39	NS
25-30d	478±34	491±43	NS
30-35d	674±41	581±39	*
35-42d	1578±64	1497±37	**
Total weight gain (g/bird)	3143±35	3007±27	*
FCR			
21-25d	1.86±0.8	1.64±0.2	NS
25-30d	1.73±0.9	1.9±0.4	NS
30-35d	1.43±0.7	1.69±0.2	*
35-42d	1.48±0.5	1.69±0.08	*
FCR (21-42 d)	1.51	1.77	*
Water intake (mL/bird/d)			
21-25d	278±16	296±40	NS
25-30d	311±20	338±33	NS
30-35d	391±30	407±22	NS
35-42d	443±43	467±29	NS
Water intake/100 g BW			
21-25d	25±1.4	26±2.5	NS
25-30d	19±1.3	21±1.5	NS
30-35d	13±0.96	15±1.5	*
35-42d	12 ±1	14±1.2	*
Water: feed			
21-25d	2.2±0.2	2.5±0.2	NS
25-30d	2.2±0.1	2.3±0.18	NS
30-35d	2.5±0.18	2.5±0.15	NS
35-42d	2.6±0.2	2.6±0.56	NS

[1] Mean values (mean±SD) of eight replicate pens each having five chickens.
* P<0.05; ** P<0.01; NS: non-significant or P>0.05.

Table 3 Effects of *ad libitum* or three hours a day feed removal from days 21-42 on the carcass traits (mean±SD) of broiler chicken[1]

	Feeding regime		Level of significance
	Ad libitum feeding	Restricted feeding	
De feather carcass weight (g)	2182±32.2	2085±32.5	NS
Empty carcass weight (g)	1705±23.1	1762±26.6	NS
Heart + liver + gizzard (g)	85+21	103±17	NS
Liver + heart + gizzard (%)	5.0±1.5	5.9±0.6	NS
Weight of the small intestine (mg)	183±20	170±20	NS
Relative small intestine length[2]	107.3±10	96.4±6	**
Abdominal fat (g)	40±12	32±10	NS
% of abdominal fat	2.4±0.76	1.8±0.5	NS
Caracas weight	1790±22.9	1866±28.0	**
Dressing (%)	82.5±7.5	89.5±1.1	**

[1] Mean values (mean±SD) of eight replicate pens each having five chickens.
[2] mg/empty carcass weight × 100.
* P<0.05; ** P<0.01; NS: non-significant or P>0.05.

intake of feed. In this experiment, though the intake of feed increased following a feed deprivation, there was no accompanying increase in water intake. It is suggested that the drive for feed after a period of deprivation was stronger than the drive to maintain normal water: feed ratio.

While the feed restriction had a less pronounced effect on feed intake during the early stage, the effects on growth became apparent during the later stages of the experiment; days 35 to 42. The higher live weight gain in *ad libitum* fed birds on day 42, seems to be highly influenced by the significant weight gain achieved during days 35 to 42. Reduction in live weight at the end of the feed restriction period and at the end of the subsequent *ad libitum* feeding period has been reported in many studies (Proudfoot *et al*. 1983; Summers *et al*. 1990; Su *et al*. 1999; Boa-Amponsen *et al*. 1991; Palo and Sell 1995; Pinchasov and Jensen, 1989; Cabel and Waldroup, 1990; Fontana *et al*. 1992).

Since the severity of the feed restriction was milder, birds might have taken relatively a longer period to evoke a growth response. A severe feed restriction (16 h a d) for a longer period (up to 42 d) has made a more pronounced live weight (12.5%) and breast meat yield (16%) losses (Balog *et al*. 2000).

Importantly, the weight loss at the end of this experiment in the feed restriction group was only about 3% compared to the live weight of *ad libitum* group. In line with our findings, even mild restrictions for longer periods such as 10% feed intake reduction from 7 to 49 days (Mollison *et al*. 1984) and 5% feed intake reduction from days 5 to 42 (Urdaneta-Rincon and Leeson, 2002) have also reduced the final live weight of broiler chickens.

The FCR of the birds fed restricted diet was also better during days 35 to 42. Since the feed intake during that period was similar for two feeding regime, increased weight gain during that period was the reason for improved feed efficiency.

