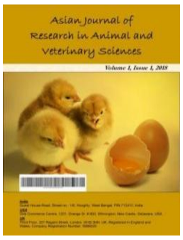

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Evaluation of Feed Restriction on Growth Performance, Haematological Parameters and Carcass Traits of Broiler Chicken

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Authors' contributions

This work was carried out in collaboration between both authors. Author MAHB designed the study, performed the statistical analysis, and wrote the protocol and first draft of the manuscript. Author MZUR managed the analyses of the study. Author MZUR managed the literature searches. Both authors read and approved the final manuscript.

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ABSTRACT

The experiment was conducted at Sher-e-Bangla Agricultural University Poultry Farm for 4 weeks to find out the effect of feed restriction (FR) on growth performance, haematological parameters and carcass traits of broiler chicken. After one week of common brooding, 150 broiler chicks were equally and randomly divided into 5 treatments and each treatment was further sub-divided 3 times consisting of 10 chicks per replicate. The FR of dietary treatments were applied at 4, 7, 10, 13 and 0% (control group) designated as T1, T2, T3, T4 and T5 respectively. The results obtained showed that control groups (fed ad libitum) consumed significantly (P<0.05) the highest feed (2191 g) than those in FR groups. However, the live weight (LW) was significantly (P< 0.05) highest under 4% FR group. The control group significantly (P < 0.05) had the poorest Feed Conversion Ratio (FCR) (1.31), while the best feed efficiency (FE) (1.20) was found in broilers under 13% FR. Cholesterol levels were not affected (P>0.05) significantly by FR application, but significant (P<0.05) difference

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was recorded in case of glucose and haemoglobin values across the FR treated groups. 13% FR group showed the lowest value of glucose (158 mg/dl) than other FR groups and control group. This study revealed that FR decreases blood glucose level, while the blood haemoglobin level was found to be significantly (P<0.05) highest in 10% FR group (15.2 g/dl) and lowest in control group (13.17 g/dl). It was observed that the major haematological parameters of FR were similar compared to the 0% FR group. The Benefit Cost Ratio (BCR) was significantly (P<0.05) affected by FR treatments. The BCR of 4% FR group ranked the best (1.55) followed by 7 and 10% (1.51), 13% (1.50) and control (1.45). In addition, all the FR groups are economically benefited due to lower feed cost than the control group. This study showed that 4% FR would be potentially beneficial for broiler production without compromising the productivity in the local condition of Bangladesh.

Keywords: Broiler chickens; feed restriction; carcass trait; haematology and benefit cost ratio.

1. INTRODUCTION

Poultry farming has emerged as one of the fastest growing agribusiness industries in the world, even in Bangladesh. Research on broiler meat production globally indicates poultry as the fastest growing livestock sector, especially in developing countries. In the poultry industry, feed alone contributes about 65 to 70% of the total cost of production. Broiler bird grows very fast and the more you feed this animal, the more it gains weight [1]. It may be a waste if the weight gain is low after ad libitum feeding. The researchers are making an effort to find the most reasonable ways of reducing the cost of broiler chicken production that are cheap and adequate for broiler meat production. Therefore, like layer chickens, ad libitum feeding to broiler should be regulated to reduce feed wastage and cost of production. There is a competition between man and poultry for cereal grains this has created a problem of shortage of these feed ingredients. It takes about 33 days to gain weight up to the body weight of 2 kg [2]. Unfortunately, this growth rate is accompanied by an increase in body fat deposition, high mortality and high incidence of metabolic diseases and skeletal disorders [3]. Moreover, ascites usually occurred in rapidly growing broiler chickens may lead to carcass condemnation or death [4]. A situation most commonly occurs in broilers that feed ad libitum [5]. Excessive fat deposition, sequel to ad libitum feeding is one of the main problems faced by the broiler producers. This reduces carcass yield and feed efficiency but also causes rejection of the meat by consumers [6] and causes difficulties in the processing of broiler [7]. Thus, the main objectives of this research were to investigate the growth performance, haematological parameters and carcass traits of broiler at certain levels of Feed Restriction (FR). This research will help to reduce fat deposition in broiler meat, as well as saving money and preventing feed wastage.

