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Full Length Article

Production Performance and Leg Abnormalities of Broilers as Affected by Different Feeding Manipulations

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Abstract

Effect of feeding management on production performance of broilers during summer was investigated. Three hundred day-old broiler chicks were reared in a group for one week (adaptation period). At day 8, all the birds were weighed individually and 180 chicks of middleweight range ($\mu \pm 1\sigma$) were selected to be used as experimental birds. The chicks were randomly divided into 18 experimental units (replicates) having 10 chicks each. These replicates were further allotted to six treatment groups (A, B, C, D, E and F) each having three replicates. Three feeding methods i.e., continuous feeding (CF, 24 h feeding), intermittent feeding (IF, 1 h feed and 3 h off) and feed withdrawal (FW, no feed from 9:00 am. to 5:00 pm.) were used. Under each feeding system, birds were fed a ration either without supplemented fat or with 3% supplemented fat. Birds kept under IF system showed significantly ($P<0.05$) lower weight gain, feed consumption and water consumption but better feed utilization than those of continuous fed birds; whereas, the birds kept under FW system showed no difference regarding feed utilization than those kept under CF system. Addition of fat in ration significantly reduced weight gain, feed intake and water consumption of the experimental birds than those fed ration without fat supplementation. However, fat supplemented ration did not show any difference regarding water consumption of the birds than those provided ration without fat supplementation, when they were kept under IF system. IF and FW systems significantly ($P<0.05$) reduced the leg abnormalities (hock burn) of the birds. No mortality was observed in the birds kept under IF system; whereas, 1.66 and 8.30% mortality was found in the birds kept under FW and CF systems, respectively. Mortality was found to be 2.22% in the birds fed fat supplemented ration and 4.44% in the birds fed ration without supplementation of fat. Birds kept under IF system fetched more profit than those kept under FW and CF feeding systems.

Keyword: Weight gain; Feed consumption; Water consumption; Feed conversion ratio; Leg abnormalities; Mortality

Introduction

Broiler production is playing a pivotal role in the provision of affordable animal protein for human consumption in Pakistan. Feed efficiency and survivability of the broilers is a key factor for profitable broiler farming. Significantly better feed efficiency and survivability has been reported due to intermittent lighting (Daghir, 2008) when feeding behavior (feed restriction) of broilers was controlled through light manipulation. Short cycle repeating light regimes (intermittent lighting) such as one hour light and two hours dark (1L: 2D) and (1L: 3D) has shown improve growth, feed conversion ratio and reduce mortality (Lewis *et al.,* 2009). However, control of feeding programs for broilers through lighting can only be performed in environment controlled houses. Whereas, in the developing countries poultry farmers are still rearing broilers in open sided poultry houses where, control of feeding behavior through light manipulation is not possible due to difficulty in the control of natural light in the shed. Hence the farmers are unable to get the optimum productivity which otherwise can be achieved through application of light regimens. Therefore, it can be envisaged that the benefits of feeding management (intermittent feeding) on production performance can be achieved in open sided poultry houses through a specially developed automatic feeding system, instead of controlling feeding regimens through light management as being practiced in environment controlled poultry houses.

Nutritional manipulation through addition of fat in the diet of birds has also been used to address the problem of heat stress in open sided poultry houses, which is the biggest threat for production performance of birds (Wiernusz, 1998; Temim *et al.,* 2000; Daghir, 2008; Özkan *et al.,* 2012). Feed restriction and addition of fat in poultry feed both have been reported to be a better practice to reduce the mortality during hot environmental conditions (Daghir, 2008). However, these practices have never been applied together in a single trial in open sided poultry houses. Keeping in view the importance of feeding management in open sided houses, this study was performed to 1) develop and evaluate a farmer friendly

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automatic feeding system to carry out intermittent feeding in open sided poultry houses; 2) evaluate whether provision of different feeding frequencies through mechanical uplifting of feed have similar effect on the performance of birds as compared to feeding management through lighting manipulation technique and 3) study the effect of feeding systems and addition of fat when birds are kept in open sided houses during hot climatic conditions.

Materials and Methods

This project was executed at the Poultry Research Centre, Department of Poultry Science, University of Agriculture, Faisalabad (Pakistan). Before the start of the trial, mechanical feed uplifting system was fabricated (Fig. 1) to provide desired feeding treatments without the help of lighting programs. For the development of feeding system, conventional feeders were attached with motorized mechanical feed uplifting system, upper and lower limits of feeders were controlled by limit switches. After the completion of mechanical system, an electronic positioner was fabricated and attached with actuator motor to drive the feeder's up- and down-words to a specific position.

