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EFFECTS OF FEED RESTRICTION DURING STARTER PHASE ON SUBSEQUENT GROWTH PERFORMANCE, DRESSING PERCENTAGE, RELATIVE ORGAN WEIGHTS AND IMMUNE RESPONSE OF BROILERS

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ABSTRACT

Effects of feed restriction during starter phase on subsequent growth performance, dressing percentage, relative organ weights and immune response of broilers were studied. One hundred and twenty day-old (Hubbard) broiler chicks were reared in a group for one week (adaptation period). At day 8 of their age, these chicks were randomly divided into 12 experimental units of 10 chicks each. These units were further allotted randomly to four treatment groups A, B, C and D such that each treatment received three replicates. The chicks in group A were fed *ad libitum* and served as control. Whereas the birds in groups B, C and D were kept on a feed restriction programme of different durations i.e. 1 hr feeding with 3 hrs off, 1 hr feeding with 5 hrs off and 1 hr feeding with 7 hrs off, respectively, from 8^{th} up to 28^{th} day of age. After 28^{th} day of age, all the birds were fed *ad libitum* up to the age of 6 weeks. The birds in group A consumed significantly more feed compared to the birds kept under restricted feeding programme. However, restricted birds utilized their feed more efficiently than controls. The dressing percentage and relative weight of heart, liver, spleen, gizzard, pancreas and intestine remained unaffected due to the treatments. The immune response against Newcastle disease and Infectious Bursal Disease at 30^{th} day of age was found to be low in the feed restricted group.

Key words: Broilers, feed restriction, growth performance, dressing percentage, relative organ weights, immune response.

INTRODUCTION

The diet of an average person in Pakistan is generally composed of cereals and vegetables, which are deficient in protein especially of animal origin (Anonymous, 2005). This adversely affects the general health and mental development of the people. The poor nutritional status is mainly due to inadequate production of good quality food and lack of purchasing power of an average person. Animal protein sources like mutton are very expensive, whereas beef has a limited use due to its high cholesterol contents. Broiler meat, therefore, may help in abridging the gap between supply and demand of animal proteins because it is the quickest and economical source of human food of high biological value.

The efficient and economical broiler production depends upon a number of conditions such as genetic make up of the birds, housing, feeding, disease prevention and marketing of broilers. The success of rearing broilers for maximum weight gain not only depends upon the strain of the birds and management but also on feed quality. It is believed that 70 to 75% of total cost on broiler production is incurred on feed (Mahmood *et al*., 2005). Therefore, any improvement in the performance of broilers due to diet can inevitably have a profound effect on profitability of broiler farming.

Feed restriction in broilers can improve feed efficiency, reduce feed cost and mortality along with the production of quality meat at cheaper rates (Zubair and Leeson, 1996). Moreover, it can reduce the chances of metabolic disorders like ascities syndrome, a common problem in broilers, which otherwise may lead to high mortality and make the enterprise unprofitable (Arce-Menocal *et al*., 1995).

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, dressing percentage and immune response of broilers.

MATERIALS AND METHODS

One hundred and twenty day-old (Hubbard) broiler chicks, purchased from the local market, were reared in a group for one week (adaptation period). At day 8 of their age, these chicks were randomly divided into 12 experimental units of 10 chicks each. These units were further allotted randomly to four treatment groups A, B, C and D, such that each treatment received three replicates. The chicks in group A were fed *ad libitum* and served as control. The birds in groups B, C and D were kept on a feed restriction programme of different durations i.e. 1 hr feeding with 3 hrs off, 1 hr feeding with 5 hrs off and 1 hr feeding with 7 hrs off, respectively, starting from 8th upto 28th day of age. After 28th day of age, all the birds were fed *ad libitum* up to the age of 6 weeks.

The birds were maintained in a thoroughly cleaned and disinfected poultry house. Each replicate was kept in a separate pen measuring 3 x 4 sq.ft. during the experimental period. Saw dust was used as litter material. The birds were kept under similar managemental conditions like space, light, temperature, ventilation and relative humidity up to the age of six weeks. Fresh and clean water was available *ad libitum* during the experimental period. The brooding temperature was maintained at 35°C during the first week of age and was reduced by 2°C/week until it reached 25°C. The birds were fed commercial broiler starter mash up to the age of 4 weeks and thereafter broiler finisher crumbs up to the age of 6 weeks. The birds were also vaccinated according to the schedule mentioned in Table 1.