2. MATERIALS AND METHODS

2.1 Experiment Site

This experiment was conducted at Sher-e-Bangla Agricultural University Poultry Farm, Dhaka. The research project was for one year, but the broiler-rearing period was 28 days and it was conducted between the months of March – April the mean annual rainfall was about 1500 mm; the mean monthly temperature was 30℃, while the mean relative humidity was 88% in the morning (06.00 h) and 55% in the afternoon (15.00 h).

2.2 Experimental Birds and Their Management

A total of 150 day-old broiler chicks (Cobb 500 Strain) purchased from Kazi Hatchery industry were used in this study. There were five treatments 4%, 7%, 10%, 13% and 0% (control group). Each treatment was replicated 3 times. After one week of common brooding, 150 broiler chicks were equally and randomly divided into 5 treatments and each treatment was further sub-divided 3 times consisting of 10 chicks per replicate. This indicated that 30birds were fed per treatment group. All the management procedures were followed according to Cobb 500 management guide. The experimental poultry house was thoroughly cleaned and disinfected before the birds were allocated in the pens. The following are the description of the treatments grouping:-

- Treatment T1= 4% FR
- Treatment T2= 7% FR
- TreatmentT3= 10% FR
- Treatment T4 = 13% FR
- Treatment T5 = (Ad libitum*)* feeding

2.3 Experimental Diets

Starter and grower commercial Kazi broiler feeds were purchased from the market. Feeds were supplied 4 times daily by following the Cobb500 Management Manual and water was also given to birds ad libitum.

2.4 Data Collection and Procedures

The parameters recorded were weekly live weight, weekly feed consumption and mortality of chicks as occurred during the period of the study. FCR was also calculated as a ratio final live weight gain and total feed per bird in each replicate. After slaughter, abdominal fat were measured from each broiler chicken. Abdominal fat was carefully separated from the abdominal region and measured using digital weighing balance. The slaughter was done at 6.00 am and all the birds were fasted overnight 3 birds were slaughtered per replicate. Dressing yield was calculated for each replication to find out dressing percentage. Blood was collected from bird of each replication and haematological parameters were examined and serum bio-chemical test was also done to evaluate the level of glucose and cholesterol.

2.5 Formulae for Calculating Different Parameters

The following formulae were used to find out different parameters-

Feed consumption (g/bird) = (Feed intake in a replicate / No. of live birds in a replicate)

Live weight (g/bird) = (Total live weight in a replicate/ No. of live birds in a replicate)

Feed Conversion Ratio (FCR) = (Feed intake (g)/bird in a replicate/ Weight gain (g)/bird in a replicate)

Mortality (%) = {(No. of death bird in a replicate/ No. of initial birds in a replicate) x100}

2.6 Benefit Cost Ratio (BCR)

The BCR was analysed considering all incomes and expenditures. The expenditures or total cost of production included cost of the chicks, feeds, litter, lime, medicine, vaccine, labour, water bill, and electricity bill. The expenditure per bird was calculated from the total expenditure of each replicate. The total income was calculated from sale value of broiler chicken, feed per bag and cost of litter. Income per bird was calculated from the total income of each replicate.

$$BCR = \frac{\text{Total income}}{\text{Total cost of production}}$$

$$\text{Dressing } \% = \frac{\text{Carcass weight}}{\text{Live weight}} \times 100$$

2.7 Statistical Analysis

Data were analysed using analysis of variance (ANOVA) in a programmed of MSTAT-C statistical package [8]. Where significant differences exist between means of treatment groups were compared and separated using Duncan Multiple Range Test (DMRT).

