# Effect of Feed Restriction on Carcass Yield and Meat Quality Characteristics of Broiler Chicken

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**Abstract**

Ninety six unsexed three weeks old Vencob strain broiler chicks were randomly allocated to four experimental treatments. Each group included three replicates of eight chicks. Chicks in the first group ($T_1$) were fed ad libitum while those in the second ($T_2$), third ($T_3$) and fourth ($T_4$) groups were fasted 4, 6 and 8 h day$^{-1}$, respectively during experimental period, i.e. 4-6 weeks of age in a completely randomized design to evaluate the effect on growth performance, meat quality and proximate composition of broiler chicken. During the first three weeks of age, chicks were fed ad libitum a commercial starter diet with 21.94% crude protein (CP) and 2,785 KCal kg$^{-1}$ metabolizable energy (ME), however, from 4 to 6 weeks of age, chicks were fed a commercial grower diet with 19.43% CP and 2,874 KCal kg$^{-1}$ ME. The result revealed that feed deprivation for 4, 6 or 8 h day$^{-1}$ decreased body weight of broiler chicks compared to those fed ad libitum at the end of the experiment. Feed restriction had significant effect on dressing percentage, primal cut-up-parts and relative weights of giblets (gizzard, heart and liver) and small intestine among the experimental birds. Insignificant difference was observed among the treatments in neck and wings weight gain. The pH of the thigh and breast meat of control group was significantly higher than treatment groups. However, among the different treatment groups, insignificant value was observed in water holding capacity. $T_3$ group of broiler showed lowest fiber diameter but highest tenderness scores. In respect to proximate composition, breast and thigh meat from feed-deprived groups exhibited most desirable characteristics in terms of lower fat and higher protein contents.

## 1. Introduction

Poultry production can play an important role in poverty alleviation and in the supply of quality protein to rural people. The high demand for chicken meat, low capital input required, early market age, rapid return over invested capital and the small space required for poultry production have increased awareness that chicken farming is a profitable venture in all over the world. Allowing birds an unlimited supply of feed results in consumption in excess of the requirements for maintenance and production and the excess energy is converted into fat (Fontana et al., 1992). Excessive fat is one of the main problems faced by the broiler industry these days, since it not only reduces carcass yield and feed efficiency but also causes rejection of the meat by consumers because of health related problem facing by human (Zubair and Leeson, 1996). Recent reports on feed restriction during growing period in broiler chickens indicate that restricting feed intake lowers body weight and carcass fat and improves feed efficiency with compensatory growth during re-feeding (Plavnik et al., 1986; Fontana et al., 1992; Al-Taleb, 2003). However, contradictory result has also reported (Leeson et al., 1991), as broiler chickens undergoing compensatory growth exhibit greater than normal feed intake relative to body weight , and may exhibit some associated digestive adaptations (Zubair and Leeson, 1994) . Use of this concept to address problems of high carcass fat requires more studies on the nutrition of the broiler chicken during the period of growth compensation. Various methods of under-nutrition have been used to retard or even stop growth during the restriction period. These methods include physical feed restriction, limiting the level of consumption of feed in time (skip-a-day feeding) or reducing the hours of illumination of feeding diet dilution, chemical methods of feed restriction and use of low protein or low energy diets. But information on the effects of daily feed withdrawal on broiler performance is limited. Petek (2000) and Ozkan et al. (2003) reported that daily feed

deprivation for 3, 4 and 6 h significantly reduced final body weight and at the same time had insignificant effects on feed intake, feed efficiency and carcass characteristics. Onbasilar et al. (2000) also observed that 4 h daily feed restriction had no significant effects on body weight, feed intake, feed efficiency, and carcass characteristics. In addition Demir et al. (2004) and Khetani et al. (2008) reported that even 8 and 16 h daily feed restriction had no significant effects on the same traits. The previous researchers illustrated quantitative feed restriction by feeding amount of a balanced diet cannot be repeated under practical conditions, since the body weight and weight gain of broiler chicks and consequently their feed requirements at the same age are strongly variable and also the distribution of the daily rations is laborious and inaccurate. Therefore, the present study was carried out to evaluate the effect of feed restriction on carcass characteristics of broiler chicks.