Table 1: Vaccination schedule of the experimental birds

Age	Vaccine	Route
7 days	Newcastle disease	Intraocular
12 days	Gumboro	Intraocular
20 days	Gumboro	Drinking water
22 days	Newcastle disease	Drinking water
32 days	Gumboro	Drinking water

The data on initial body weight, weekly feed consumption, body weight and mortality, if any, were collected during the trial. The data thus collected were used to calculate weight gain and feed conversion ratio. Blood samples at 30th day of age of two birds from each replicate were collected to study immune response against Newcastle and Gumboro diseases. At the end of experimental period, two birds from each replicate were selected randomly, weighed and slaughtered for their dressed, abdominal fat, heart, gizzard, liver, spleen, pancreas and intestinal weights. The data recorded for different parameters were used to calculate dressing percentage and relative weights (g organ weight/100g body weight) of heart, liver, spleen, gizzard, abdominal fat and pancreas. Cost of production of broilers in each group was calculated on per Kg body weight basis to see the economics of production of the birds for each group.

Statistical analysis

The data thus collected were subjected to statistical analysis using completely randomized design. The differences in the means were compared by least significance difference test (Steel *et al.*, 1997).

RESULTS AND DISCUSSION

The mean values (± SE) 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. The weight gained by the birds in group A (control) was significantly ($P<0.05$) higher than that of the other groups kept under different feeding regimes. The lowest weight gain was observed in the birds of group D, which were kept under one hour feed with seven hours off during 2nd to 4th week of age. However, the weight gain of birds in group B (1-hour feed with 3 hours off) and group C (1- hour feed with 5 hours off) were not statistically different from each other.

These results show that the broilers kept under restricted feeding programme gained less weight than those kept under *ad libitum* feeding. Newcombe *et al.* (1992) and Palo *et al*. (1995) also observed that feed restricted birds gained less weight than full-fed control birds. Similarly, Cabel and Waldroup (1990) reported that feed restriction resulted in reduced weight gain. The probable explanation of the lower body weight in the feed restricted birds may be the decrease in feed intake compared to the *ad libitum* fed birds.

The result of the present study are not in accordance with those of Fontana *et al*. (1992), Zhong *et al.* (1995) and Zubair and Leeson (1996), who observed similar weight gain in feed restricted and *ad libitum* fed birds. However, Ohtani and Leeson (2000) and Lee and Leeson (2001) reported higher weight gain in feed restricted birds than those fed *ad libitum*. Probable explanation of these differences may be the difference in feed restriction schedules used in these studies.

A significant difference was recorded in the feed consumption of birds kept under different feed restriction regimes (Table 2). The birds in group A (control) consumed significantly (P<0.05) more feed compared to the birds kept under restricted feeding. The lowest feed consumption was observed in group D (1-hour feed with 7 hours off) during second, third and fourth weeks of age, which may be due to longer period of feed restriction than those of other feed restricted groups. Mahmood *et al.* (2005) reported that birds subjected to longer period of feed restriction consumed less feed than those in which feed was restricted for shorter period. However, Ohtani and Leeson (2000) reported that feed intake was higher in feed restricted birds than *ad libitum* fed birds. The difference in the results of these studies may be due to the difference in the durations of feed restriction.

A significant (P<0.05) difference among feed conversion values of different groups was observed (Table 2). Birds kept under different feed restriction durations utilized their feed more efficiently than those fed *ad libitum* (group A). Among the feed restricted groups, the best feed conversion ratio was found in the birds of group B (1-hour feed, 3 hours off), followed by group C (1- hour feed, 5 hours off) and group D (1-hour feed, 7 hours off), respectively. Significantly (P<0.05) poor feed utilization was observed in *ad libitum* (group A) fed birds than the feed restricted groups. These results show that birds kept under 1- hour feed with 3 hours off utilized their feed more efficiently than all other groups including control.