3. RESULTS AND DISCUSSIONS

The effects of FR on feed consumption, live weight, FCR, abdominal fat, mortality and dressing percentage are shown in Table 2. These parameters were analysed under restricted feeding regimes in order to identify which was potentially more adequate to use under field conditions.

3.1 Feed Consumption (FC)

Feed consumption in different treatment groups of broiler chicken is shown in the Table 2.The FR treatment groups were significantly (P<0.05) affected the feed consumption among different treatments. The control group (T5) fed ad libitum consumed the highest value of feed (2191 g) and T4 (13% FR) consumed the lowest (1972 g) feed compared to other groups. The feed cost (FC) decreased as percent FR was increased. When the feed restriction was occurred the amount of feed per bird was also reduced so the crucial feed cost was lower automatically, but higher value of FC group is not always better for maximum profit in poultry production industry. These can be evaluated using the values of FCR and live weight gain by birds. Therefore, FR may be beneficial to farmers as they may get optimum profit from the reduction of FC through FR. This agreed with work of Chiemela et al. [11] who reported similar findings on feed consumption by birds.

3.2 Live Weight

The results in the Table 2 showed that there were a significant difference (P<0.05) in the final live weight of broiler chickens among the treatments. The result indicated that T1 (4% FR) had significantly (P<0.05) the highest live weight (1765 g) than T2 (7% FR) 1695 g and T4 (13% FR) 1634 g. However, the live weights of T2 and T4 groups different non-significantly (P0.05) from those of T3 1695 g and T5 (control) 1667 g. The higher values of live weight were obtained in 4, 7 and 10% FR groups compared to others having 1765, 1695 and 1670 g respectively. This agreed with report of Jones [12] who explained that the reduced maintenance requirements induced by FR caused the dietary nutrients of a normal ration to be used more efficiently. Summers et al. [13] Lee et al. [14], Leeson and Summers [15] also obtained better growth of broilers compared to birds fed ad libitum. The findings of this study are in agreement with above live weight data. However, Jahanpour et al. [16] conducted an experiment of FR on broiler performance and found dissimilar results. They observed that during the period of restricted feeding the growth rate was less in the birds on a restricted diet than in those fed the full diet.

3.3 Feed Conversion Ratio (FCR)

The FCRs of different treatment groups of broiler chicken is presented in the Table 2. Different FCRs of broiler chicken were affected significantly (P<0.05) by different FR regimes. The values of FCR obtained for T1, T2, T3, T4 and T5 were 1.22, 1.3, 1.21, 1.20 and 1.3 respectively. This indicated that *ad ibitum* fed group (T5) had the worst value of FCR (1.31), while the best FCR value (1.20) was obtained in the FR group T4 (13%). Lower FCR means lower feed needed for obtaining higher amount of feed [17]. This treatment group supported the findings that FR improves feed efficiency than the control group. This is in line with work of Zhong et al. [18] who reported similar finding that feed conversion was better (P<0.05) for feed restricted broiler chickens than full fed birds. Benyi et al. [19] examined the effects of skip-a-day feeding for 14 or 28 days during the starter and grower periods and found a contrary result that feed efficiency was unaffected.

Table 1. Composition and calculated analysis of the control starter, grower and finisher diets

Items%	Starter (7-14 days)	Grower (15-21 days)	Finisher (22-28 days)
Yellow corn, ground(8.5%CP)	64.37	70.40	74.22
Soybean meal (44%CP)	23.08	16.78	12.30
Corn gluten meal (60%CP)	8.56	9.00	10.00
Dicalcium phosphate	1.80	1.70	1.50
Calcium carbonate	0.90	0.85	0.80
Vit. and Min. premix*	0.30	0.30	0.30
Salts (NaCl)	0.30	0.30	0.30
DL–Methionine	0.24	0.20	0.15
L-Lysine HCl	0.45	0.47	0.43
Total	100.0	100.0	100.0
Calculated analysis%**			
Crude protein (CP)	21.50	19.5	18.5
Crude fat	2.84	3.03	3.17
Crude fiber	3.00	3.00	3.00
Calcium	0.90	0.84	0.76
Available phosphorus	0.45	0.42	0.38
Methionine	0.50	0.48	0.50
Methionine+Cystine	0.98	0.89	0.82
Lysine	1.32	1.19	1.05
ME, kCal./Kg	3008.00	3086.00	3167.00