## 2. Materials and Methods

A total of ninety six (96) unsexed three weeks old Vencobb strain of broiler chicks were selected randomly on the basis of uniform body weight and were distributed in 4 groups consisting 24 birds each group. The experimental groups were control group ($T_1$) having ad libitum feeding for 24 h, $T_2$ having 4 h feed restriction, $T_3$ having 6 h feed restriction and $T_4$ having 8 h feed restriction in a day; and each group consisting of three replicates having eight birds in each replicate. Space for feeding (4 cm) and watering (1.5 cm) bird$^{-1}$ was remained same for all groups. Birds were fed standard rations, i.e. starter diet containing 21.94% crude protein (CP) and 2,785 KCal kg$^{-1}$ metabolizable energy (ME) from 1 to 3 weeks and from 4 to 6 weeks of age they were fed a commercial finisher diet containing 19.43% CP and 2,874 KCal kg$^{-1}$ ME and provided continuous sunlight during day time and electric bulbs during night time until the end of the experiment (6$^{th}$ week). The live weight of individual bird was recorded at first day and end of the growth and performance study. Four birds from each replicate were randomly selected, fasted for 12 h to empty their crops and slaughtered as per standard method. The giblets (heart, liver and gizzard) and small intestine were carefully collected and weighed. The weight of carcass was taken to determine dressed weight. Then a cut was made below the keel bone to separate the viscera. After removal of the viscera, the weight of carcass was taken to determine eviscerated weight. Inedible offals like spleen, lungs, trachea, esophagus and genital tract were disposed off. Two carcasses from each replicate were randomly selected for determination of various primal cuts namely breast, back, thigh, drum stick, wings and neck. The breast and thigh muscles were collected in low density polyethylene (LDPE) bags stored at 4°C for analysis of water holding capacity (WHC) (Wardlaw et al., 1973), pH (Trout et al., 1992), fiber diameter (FD) and tenderness. For tenderness determination, cooked meat chunks were served to semi-trained taste panel members for evaluation using 9-point descriptive scale (Keeton, 1983), where '9' indicates extremely tender and '1' indicates extremely tough. The proximate composition (moisture, CP, ether extract and total ash was determined following the procedure of AOAC (2007). Statistical analysis was performed using statistical software packages following the procedure of Snedecor and Cochran (1994). All data were analyzed by one-way analysis of variance and critical differences among the treatments were analyzed by employing Duncan's Multiple Range Test (DMRT).

## 3. Results and Discussion

### *3.1. Effect of feed restriction on carcass traits of broiler chicken*

The result of feed restriction indicated negative effect on the growth performance of broiler chickens (Table 1).

The live weight of broiler chicken was highest in $T_1$ (control) group followed by $T_3$, $T_2$ and $T_4$ groups. The difference in live weight among $T_1$ and $T_3$ was not statistically significant. Results of numerous researches indicated similar observation on final body mass of broiler chickens (Proudfoot et al., 1982; Mahamood et al., 2007). But liver weight under $T_2$ was found to be higher ($p$<0.01) than $T_1$, $T_3$ and $T_4$ groups. The analysis also indicated that difference in liver weight was highly significant among feed restriction treatments at ($p$<0.01) level of significance. Pinchasove et al. (1985) found that intermittent feeding was accompanied by a consistent increase in the relative weight of the liver. But this result is not in consistent with the observation of Susbilla et al. (1994) and Jones (1995) who reported a non-significant difference in relative weights of liver at slaughter due to the feeding regimes. The mean gizzard weight of broiler birds in different feed restricted groups showed that it was highest ($p$<0.01) in birds under $T_4$ feed restriction followed by $T_3$, $T_1$ and $T_2$, respectively. Plavink and Hurwitz (1983) and Katanbaf et al. (1989) also obtained a significant increase in gizzard weight following feed restriction, though Mahamood et al. (2007) found no significant difference in gizzard weight among the treatments. However, the heart weight was significantly highest ($p$<0.01) in control and $T_2$ group and lowest in $T_3$ group. The present finding is in agreement with the observation of Onbasilar et al. (2009) but contradicted with the findings of Mahamood et al. (2007) who reported relative weight of heart remained unaffected due to feed restriction. Weight of small intestine was significantly ($p$<0.01) highest in $T_4$ and lowest in $T_3$ group for which no plausible justification could be found from available literature to favor or disfavor. The eviscerated carcass weight of these