Three hundred day-old chicks were purchased from a hatchery and reared in a group for one week (adaptation period). Thereafter, at day 8, all the birds were weighed individually and one hundred eighty chicks of middle-weight range ($\mu \pm 1\sigma$) were selected to be used as experimental birds, whereas, the chicks on both the extremes were discarded. The chicks were randomly divided into eighteen experimental units (replicates) having ten chicks each. These replicates were further allotted to six treatments (A, B, C, D, E and F) i.e. 3 replicates per treatment at random.

Three feeding methods i.e., continuous feeding (CF, 24 hours feeding), intermittent feeding (IF, 1 h feed and 3 h off feed) and feed withdrawal (FW, no feed from 9:00 am to 5:00 pm) were used for the study. Under each feeding system birds were fed a ration either without supplemented fat (0%) or the ration with three percent supplemented fat (3%).

Each experimental unit was reared in a thoroughly cleaned and disinfected pen measuring 3′×4′. The birds were kept under the same managemental conditions like floor space, light, temperature, ventilation and relative humidity. Fresh and clean water was provided *ad libitum* throughout the experimental period.

The data regarding weekly feed consumption and weight gain were recorded to calculate feed conversion ratio in terms of feed consumed per kg of live weight. Special water tanks were developed along with water measuring gauge and were attached to each automatic waterer installed in experimental unit and water consumption was recorded daily. Leg abnormalities in terms of gait scoring were recorded as described by Kestin (1994). The bird's ability to walk was recorded on

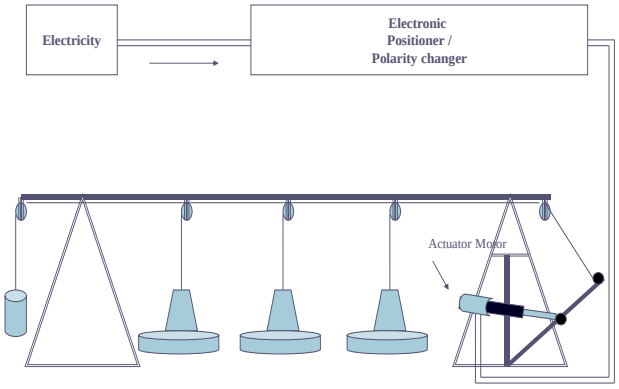

Fig. 1: Automatic feeding system for intermittent feeding

six point scale (0-5) by a panel of judges. Score zero indicated perfect gait, while 5 exhibited the maximum abnormality (no walking at all). Similarly hock burn and foot burn were scored from 0-3. Score zero was taken as no sign of abnormality while 3 was taken as maximum abnormality (Su *et al.*, 1999). Record regarding mortality of experimental birds was maintained in order to find out the death losses under different experimental units and its impact on the economics of the broiler production. The economics of different treatments was also worked out using the prevailing cost of inputs and income received from the sale proceeds.

The data thus collected were analyzed by analysis of variance technique using Completely Randomized Design with 3 × 2 factorial arrangement of treatments (Steel *et al.*, 1997). The differences in means of the treatments were compared by Duncan's Multiple Range test.

Results

The results regarding weight gain, feed consumption, feed conversion ratio and water intake of the birds kept under different feeding systems are shown in Table 1. The birds maintained under intermittent feeding or feed withdrawal system, in general, gained significantly ($P<0.05$) less body weight as compared to the birds using continuous feed during the trial. Fat supplementation in the ration of broilers kept under various feeding methods significantly ($P<0.05$) reduced the body weight gain than those fed ration without supplementation of fat.

Feed consumption of the birds kept under various feeding methods was found to be significantly ($P<0.05$) different. Birds kept under intermittent feeding and feed withdrawal systems consumed 11% and 6% less feed, respectively, than those fed *ad libitum*. The addition of fat significantly reduced (7.22%) the feed consumption of the birds than those fed ration without fat supplementation.

