ISSN: 2456-2912
VET 2023; SP-8(4): 86-89
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www.veterinarypaper.com
Received: 27-04-2023
Accepted: 31-05-2023

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On farm evaluation of phase feeding on the growth performance and carcass characteristics of broiler chickens

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Abstract
An on-farm experiment was designed to examine the impact of varied feeding frequencies on the growth performance and carcass characteristics of broiler chicks. Four hundred day-old broiler chicks were allocated randomly in a completely randomized arrangement to four treatment groups T_1, T_2, T_3, and T_4 where feeding frequencies for these groups were set at four times, three times, two times, and one time per day, respectively. All chicks were exclusively provided with a commercially formulated balanced broiler diet throughout the study. Results indicated that the best feed intake was achieved among birds subjected to the feeding regime of T_4. In terms of Feed Conversion Ratio (FCR), T_1 and T_2 exhibited significantly improved performance compared to the other groups. Notably, the analysis of carcass attributes revealed that T_2 had notably reduced abdominal fat content ($p<0.05$) when compared to the control group. Additionally, blood analyses highlighted that levels of cholesterol, LDL, and HDL were significantly better in T_1 and T_2 compared to the remaining groups. The findings collectively suggest that providing broiler chicks with three feedings spaced at equal intervals leads to improved meat quality attributes, concurrently lowering abdominal fat levels without compromising chick growth progress.

Keywords: FCR, broiler, carcass characteristics, phase feeding

1. Introduction
The meat industry plays a vital role in driving the livestock economy of the country, with a significant portion contributed by the poultry sector, accounting for approximately 40% of the overall meat industry. Poultry meat, particularly chicken, holds a distinct position due to its affordability compared to other animal-derived products. This affordability has led to its widespread consumption as a primary source of animal protein in the daily diets of average Indians. The sustainable and profitable growth of the broiler industry hinges on factors such as enhanced growth rates, efficient feed utilization, and maintaining bird health [1]. Notably, more than 65% of the total expenses in broiler husbandry are attributed to feed costs [2]. Consequently, ensuring optimal feeding efficiency for chicks becomes a pivotal determinant for the successful operation of broiler businesses. In contemporary broiler strains, the meat typically contains around 15% - 20% fat, a considerable portion of which, approximately 85%, is deemed non-essential for physiological functions. During carcass processing, a portion of this accumulated fat is removed, resulting in decreased yields [3]. The control of various nutritional aspects in the broiler diet plays a role in managing internal fat deposition [4]. To achieve this, feed restriction programs can be implemented either through providing access to less nutrient-dense diets (qualitative restriction) or by precisely regulating the daily supplied feed (quantitative restriction). Implementing feed restriction strategies in broiler production contributes to mitigating health issues in the birds. However, its effectiveness remains a subject of debate due to varying outcomes related to final live body weight, feed conversion ratio, and abdominal fat accumulation [5]. These discrepancies can be attributed to the diversity in feeding strategies that have been employed. Ultimately, the feeding regimen adopted in the broiler diet holds paramount significance in the industry, as it influences the production of high-quality broiler chicken meat that aligns with consumer expectations. Thus, an experiment was designed to evaluate the impact of timed restriction on the total daily feed intake in terms of its effects on growth performance, internal fat accumulation, and carcass characteristics of broiler chicks.

2. Material and Methods

2.1 Bird Selection and Experimental Design

Four hundred day-old Cobb-400 broiler chicks were chosen randomly and distributed across four treatment groups denoted as T_1, T_2, T_3, and T_4. A Complete Randomized Design (CRD) was employed, with each treatment having four replications consisting of 25 birds per replication. In T_1, feed was administered four times a day, in T_2 three times, in T_3 twice at equal intervals, while T_4 was designated as the control with feed given only once daily. The quantity and quality of feed provided were uniform across all treatment groups. Daily feed allowances followed the recommendations outlined in the Venky's India Limited broiler management manual. Standard commercial broiler starter (From D 1 to D 21) and finisher (from d 22 until slaughter) feeds were given, and water was made available ad libitum. Standard management practices were maintained consistently across all treatments until the point of slaughter.

2.2 Data Collection and Calculations

Feed intake was measured daily over the six-week study duration by recording both given and remaining feed per pen. Weekly recordings of body weight were conducted, and weight gain and feed conversion ratio (FCR) were calculated accordingly. At slaughter, live body weight and carcass weight were measured to determine the dressing percentage. The weights of internal organs including heart, gizzard, liver, pancreas, caeca, and small intestine were also recorded as percentages of the carcass weight. Abdominal fat weight was measured and analyzed for any noteworthy differences among the treatments.