Even though the severity of the feed restriction used in this experiment was mild, it lasts for a relatively longer period from days 21 to 42. In general, results of the studies such as Plavnik and Yahav (1998) and Yu and Robinson (1992) suggested that as the span of the feed/nutrient restriction increased the possibility of compensatory growth became low.

It seems that even though the feed intake loss due to feed restriction compensated when re-fed, no such compensation in relation to nutrient digestion/utilization seems to have occurred in the feed restricted group. Corring (1980) reviewed the literature and concluded that when feed restriction was not too severe, the biosynthesis of all digestive enzymes markedly reduced. Later, Zubair and Leeson (1994a) also found that feed restriction had no effect on nutrient digestibility.

Increased weights of liver (Rosebrough *et al*. 1988; Palo and Sell 1995), heart, gizzard (Boa-Amponsen *et al*. 1991) due to restricted feeding have been reported. Though the methodology used in our experiment was quite different from those cited above, we also found that the total weight of the liver, heart and gizzard increased ($P<0.10$) when feed was withdrawn for three hours a day from days 21 to 42. Feed restriction during early stages (from days 7-14 and 11-14) and subsequent *ad libitum* feeding significantly reduced the weights of liver, gizzard and pancreas at the end of the restriction period but were similar at the end of the experiment on day 42 (Palo and Sell, 1995). Palo and Sell (1995) suggested that supply organs such as the digestive tract compared to whole body respond more quickly to *ad libitum* feeding regime after a period of feed restriction. In this experiment there was a trend to reduce live weight at the end of the experiment due to feed restriction. At the same time, there was a trend to have a higher digestive organ weight. These observations suggest that even at the later stage of growth when nutrients are limited, priority is given for the growth of supply organs such as liver, heart and gizzard than to whole body.

Boa-Amponsen *et al*. (1991) found that length of the small intestine in relation to carcass weight increased when broilers were fed at alternate days. In our experiment, the weight of the empty carcass in the restricted feeding group was not significantly reduced, but was numerically higher compared to that of *ad libitum* group. It seems possible that increased small intestinal length they have reported due mainly to a reduction of carcass weight rather than an increase in the absolute length of the small intestine since the carcass weight of the restricted birds in that experiment was 60% of the *ad libitum* group.

Normally, organs such as the liver, heart and gizzard are edible and thus are included in the carcass. Consequently, the weight of the eviscerated carcass ($P<0.05$) and the dressing percentage ($P<0.05$) were also became significantly improved when feed was removed for three hours a day. In contrast, Boa-Ampenson *et al*. (1991) found that carcass weight was reduced when broilers were fed at alternate days. FCR values calculated as the feed required (g) to produce g of eviscerated carcass were 1.35 and 1.43 for feed restriction and *ad libitum* groups, respectively. When edible giblets were included into the carcass and are priced as or above the normal broiler chicken meat, increase in giblet weight, carcass weight and dressing percentage resulting from feed withdrawal will have an economic significance.

The other important carcass trait that altered due to feed restriction was abdominal fat content as a percentage of empty carcass weight. Effects of feed restriction on carcass or abdominal fat are conflicting.

Studies such as Boa-Amponsen *et al*. (1991) and Plavnik and Hurttz, (1985) have reported reduced carcass weight or abdominal fat contents while others have found either increased (Beane *et al*. 1979; Santoso *et al*. 1995) or unchanged carcass or abdominal fat in broilers under restricted feeding strategies (Summer *et al*. 1990; Palo and Sell, 1995). In most cases, reduction in carcass or abdominal fat levels was accompanied with reduction in final live weight of broiler males on feed restriction when compared to their *ad libitum* fed counterparts. In this experiment, there were trends to reduce the final weight as well as abdominal fat contents. On one hand, it may be argued that, had the experiment lasted for some more days, the growth and abdominal fat contents of the restricted birds could have been reduced as found in many restricted feeding studies. On the other hand, the strategy adopted in the present study may be viewed as a compromised mild feed restriction strategy that increases the eviscerated carcass weight with low fat contents. The possible welfare benefits of feed restriction during hot hours of the day are also of study worthy.

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