The effect of intermittent feeding on water intake

Table 1: Weight gain (g), feed consumption (g), feed conversion ratio and water intake (ml) of broilers kept under different feeding management practices

Feeding method	Body weight gain/bird	Feed consumed/bird	Feed Conversion Ratio	Water intake/bird
CF	1673.10±25.29^{A}	2958.3±57.47^{A}	1.77±0.024^{A}	7581.80±44.90^{A}
IF	1590.10±19.59^{B}	2634.6±69.34^{C}	1.66±0.024^{B}	6767.95±74.80^{C}
FW	1592.60±33.20^{B}	2788.2±40.58^{B}	1.75±0.029^{A}	7294.30±25.80^{B}
Fat Supplement				
0%	1656.20±22.84^{X}	2898.30±46.13^{X}	1.75±0.022	7297.53±96.50^{X}
3%	1581.10±19.56^{Y}	2689.01±59.79^{Y}	1.70±0.029	7131.80±113.00^{Y}
Interaction				
CF x 0%	1714.80±20.38	3053.30±45.63	1.78±0.026	7668.80±35.40^{a}
CF x 3%	1631.30±32.21	2863.40±73.54	1.76±0.046	7494.70±35.80^{b}
IF x 0%	1624.10±16.46	2771.00±53.64	1.71±0.016	6804.60±37.20^{e}
IF x 3%	1556.20±22.23	2498.10±50.42	1.61±0.012	6731.30±35.60^{e}
FW x 0%	1629.50±54.66	2870.50±08.48	1.77±0.056	7419.20±38.20^{c}
FW x 3%	1555.80±34.15	2705.90±37.32	1.74±0.029	7169.40±36.90^{d}

CF = Continuous feed; IF = Intermittent feed; FW = Feed withdraw

3% = Fat supplementation; 0% = Ration without fat supplementation

Means sharing similar letters in a column are statistically non-significant. Small alphabets are used for interaction mean (a, b), capital alphabets (A, B) for feeding method and (X, Y) for Fat

Table 2: Gait scoring, foot burn and hock burn scoring of broilers kept under different feeding management practices

Feeding Method	Gait Scoring	Foot Burn (L)	Foot Burn (R)	Hock Burn (L)	Hock Burn(R)
CF	1.60±0.147	0.200±0.129	0.083±0.065	1.46±0.25^{A}	1.38±0.39^{A}
IF	1.26±0.081	0.033±0.021	0.017±0.017	0.58±0.17^{B}	0.41±0.11^{B}
FW	1.53±0.143	0.017±0.017	0.017±0.017	0.63±0.06^{B}	0.28±0.03^{B}
Fat Supplement					
0%	1.44±0.115	0.122±0.091	0.056±0.044	0.90±0.25	0.76±0.34
3%	1.49±0.111	0.044±0.018	0.022±0.015	0.88±0.13	0.62±0.12
Interaction					
CF x 0%	1.52±0.299	0.367±0.233	0.167±0.120	1.60±0.52	1.73±0.79
CF x 3%	1.68±0.107	0.033±0.033	0.000±0.000	1.32±0.14	1.02±0.10
IF x 0%	1.18±0.117	0.000±0.000	0.000±0.000	0.40±0.31	0.23±0.15
IF x 3%	1.33±0.117	0.067±0.033	0.033±0.033	0.77±0.15	0.59±0.11
FW x 0%	1.61±0.069	0.000±0.000	0.000±0.000	0.70±0.06	0.30±0.06
FW x 3%	1.45±0.301	0.033±0.033	0.033±0.033	0.57±0.09	0.27±0.03

CF = Continuous feed; IF = Intermittent feed ; FW = Feed withdraw

3% = Fat supplementation; 0% = Ration without fat supplementation ± = standard deviation

Means sharing similar letters in a column are statistically non-significant. Capital alphabets (A, B) are used for feeding methods

L = Left; R = Right

of the birds was more pronounced than feed withdrawal and continuous feeding system. Broilers kept under intermittent feeding consumed less water than those kept under feed withdrawal and continuous feeding system. The birds kept under feed restriction methods showed a significant reduction in water consumption at the same ambient temperature as compared to continuous fed birds. Addition of fat caused reduction in water intake of the experimental birds. The interaction between feeding system and fat supplementation in respect of water consumption was found to be significant ($P<0.05$). The broilers provided fat supplemented ration showed significant decrease in water consumption when they were kept under continuous feeding and feed withdrawal system; whereas, the birds kept under intermittent feeding system did not follow this pattern. Birds kept under intermittent feeding system showed non significant difference in the values of water consumption when they were provided ration either supplemented with fat or without it.