Table 1: Effect of feed restriction on the carcass components of broiler chickens

| Parameter (weight in g) | Treatment | | | | *p*-value |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | |
| Live weight | 1793.62±1.13[a] | 1783.75±1.53[b] | 1789.93±1.45[a] | 1769.44±1.45[c] | ** |
| Liver | 64.58±0.18[b] | 65.83±0.29[a] | 62.56±0.34[b] | 64.29±0.29[b] | ** |
| Gizzard | 68.03±0.28[b] | 66.99±0.39[c] | 68.51±0.18[b] | 69.82±0.21[a] | ** |
| Heart | 17.91± 0.17[a] | 18.18±0.28[a] | 15.27±0.29[a] | 16.50±0.26[b] | ** |
| Intestine | 98.83±0.41[c] | 100.55±0.31[b] | 96.54±0.26[d] | 105.01±0.13[a] | ** |
| Eviscerated carcass | 1173.99±4.52[a] | 1168.82±2.40[ab] | 1171.72±2.45[a] | 1159.91±2.91[b] | ** |
| Dressing percentage | 69.87±0.27[a] | 67.84±0.28a[b] | 67.39±1.52[b] | 67.10±0.014[b] | ** |
| Neck | 153.11±0.38[a] | 154.64±0.27[a] | 153.88±0.03[a] | 153.75±0.03[a] | NS |
| Wing | 212.89±0.28[a] | 211.78±0.21[a] | 212.80±0.36[a] | 211.65±0.36[a] | NS |
| Back | 324.23±0.30[a] | 324.51±0.26[a] | 316.67±0.39[b] | 315.60±0.26[b] | ** |
| Breast | 398.36±0.42[b] | 401.14±0.26[a] | 398.64±0.95[b] | 392.05±0.39[c] | ** |
| Drumstick | 231.01±0.40[a] | 234.80±0.36[a] | 222.61±0.78[b] | 218.96±0.40[b] | * |
| Thigh | 304.37±0.25[a] | 299.76±0.37[b] | 299.63±0.36[b] | 298.85±0.37[b] | ** |

[a-d]Mean with similar superscripts (row-wise) did not differ significantly *Significant at ($p$<0.05) **Significant at ($p$<0.01)
[NS]=Non-significant

broiler birds were almost similar in groups with control, $T_2$ and $T_3$ group, whereas birds under $T_4$ group had significantly lower ($p$<0.01) eviscerated carcass weight. In regards to dressing percentage, highest performance was recorded for the $T_1$ and $T_2$ groups. Contradictory result was obtained by Mahamood et al. (2007) who reported feed restriction had no effect on dressing percentage of broiler chickens. It was found from the present study that feed restriction had no significant effect on neck and wings weight gain. Similar observation was reported by Novel et al. (2009). The back weight showed sporadic result. Yield of breast, drumstick and thigh also showed significantly ($p$<0.01) highest in $T_1$ and $T_2$ and lowest in $T_4$ group. The present finding was in agreement with the finding of Undaneta et al. (2002) who observed that breast meat yield at 42 days was less in broilers subject to mild feed restriction. However, better development of hind limbs expressed in short term feed restricted birds and birds fed ad libitum adequately increased the share of thighs and drumsticks. Similar results were obtained by Novel et al. (2009), whereas, others denied the presence of significant effect of feed restriction on yield of thigh and drumstick.

### *3.2. Effect on meat quality*

Table 2 shows that pH of breast muscle was highest in $T_1$ followed by $T_4$, $T_2$ and $T_3$, respectively. Similar findings also observed for the pH of thigh muscle. However, this observation on pH of breast and thigh muscle was not in agreement with observation of Reddy et al. (1979). While considering the water holding capacity the result showed statistically insignificant result among the treatments in both breast and thigh muscle. Both the thigh and breast muscle exhibited lowest and highest values in terms of fiber diameter and tenderness scores for $T_3$ group. The present result is consistent with the findings of Proudfoot et al. (1981) who reported that restricting daily feeding time gave more grade-A carcass. When muscles of breast and thigh were compared, in both cases of fiber diameter and tenderness, breast muscle had less fiber diameter but better tenderness scores than thigh muscle.