These results are in agreement with the earlier findings of Cabel and Waldroup (1990), Newcombe *et al.* (1992), Deanton (1995), Zhong *et al.* (1995) and Lee and Leeson (2001), who observed better feed conversion values in birds kept on restricted feeding compared to *ad libitum* fed birds. Scheideler and Baughman (1993) reported that feed efficiency was not affected in broilers maintained under restricted feeding versus *ad libitum* feeding at 42 days of age. The difference in the results of these studies may be due to differences in the experimental conditions during the conduct of the studies.

Mean values regarding various slaughter characteristics and relative organ weight of the broilers from different treatment groups have been shown in Table 3. Statistical analysis of the data regarding dressing percentage and relative weights (g organ weight/100g body weight) of heart, liver, spleen, gizzard, abdominal fat, pancreas and intestine did not show any difference in the mean values among the treatment groups due to any feed restriction programme when compared to those of control group. Based upon these results, it can be inferred that feed restriction did

Table 2: Mean values of final body weight, weight gain, feed consumption and feed conversion ratio of broilers kept under various feeding regimes at 6 weeks of age

Parameters	Treatments			
	A	**B**	**C**	**D**
Weight of chicks at 8th day (g)	104.6 ± 3.40	106.3 ± 2.66	105.0 ± 2.42	107.3 ± 3.86
Final body weight (g)	1842 ± 77.84	1820 ± 94.52	1820 ± 88.22	1713 ± 93.05
Weight gain (g)	1737[a] ± 9.17	1714[b] ± 11.59	1715[b] ± 19.97	1606[c] ± 23.39
Feed consumed (g)	3816[a] ± 82.38	3392[c] ± 43.00	3482[b] ± 52.85	3380[c] ± 23.50
Feed conversion ratio (g feed/g wt. gain)	2.19[a] ± 0.05	1.97[d] ± 0.02	2.03[c] ± 0.01	2.10[b] ± 0.02

The values in the same row with different superscripts are significantly different (P< 0.05).

Table 3: Mean values of dressing percentage and relative weight of giblets (g/100 g of body wt.) of broilers kept under various feeding regimes at 6 weeks of age

Parameters	Treatments			
	A	**B**	**C**	**D**
Dressing percentage	66.77 ± 3.31	65.31 ± 2.42	65.12 ± 2.99	65.25 ± 2.74
Liver weight	2.40 ± 0.20	2.38 ± 0.21	2.43 ± 0.23	2.46 ± 0.09
Heart weight	0.39 ± 0.04	0.41 ± 0.03	0.40 ± 0.04	0.46 ± 0.05
Gizzard weight	1.46 ± 0.12	1.45 ± 0.03	1.46 ± 0.09	1.48 ± 0.07
Spleen weight	0.10 ± .009	0.13 ± .011	0.11 ± .012	0.12 ± .014
Pancreas weight	0.21 ± 0.026	0.22 ± 0.016	0.24 ± 0.027	0.29 ± 0.028
Abdominal fat weight	1.81 ± 0.15	1.61 ± 0.16	1.42 ± 0.18	1.37 ± 0.09
Intestinal weight	2.79 ± 0.30	2.81 ± 0.20	2.95 ± 0.24	2.99 ± 0.31

The differences in meal values for all parameters among four groups are non-significant (P>0.05).

not exert any adverse effect on the mean values of the dressing characteristics of the broilers. Similar findings have been reported with respect to the effect of feed restriction on the dressing percentage by Azahan (1984) and on liver, heart, spleen and gizzard weights by Mahmood *et al.* (2005).