Gait scoring and foot burn of both right and left sides did not show any significant difference due to the treatments (Table 2). However, hock burn of both the sides showed higher values for abnormality in the birds maintained on continuous feeding followed by feed withdrawal and intermittent feeding system. The results of the present study indicated that mechanical uplifting of feed (intermittent feeding) proved to be equally effective in controlling the leg abnormalities as these abnormalities were previously controlled by light manipulation. Addition of fat did not show any effect on leg abnormalities.

Feeding systems exhibited a marked effect on mortality of the birds (Table 3). Mortality rate was higher (8.3%) in the birds kept under continuous feeding as compared to those maintained on feed withdrawal (1.66%) and intermittent feeding system (0%). These birds died during the last week (6^{th} week of age) of experiment at afternoon time and were over sized. Postmortem findings indicated that these birds died as a

Table 3: Mortality (%) and profit (Rs. per kg body weight.) of broilers kept under different feeding management practices

Feeding method	Mortality	Profit
CF	8.30	5.48
IF	0.00	9.10
FW	1.66	6.92
0%	4.44	8.04
3%	2.22	6.26
CF x 0%	10.00	6.55
CF x 3%	6.60	4.41
IF x 0%	0.00	9.74
IF x 3%	0.00	8.39
FW x 0%	3.33	7.85
FW x 3%	0.00	6.00

CF = Continuous feed; IF = Intermittent feed; FW = Feed withdraw
3% = Fat supplementation; 0% = Ration without fat supplementation

result of heat prostration. Addition of fat also exhibited reduced mortality in the broilers than those fed ration with out supplementation of fat. The mortality of birds maintained on fat supplemented ration was 50% less than in their counterparts.

Discussion

The lesser weight gain in the feed restricted birds indicated that mechanical feed uplifting technique applied in this study resulted in reduced weight gain of the broilers compared to those fed continuously. Likewise, fat supplementation in the ration of broilers kept under various feeding methods significantly ($P<0.05$) reduced the body weight gain. This reduction in weight gain may be due to the lower feed intake of the birds using ration supplemented with fat (Crespo and Esteve-Garcia, 2001). However, the reduction in weight gains during summer lead towards better survival and the scientists are of the view that during hot weather, emphasis should been given towards lowering the weight gain and increasing the survivability, instead of effort to enhance body weight which makes the birds more susceptible to heat shock (Daghir, 2008). The results also indicated that reduction in weight gain was more pronounced when feed restriction was conducted along with fat supplementation. This indicates that both the techniques (mechanical feed uplifting and fat supplementation in ration) work together in a similar way and reduced the weight in favor of survival of birds.

In contrast to the present findings, Gonzalez *et al.* (2000) have reported a non-significant effect of feed restriction on the feed intake of birds. The difference in the findings may be either due to the difference in the methods or the duration of feed restriction (Abreu *et al.*, 2011) or both. The contradiction in the results indicated that all the methods of feed restriction did not result into reduced feed intake; whereas, in present study this can be stated that the new technique applied for feed restriction in open sided houses works effectively and may be used for better results of feed restriction in broilers productions. Reduction in feed consumption due to fat supplementation has also been reported earlier (Jaffar *et al.*, 1996; Bryant *et al.*, 2005) due to increase in the energy density of the ration at high ambient temperature.

As found in the current study, efficient feed utilization due to feed restriction has also been observed by Zulkifli and Fauzi (1996); whereas, Sheila *et al.* (1993) did not find any effect of feed restriction on the feed conversion ratio of the birds. In the present study, two different methods of feed restriction were used and both the methods of feed restriction showed different trend for feed utilization. Therefore, it may be concluded that all the methods of feed restriction do not improve feed utilization in a similar fashion. Hence, selection for a right method for a specific climatic condition is important for economical production of broilers. These results also prove the hypothesis that feed efficiency can be improved by providing different frequencies of feed through mechanical up lifting of feed in open sided houses instead lighting manipulation. Furthermore, intermittent feeding (1 h feed: 3 h feed restriction cycles in 24 h) was found to be a better technique for improving feed efficiency as compared to feed withdrawal method (8 h continuous feed restriction/24 h). However, application of intermittent feeding in open sided houses was a difficult task to address. In the present study, implementation of a new technique (mechanizing the feeders to move up words and down words and therefore controlling their placement through electronic timers and limit switches in order to generate different feeding frequencies) made it possible to apply intermittent feeding. The results of new technique in respect of feed efficiency were similar to that of controlling feed through light manipulation. Hence, it can be envisaged that new technology may affectively be applied to achieve better feed efficiency in open sided houses.