During slaughter, blood samples were collected from four randomly chosen birds representing each replication. Serum was promptly extracted from the samples and stored at -20 °C till further analysis. Serum samples from each replication were assessed for total cholesterol, high-density lipoproteins (HDL), triglycerides (TAG), and low-density lipoproteins (LDL) using a spectrophotometer, following the manufacturer's guidelines.

2.3 Data Analysis

Growth performance, feed consumption, carcass yield, and serum lipid profile data were subjected to analysis using the Analysis of Variance (ANOVA) procedure in SPSS 2016. Differences among treatments were considered significant at a 5% level based on Duncan's multiple range tests [6].

3. Results and Discussion

3.1 Growth performance of broiler chicks

The impact of feeding frequency on the growth performance of broiler chickens is presented in Table 1. Throughout the study period, the weight gain of the birds showed no significant differences among the treatment groups. Numerically, the highest weight gain was observed in T_2, followed by T_1, T_4, and T_3. The increased weight gain in the groups with more frequent feedings could be attributed to a timely approach to satiety, thereby optimizing feed digestibility. This might also be linked to the birds' physiological adaptation to the various feeding schedules, potentially enhancing the efficiency of feed conversion. Similar findings were reported regarding bird weight gain by Camacho *et al*. (2004) [7] and Khurshid *et al*. (2019) [8]. Nonetheless, Zhan *et al*. (2007) [9] argued that bird weight gain was significantly influenced by different feeding frequencies. The analysis revealed that feed intake was notably lower in T1 compared to the other treatment groups. On the contrary, Farghly and Hassanie (2012) [10] observed higher feed intake in the group with higher frequency of feed delivery. Over the entire study duration, the Feed Conversion Ratio (FCR) for birds subjected to different feeding frequencies exhibited significant differences ($p<0.05$) among the treatments. Groups with lower feeding frequencies exhibited higher FCR values, while the group with a higher rate of feed delivery demonstrated a better FCR. These FCR outcomes align with Saber *et al*. (2011) [11]. However, here FCR findings did not align with those of Pan *et al*. (2005) [12], who reported that cumulative FCR remained unaffected by feed restriction.

Table 1: Effect of feeding frequency on growth performances of broiler chicken

Parameter	Treatments				SE
	T_1 (Four Time Feeding)	T_2 (Three Time Feeding)	T_3 (Two Time Feeding)	T_4 (one Time Feeding)	
Initial body weight (g)	45	44	44	42	0.03
Live weight, g	1992	2035	1956	1968	35
Weight gain, g	1947	1991	1912	1926	31
Starter period Weight gain, g (Week 1-3)	1100	1157	1099	1238	47
Finisher period Weight gain, g (Week 4-6)	847	834	813	688	68
Daily weight gain (g)	46	47	46	46	1.5
Feed intake (g/bird)	3154^a	3245^b	3270^b	3284^b	49
Starter period Feed intake (g/bird) (Week 1-3)	1121	1139	1133	1198	42
Finisher period Feed intake (g/bird) (Week 4-6)	2033^a	2106^b	2139^b	2086^b	72
FCR	1.62^a	1.63^a	1.71^b	1.71^b	0.1
Starter period FCR	1.02^a	0.98^a	1.03^b	0.97^a	0.04
Finisher period FCR	2.40^a	2.53^a	2.63^a	3.03^b	0.06

$^{a, b}$ means within the same row with different superscripts are significantly different ($p<0.05$)

3.2 Carcass Yield and Abdominal Fat Analysis

The carcass yield parameters, with the exception of abdominal fat, exhibited no significant differences among the various feeding frequencies as shown in Table 2. However, a noteworthy discrepancy ($p<0.05$) emerged in the abdominal fat content of the birds during the slaughtering process. Birds that were fed four and three times a day displayed significantly lower levels of abdominal fat compared to the other feeding frequency groups. This finding aligns with the results of Benyi *et al*. (2010) [13], who demonstrated that increasing the feeding frequency up to three times a day, coupled with feed restriction, led to a decrease in abdominal fat content in broiler breeder hens. The variation in abdominal fat content might be attributed to alterations in the fatty acid composition of the birds, a factor known to influence fat accumulation in chickens, as noted by Moradi *et al*. (2013) [14].