Average antibody titers against Newcastle disease and Infectious Bursal disease in the birds of four groups are presented in Table 4. The birds kept under feed restriction programme showed lower immune response when compared with those fed *ad libitum*. The lowest value of titer against Newcastle disease was observed in group D (1- hour feed with 7 hours off), followed by group C (1- hour feed with 5 hours off) and group B (1-hour feed with 3 hours off). The best immune response against Newcastle and Infectious Bursal disease was recorded in the birds fed *ad libitum*. This indicates that as the duration of feed restriction was increased, the immune response against Newcastle and Infectious Bursal disease decreased. A probable explanation of the reduced antibody titer against these diseases in the birds kept under the feed restricted programme may be the fact that fasting and stress might have stimulated secretions of corticosteroids, which are powerful inhibitors of immune cell proliferation including that required for the response to a vaccine (Dibner and Knight, 1998). The effects of stress on immune function have also been documented by Siegel (1987), who observed that stress of high temperature depressed the immune function of birds by impeding production of antibodies (Thaxton and Siegel, 1972, 1973) and effective cell-mediated immunity (Zulkifli *et al*., 1997). The phagocytic potential of chicken microphages was also decreased during heat exposure (Miller and Qureshi, 1992). Results of the present study are in line with the findings of Dibner and Knight (1998), who reported that feed restriction retarded the immune system of broilers. The poor immune response of broilers restricted for longer duration may be attributed to the stress due to feed restriction during the experimental period.

Table 4: Antibody titer against Newcastle and Infectious Bursal diseases at 30th day of age in broilers kept under various feeding regimes

Diseases	Treatments			
	A	**B**	**C**	**D**
Newcastle	682.66^{a}	362.66^{b}	37.30^{c}	26.66^{c}
Gumboro	426.66^{a}	170.66^{b}	53.33^{c}	53.33^{c}

The values in the same row with different superscripts are significantly different (P<0.05).

During the entire experimental period, two birds died from control group (fed *ad libitum*) and one from group B (1-hour feeding with 3 hours off). Ascities was the cause depicted after postmortem of the dead birds. No mortality was observed in the feed restricted groups C (1-hour feeding with 5 hours off) and D (1-hour feeding with 7 hours off). It indicates that feed restriction may be helpful to reduce mortality from ascities. Acre-Menocal *et al.* (1995) also observed that *ad libitum* feeding of high energy diet increased the mortality, whereas restricted feeding reduced the mortality significantly.

The total costs of feed of broilers of groups A, B, C and D were Rs. 1482, 1326, 1378 and 1326, respectively (Table 5). The total live weight gains were 52.14, 51.40., 52.34 and 48.18 Kg in the respective groups. As the experiment was conducted at the Poultry Research Centre, University of Agriculture, Faisalabad, the cost of production of broilers per Kg live weight was calculated excluding the cost of labour. Miscellaneous cost summed up as Rs.400/group, which included, cost of electricity, gas, litter, disinfections, vaccination and medication. The results of the study exhibited that feed cost/kg live weight gain was lower in feed restricted birds (Group B, C, and D) than *ad libitum* feeding (Group A) birds.

The broilers were sold on live weight basis at the rate of Rs. 43 per Kg. Thus, the net profit per Kg live weight was Rs. 4.61, 7.09, 6.74 and 4.69 in groups A, B, C and D, respectively. This indicates that the net profit per Kg live weight was higher in the birds kept under feed restricted programme than *ad libitum* fed birds. Among the feed restricted groups, the birds of group B (1 hour feeding with 3 hour off) fetched more profit compared to those of other feed restricted groups (C and D), indicating that reduction in off feed duration resulted in better profit margin.

Based on the findings of the present study, it can be suggested that feed restriction for duration of 1- hour feeding with three hours off during 2nd, 3rd and 4th weeks of age in broilers may help to improve feed utilization than those kept for longer period of feed restriction (1 hour feeding with five hours off and 1 hour feeding with seven hours off during 2nd, 3rd and 4th weeks of age) or those fed *ad libitum*.

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Table 5: The effect of quantitative feed restriction on the economics of production of broilers kept under various feeding regimes

Parameters	Treatments			
	A	B	C	D
Cost of chicks	180	180	180	180
Feed consumed (Kg)	114	102	106	102
Feed price/Kg (Rs)	13.0	13.0	13.0	13.0
Total feed cost (Rs)	1482	1326	1378	1326
Miscellaneous cost (Rs)	340	340	340	340
Total cost (Rs)	2002	1846	1898	1846
Total live weight (Kg)	52.14	51.40	52.34	48.18
Sale price/Kg live weight (Rs)	43.00	43.00	43.00	43.00
Cost/Kg live weight (Rs)	38.39	35.91	36.26	38.31
Profit/Kg live weight (Rs)	4.61	7.09	6.74	4.69

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