### *3.3. Effect on proximate composition*

The proximate composition of broiler meat indicated that the moisture (%) in different feeding regiment differed among all the groups for both thigh and breast muscles but the difference between $T_3$ and $T_4$ group for thigh muscle was not found to be significant ($p$<0.01). It was evident that moisture (%) was highest in $T_2$ for thigh and in $T_4$ group for breast muscle. The protein fraction in four different feed restrictions was found statistically different ($p$<0.01). The $T_1$ and $T_3$ had higher protein (%) for thigh and breast meat, respectively and the mean value of protein showed higher protein (%) in thigh muscles in comparison to that of breast muscle. The fat (%) of meat of $T_1$ was highest and lowest in $T_4$ group for both thigh and breast muscle. It indicates that higher level of feed restriction decreased abdominal fat. This observation was in agreement with the findings of Plavnik and Hurwitz (1985) and Jones and Farrel (1992) who stated that body fat was depressed when chickens were exposed to feed restriction. The abdominal fat was negatively correlated with live weight, carcass weight

Table 2: Effect of feed restriction on thigh and breast meat quality and proximate composition of broiler chickens

| Parameters | Treatments | | | | *p*-value |
|---|---|---|---|---|---|
| | $T_1$ | $T_2$ | $T_3$ | $T_4$ | |
| pH | | | | | |
| Thigh | 6.48 ± 0.07[a] | 6.28±0.02[b] | 6.20±0.01[b] | 6.20±0.06[b] | ** |
| Breast | 6.57±0.07[a] | 6.32±0.01[b] | 6.23±0.02[c] | 6.42±0.06[b] | ** |
| Water holding capacity (%) | | | | | |
| Thigh | 49.43±1.50[a] | 50.50±0.10[a] | 45.38±0.08[b] | 50.63±0.09[a] | NS |
| Breast | 42.77±1.23[a] | 41.60±0.12[ab] | 39.40±0.09[b] | 40.50±0.11[ab] | NS |
| Fiber diameter (µm) | | | | | |
| Thigh | 3.75±0.02[a] | 3.83±0.01[a] | 3.87±0.01[a] | 3.10±0.01[b] | ** |
| Breast | 3.27±0.01[c] | 3.62±0.02[a] | 3.66±0.01[a] | 3.40±0.07[b] | ** |
| Tenderness† | | | | | |
| Thigh | 76.83±0.02[b] | 78.17±0.01[a] | 72.19±0.01[c] | 72.08±0.21[c] | ** |
| Breast | 75.62±0.01[b] | 75.29±0.0[c] | 74.53±0.01[d] | 76.21±0.07[a] | ** |
| Moisture (%) | | | | | |
| Thigh | 76.83±0.02[b] | 78.17±0.01[a] | 72.19±0.01[c] | 72.08±0.21[c] | ** |
| Breast | 75.62±0.01[b] | 75.29±0.0[c] | 74.53±0.01[d] | 76.21±0.07[a] | ** |
| Protein (%) | | | | | |
| Thigh | 22.40±0.10[a] | 21.43±0.01[c] | 22.18±0.02[b] | 21.46±0.08[c] | ** |
| Breast | 19.80±0.10[c] | 20.19±0.01[b] | 21.64±0.01[a] | 20.19±0.05[b] | ** |
| Fat (%) | | | | | |
| Thigh | 2.68±0.01[a] | 2.68±0.07[a] | 2.64±0.01[a] | 2.42±0.01[b] | ** |
| Breast | 2.54±0.08[a] | 2.53±0.01[a] | 2.45±0.01[a] | 2.30±0.01[b] | ** |
| Ash (%) | | | | | |
| Thigh | 1.22±0.05[ab] | 1.21±0.01[ab] | 1.27±0.01[a] | 1.15±0.01[b] | * |
| Breast | 1.26±0.01[b] | 1.12±0.01[c] | 1.53±0.01[a] | 1.19±0.05[bc] | * |

[a-d]Mean with similar superscripts (row-wise) did not differ significantly *Significant at ($p$<0.05) **Significant at ($p$<0.01)
NS=Non-significant †Based on 9-point descriptive scale, where 9=Extremely tender and 1=Extremely tough

and breast muscle weight. The total ash of breast and thigh muscle was highest in $T_3$ for both thigh and breast muscle followed by $T_1$, $T_2$ and $T_4$. The differences among the different group were found to be significant ($p$<0.05) for breast and thigh muscles.

## 4. Conclusion

Based on the findings of the present study, it can be suggested that feed deprivation has a negative effect on body weight, cut up parts, dressing percentage but positive effect on meat quality and proximate composition of broiler chicken meat. However, additional experimental studies need to be conducted on meat quality parameters with more number of birds before giving final recommendation on duration of feed restriction for broiler birds.

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