Each 3.0 kg of premix supplies one ton of the diet withVit. A, 12000000 I.U; Vit. D3, 2000000 I.U.; Vit. E, 40 g; Vit. K3, 4 g; Vit. B1, 3 g; Vit. B2, 6 g; Vit.B6, 4 g; Vit.B12, 30mg; Niacin, 30 gm; Biotin, 80 mg; Folic acid, 1.5 g; Pantothenic acid, 12 g; Zn, 70 g; Mn, 70 g; Fe, 40 g; Cu, 10 g; I, 1.5 g; Co, 250 mg; Se, 200 mg; Choline chloride, 350 g and complete to 3.0 Kg by calcium carbonate.
***According to NRCNRP [9] AOAC [10]*

Table 2. Effect of feed restriction (FR) on production performance of broiler chicken

Parameters	Different feed restriction level as treatments							
	T1 (4% FR)	**T2 (7%FR)**	**T 3 (10%FR)**	**T4 (13%FR)**	**T5 (Control)**	**SEM**	**CV%**	**LSD $_{(0.05)}$**
Feed Consumption (g/bird)	2152^{b}	2094^{c}	2031^{d}	1972^{e}	2191^{a}	2.52	0.21	8.22
Live Weight (g/bird)	1765^{a}	1695^{b}	1670^{bc}	1634^{c}	1667^{bc}	10.87	1.12	35.46
Feed Conversion Ratio	1.22^{c}	1.23^{b}	1.21^{d}	1.20^{e}	1.31^{a}	0.0005	1.27	0.0018
Abdominal Fat (g/bird)	23.67^{a}	30.33^{a}	23.33^{a}	20.67^{a}	32.67^{a}	11.39	16.17	37.14^{NS}
Mortality (%)	3.33^{a}	0.00^{a}	3.33^{a}	3.33^{a}	3.33^{a}	2.98	193.65	9.72^{NS}
Dressing Percent	73.10^{a}	72.44^{a}	71.54^{a}	73.43^{a}	72.85^{a}	0.622	1.48	2.031^{NS}
Benefit Cost Ratio (BCR)	1.55^{a}	1.51^{b}	1.51^{b}	1.50^{c}	1.45^{d}	0.0005	1.24	0.001

Means within a row with different superscripts a, b, c, d, e are significantly different (P<0.05)
SEM =Standard Error Mean, LSD =Least Significant Difference
CV=Coefficient of Variation NS=Non Significant

Table 3. Effect of feed restriction on haematological and some bio-chemical parameters of broiler chickens

Parameters	Different feed restriction level as treatments							
	T1(4% FR)	**T2 (7%FR)**	**T 3 (10%FR)**	**T4 (13%FR)**	**T5 (Control)**	**SEM**	**CV%**	**LSD $_{(0.05)}$**
Glucose(mg/dL/bird)	168^{ab}	167^{ab}	175^{ab}	158^{b}	207^{a}	12.94	12.80	42.24
Hemoglobin(g/dL/bird)	13.43^{ab}	14.60^{ab}	15.20^{a}	14.27^{ab}	13.17^{b}	0.57	7.04	1.87
Cholesterol(mg/dL/bird)	215^{a}	241^{a}	217^{a}	190^{a}	219^{a}	20.95	16.75	68.34^{NS}

Means within a row with different superscripts a, b are significantly different (P<0.05)
SEM =Standard Error Mean, LSD =Least Significant Difference
CV=Coefficient of Variation, NS=Not Significant difference