Table 2: Effect of feeding frequency on carcass yield and meat quality of broiler chickens

Parameter	Treatments				SE
	T_1 (Four Time Feeding)	T_2 (Three Time Feeding)	T_3 (Two Time Feeding)	T_4 (one Time Feeding)	
Live weight, G	1992	2035	1956	1978	54
Carcass weight, G	1540	1616	1532	1521	53
Dressing percentage, %	77.31	79.41	78.32	76.90	3.3
Abdominal fat, G	14^a	16^a	23^b	27^b	3
Breast, G	530	610	510	500	30
Leg and thigh, G	462	495	440	425	14
Wings, G	180	178	162	158	6

$^{a, b}$ means within the same row with different superscripts are significantly different (p<0.05)

3.3 Serum lipid profile analysis

Serum lipid profile in restricted feeding condition has summarized in the table 3, which reveals that cholesterol concentration in the serum was found significantly lower in T_1 (138 mg/dl) and T_2 (142 mg/dl) group in comparison to other groups. It may be due to the irregularity in the feed consumption during single or two time feeding. LDL was found significantly (p<0.05) higher in T_4 followed by T_3. T_1 and T_2 group were having significantly lowest LDL concentration in the serum. In contrast to it, HDL was found significantly highest (p<0.05) in four time feeding group in comparison to others feeding restriction group. These finding were in the agreement with Azis and Afriani (2017) [15] report. Level of triglycerides was found non-significantly differ among all the groups. A comparison of serum profile has also represent in the figure 1 which showed the fluctuation in the cholesterol, LDL and HDL during different feeding regimes of feeding restriction in broiler chicken also support previous findings (Balog *et al*., 2004) [16].

Table 3: Effect of feeding frequency on serum lipid profile of broiler chickens

Parameter	Treatments				SE
	T_1 (Four Time Feeding)	T_2 (Three Time Feeding)	T_3 (Two Time Feeding)	T_4 (One Time Feeding)	
Cholesterol, mg/dL	138^a	142^a	179^{bc}	196^c	0.46
LDL, mg/dL	78^a	74^a	128^b	136^c	1.86
HDL, mg/dL	68^a	45^b	35^c	36^c	0.84
Triglycerides, mg/dL	49	51	52	53	3.49

$^{a, b,c,d}$ means within the same row with different superscripts are significantly different (p<0.05)

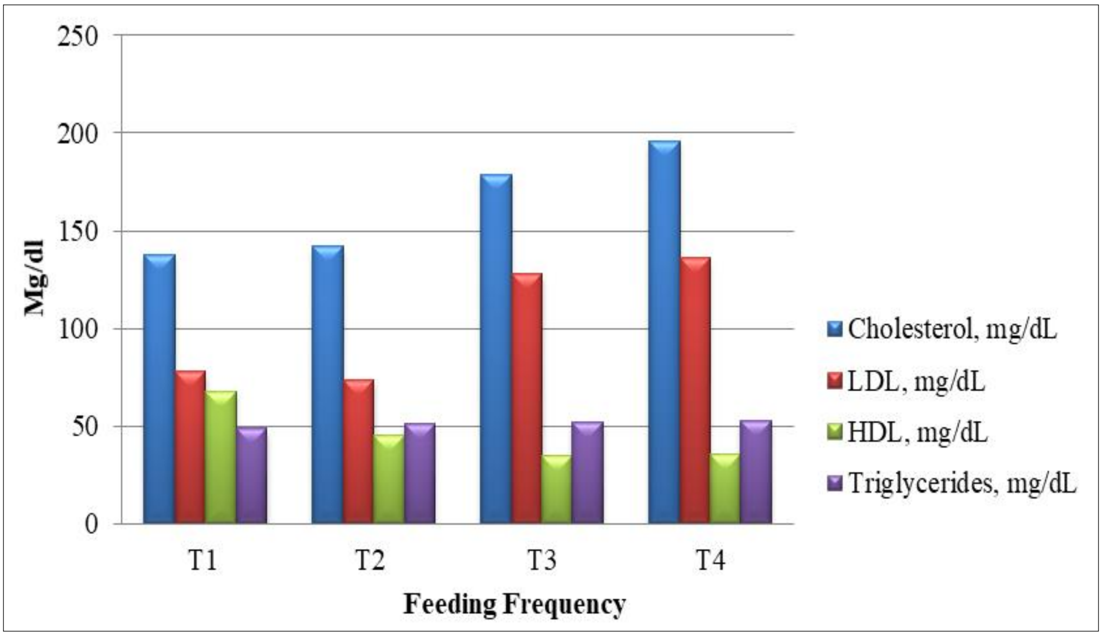

Fig 1: Serum lipid profile of broiler chickens in different feeding frequency

4. Conclusion

The implementation of a timed feed restriction program evidently exerts an influence on various parameters including live weight, weight gain, carcass weight, and dressing percentage in broiler chicks. Furthermore, it contributes to the enhancement of carcass characteristics in broilers, appealing to individuals with quality-centric preferences. As a result, it can be inferred that the manipulation of carcass weight in broiler chickens is achievable through the adoption of diverse feed restriction approaches, tailored to match market requirements. This flexibility empowers producers to select a feed restriction strategy that aligns with their specific farm circumstances and caters to market demands, all while keeping a close eye on the economic implications.

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