Low water consumption in broilers kept under intermittent feeding than those kept under feed withdrawal and continuous feeding system may be due to reduced feed intake of the birds. Moreover, decrease in feed intake may reduce quantity of metabolic wastes as well as reduced body heat increment (Daghir, 2008). Resultantly, less water was required for thermoregulation and for the removal of metabolic wastes. Water intake of the birds increased at high temperature (Khadi *et al.*, 1988; Deyhim and Teeter, 1991), because it works as heat sink and helps in process of evaporative cooling (Wiernusz and Teeter, 1993). These results also favor the hypothesis that intermittent feeding could be a better method of feed restriction if applied in open sided house in order to cope with heat

stress. However, birds followed a normal pattern of water consumption under intermittent feeding due to a reduced stress on thermoregulation and excretion process inside the body of the birds. Therefore, it may be stated that intermittent feeding negated the effect of fat supplementation by lowering down the body temperature to its optimum levels.

Findings of the present study regarding gait scoring and leg abnormalities support Edward and Sorensen (1987) who found reduced growth rate as well as reduced leg abnormalities in broilers kept under intermittent lighting programs. The results of the present study indicated that mechanical uplifting of feed (intermittent feeding) proved to be equally effective in controlling the leg abnormalities as theses abnormalities were previously controlled by light manipulation. Leg abnormalities like gait scoring and hock burn are weight related and their severity increases when body weight cross the limits of 2400 g (Kristensen *et al.,* 2006). Hence, it can be concluded that the technique applied in this study effectively controlled the weight gain and consequently the reduced leg abnormalities even without fat supplementation.

As described above, death of heavy birds (above average) is an indicator that heavy birds are more prone to heat prostration. The situation may further aggravate if combined with *ad libitum* feeding during hot and humid climatic conditions (Wiernusz, 1998; Daghir, 2008). Our findings also support Basilio *et al.* (2001) who observed a decreased mortality due to feed restriction in the birds kept under high environmental temperature. However, in the present study two methods of feed restriction were studied and it was observed that intermittent feeding through mechanical uplifting of feed performed better in controlling the mortality as compared to feed withdrawal method. No mortality in the birds kept under intermittent feeding system suggested that the system helped to alleviate the effect of high ambient temperature during hot and humid environmental conditions.

There was reduced mortality in the broilers fed on fat supplemented rations, which may be due to reduced feed intake, body weight and or lower heat increment of fat supplemented ration. Combined effect of intermittent feeding and fat supplementation reduces mortality down to zero.

Broilers kept under intermittent feeding system gained more profit/kg body weight followed by those kept under feed withdrawal system and continuous feeding system. Increased profit margin in the birds kept under intermittent feeding system and feed withdrawal system than those kept under continuous feeding may be attributed to lower mortality and improved feed utilization of birds kept under feed restriction systems. Addition of fat, however, exhibited a negative effect on the profit margin of the broilers kept under various systems of feeding. Highest profit margin was found in the birds kept under intermittent feeding system and fed ration without fat supplementation. Although birds kept under intermittent feeding and fed fat supplemented ration showed minimum feed consumption/kg weight gain, yet they showed less profit margin than those provided ration without fat supplementation. This may be due to extra expenditure incurred on addition of fat in the ration. Hence, an inference can be drawn that improved feed utilization alone cannot be the only trait for a profitable poultry production but it must be accompanied by a cost effective balanced ration and lowest possible mortality as well.

In conclusion, the mechanical feed uplifting system developed to control feeding cycles effectively controlled the feeding program of the broilers and made it possible to apply intermittent feeding cycles in open sided poultry houses without light manipulation. Hence it can be concluded that the advantages of intermittent feeding in terms of better feed efficiency, low mortality, less leg abnormalities and consequently economical production performance can be achieved by the application of mechanized feed uplifting system in open sided poultry houses. Although the birds showed better production performance when intermittent feeding and fat supplementation techniques were applied together. However, addition of fat was found to be uneconomical due to its additional cost. Therefore, it can be suggested that intermittent feeding without fat supplementation can be effectively applied in open sided houses during hot climatic condition.

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