3.4 Abdominal Fat

Table 2 shows no significant difference (P > 0.05) was found in the abdominal fat of broiler chickens of different treatment groups and control group. However, T5 had numerically the highest value (32.67 g) and T4 (13% FR) had thelowest abdominal fat deposition compared to others groups. The highest abdominal fat deposition in the control group showed no significant (P > 0.05) difference followed by the T2 (7% FR), T1 (4% FR), T3 (10% FR) and T4 (13% FR) 32.67 having 30.33, 23.67. 23.33 and 23.67 respectively. Feed restricted broiler chickens had less fat deposition compared to the control group. Thus, a portable broiler chicken should have a well developed muscle prior to slaughter and not contain too much fat as this may subsequently result in a lower weight due to abdominal fat. Jones and Farrel [20] reported that fat storage process and the development of body fat in broilers take place in a two-stage process. The first stage is proliferation rate of fat cells are predominating; later, fat storage becomes more evident until the third week of life, in which fat storage rate becomes dominant. However, in this study after 4 weeks the authors found no significant (P > 0.05) improvement in the fat storage. The possibility to reduce body fat weight by FR thus may be explained by the decreased rate of fat cell proliferation as considered looking at 42-day-old broilers; Kalia et al. [17] did not observe that FR reduced the amount of abdominal fat cells. Benyi et al. [19] examined the effects of skip-a-day feeding for 14 or 28 days during the starter and grower periods and found that abdominal fat were unaffected. In contrast, Zubair [3] showed that, at 42 days of age, lipocyte numbers decreased in the abdominal fat of restricted chicks. Tottori et al. [21] noted that only a short period of FR had an effect on the amount of abdominal fat.

3.5 Mortality

The overall mortality was low and there was no significant difference (P > 0.05) among the treatments and control group. The mortality data of feed restricted treatment T1, T3, T4 and T5 (control) groups were similar (3.33%). This mortality was found due to the hot and humid climatic condition in Bangladesh and some mangemental problem may also the cause of this result of mortality, but no mortality was recorded in T2. The result is similar with Aerts et al. [22] they also find out that FR programs reduced mortality. These findings are consistent with those of Leeson and Summers [15] Lippens et al. [23], but contrasted those of Gonzales et al. [24] and Teimouri et al. [25], who reported a higher rate of mortality. However, all these authors used only mildly restricted rations. The level of the reduction of mortality by metabolic diseases seems to depend on the level and duration of the FR program applied [15].

3.6 Dressing Percentage

The dressing percent of broiler chickens is presented in Table 2 and was not significantly (P > 0.05) affected by either FR or full feeding, but the overall dressing percentages was higher across the trestment groups. The dressing percent were 73.10, 72.44, 71.54, 73.43, and 72.85% for treatment groups T1, T2, T3, T4and T5 (control group) respectively.

Some research findings that are alike with the present study stated below.

Ramlah et al. [26] concluded that there was no effect on dressing percentage due to early FR in broilers. The effect of different restriction feeding programs was studied by Cristofori et al. [27] concluded that broilers subjected to FR by daily amount to satisfy their metabolic requirements in early stage from 7 to 21 days showed the best carcass visual scores. The effect of three feeding levels (control, 15% and 30% below ad libitum) during 7 to 14 days of age on male and female broiler performance was demonstrated by Shariatmadari and Torshizi [28] and found that FR had no effect on carcass components and there was no difference between carcass components of male and females. Saleh et al. [29] studies on broilers subjected to FR by 20, 30 or 40% of the fully fed group on day 8, 9, 12 and 13 followed by ad libitum feeding and found that the dressing percentage of most severely restricted groups was higher than that of corresponding controls.

3.7 Benefit Cost Ratio (BCR)

Benefit Cost Ratio of different treatment groups was presented in Table 2. The BCR was affected significantly (P<0.05) by FR. T1 (4% FR) group had (1.55) considering the economic benefit followed by T2 (1.51), T3 (1.51), T4 (150) and T5 (1.45). This study revealed that all FR groups were economically beneficial than the control group because when FR was done, the amount of feed was lower compare to control group. This means feed cost was lowered by FR method.

Additionally, maximum level of FR should be considered at the 13% FR (T4), the BCR value was closed to the control group, while those of T2 (7% FR) and T3 (10% FR) were also similar. The BCR value was almost similar among the groups that's why FR is more beneficiary compare to control group because feed cost was lower and cost of production also lower. However, in this study, 4% FR is more convenient and cost effective for broiler rearing in Bangladesh because its live weight was best and highest BCR. Zhan et al. [30] also obtained a maximum profit from FR in chicken and he also suggested that early FR of birds and later returned to ad libitum gave higher profit.

The results on hematology and some serum parameters are presented in Table 3. The blood glucose, hemoglobin and cholesterol of broiler chicken were evaluated and analysed in response to FR treatments.

3.8 Glucose

There was a significant difference (P<0.05) in the blood glucose level among the feed restricted and control groups. The blood glucose level was found to be highest (207 mg/dl/bird) in T5 (control) group and lowest in T4 (13% FR) (158 mg/dl/bird).This findings were indicate that higher amount feed consumption enhance the blood glucose level. Although, T5 different non-significantly (P > 0.05) from T1 (168 mg/dl/bird), T2 (167 mg/dl/bird), and T3 (175 mg/dl/bird), however, the trend of the values declined graduallyThe values decreased at 41 days of age in broilers fed ad libitum compared to those restricted for 4hrs per day from 7 to 21 day and fed ad libitum [31]. This results are contradictory the reasons may be the FR length, in this study FR was implemented for all the time and age was only 28 days.

3.9 Hemoglobin

Table 3 shows the hemoglobin values of different feed restricted groups of broiler chickens. The results revealed that FR at 10% (T3) significantly (P<0.05) increased the hemoglobin level (15.20 g/dl/bird) than control group (T5) which had the lowest level (13.17g/dl/bird). However, the hemoglobin levels of both T3 and T5 groups were non-significantly (P>0.05) different from T1 (13.43 g/dL/bird), T2 (14.60 g/dl/bird) and T4 (14.27 g/dl/bird) feed restricted groups. Feed restriction may be help to produce more hemoglobin compare to the control one.

Oyawoye and Krueger [32] found significant effect (P<0.05) of FR on hemoglobin content of broiler chickens. However, Wideman conducted an experiment on broiler chickens and showed that FR in broiler chicks have no significant effect (P>0.05) on the hemoglobin content. Here, both the findings of the above two authors supported the results of this present experiment. Both the experiment partially support to the present study because the hemoglobin results indicate significant difference in 10% FR group and nonsignificant results were found among the rest.

3.10 Cholesterol

The results on cholesterol is presented in Table 3 that the cholesterol values varied from T4 (190 mg/dl/bird) to T2 (241 mg/dl/bird). No significant difference (P>0.05) was observed in blood cholesterol level between the feed restricted treatments and control group. Both the highest and lowest cholesterol values were found in the feed restricted groups than control group.

However, a contrary trend was observed in the plasma cholesterol by Wideman [33]. Feed restriction significantly (P<0.05) decreased plasma cholesterol by 3.2 %. The present study showed no difference of plasma cholesterol, this result was found may be due to hot climate that force to eat more feed that helps to improve cholesterol level and effects of dietary feeds.

4. CONCLUSION AND RECOMMENDATIONS

Based on this study, it was concluded that, globally, a slight feeding restriction (FR), namely 4% FR, is slightly beneficial in economical terms, without impairing the other biological characteristics of broiler chickens. Indeed, a roughly 6% higher Benefit Cost Ratio (BCR) was observed by comparison to feeding *ad libitum*. So, 4% feed restriction would be potentially beneficial and more convenient for broiler production in Bangladesh local conditions.

ETHICAL APPROVAL AND CONSENT

The article does not contain any studies with human subjects performed by the authors. The University's Animal Ethics Committee approved the experiment.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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