Al-Qadisiyah Journal of Veterinary Medicine Sciences
(P-ISSN 1818-5746/ E-ISSN 2313-4429)
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The Effects of Feed and Light Restrictions on Broiler Chickens: A Comparative Study

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Received:1/12/2022. Accepted:27/2/2023. Published:12/9/2023

Abstract

The feed and light restriction programs are two of the main growth curves that influence methods for improving productivity in broiler chickens. However, when birds are fed unlimited amounts, their rapid growth rate is accompanied by body fat accumulation, mortality, and a high frequency of metabolic problems that also weaken their immune system. The current research studied the effects of feeding and light restrictions on broiler productivity, humoral immunity (IgG), and histological changes in the liver, spleen, kidney, and intestine of Ross 308 broilers. The experiment involved 110 broiler chicks (divided into four groups, each with 25 chicks) with the following conditions: G1 served as a negative control group since they were not subject to restrictions or vaccination. G2: served as a positive control and received vaccination without any restriction. G3: Chicks were under feeding restriction for one hour every three hours. G4: Chicks were under light restriction for one hour every three hours. The chicks were vaccinated against Newcastle disease, influenza and Gumboro disease. Feed restriction was far superior to light restriction in terms of increasing growth performance and the immunological response to vaccination in broiler chickens. Compared to the first group, the fourth and second groups exhibited the highest pathological abnormalities in the liver, spleen, kidney, and intestine. Feeding limits of one hour every three hours improve the immune response and enhance broiler performance.

Key words: Feed restriction, NDV, IgG, ELISA, Histopathological changes.

Introduction:

Poultry is regarded as the most resource-efficient livestock product in terms of raw materials and natural resources (1). Furthermore, chicken is favored over other meats in many parts of the world as a low-cost source of animal protein with a positive image, no environmental impact, and no religious restrictions. As a result, poultry farming plays a critical role in supplying protein sources to meet an ever-increasing global demand (2, 3). For the past 60 years, the broiler business has focused on increasing body weight gain and feed efficiency by allowing birds to have continuous access to feed to maximize feed intake (4). In the past ten years, consumer concern over issues like sustainability, food safety, and welfare has called into question the benefit of broiler body weight gain (5). In this sense, excessive growth rates associated with eating are typically connected to a rise in the occurrence of skeletal and metabolic issues (6). Feed restriction tactics have been utilized to control excessive growth in young birds while also increasing their health and welfare (7). The immunological response of chickens is improved by fasting periods (8). The goal of this study was to prove how feed and light restrictions affect growth performance and immunological response in broiler chickens over the course of 35 days.

Materials and methods:

The experiments took place on the poultry farm of the Veterinary College at Baghdad University for two months in November and December 2021. Following

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cleaning and disinfection, formalin (37%) was mixed with potassium permanganate in a 2:1 ratio. At one day old, a hundred and ten chicks (Ross 308) were separated into four groups, each with 25 chicks, and handled as follows: G1: acted as the negative control group because neither vaccinations nor feed or light limitations were applied. G2: used as a positive control that received the vaccine with no feed or light restrictions. G3: Chicks were subject to a one-hour feeding restriction every three hours. G4: Every three hours, chicks were subjected to a one-hour light restriction. Ten chicks were slaughtered to determine maternal immunity at day one of age. The study was conducted for 35 days.

Vaccinations:

On the first day, chicks received a subcutaneous injection of a killed oily vaccine against Newcastle disease (ND) and influenza (AIV), as well as an intraocular vaccine against ND (La Sota strain). At 10 days, the chicks received a booster dose of ND (La Sota strain) through drinking water, and at 14 days, a Gumboro D78 intermediate strain vaccination was used.

Collections of samples:

Blood was obtained from the jugular vein of five birds on 7, 14, 21, 28, and 35 days for each group and brought to the laboratory for serum separation. All serum samples were frozen at -20 °C until use. After killing the chicken using the dislocation method, tissue samples of internal organs, such as the kidney, liver, and intestine, were taken from each group of 1x1x1 cm dimensions. These samples were used for a histological study. The histology procedure was performed in accordance with (9) recommendations.

Serological examination:

To measure antibody titer (IgG), the indirect method of ELISA was carried out according to the ProFlock® ELISA kit (Synbiotics – USA) manufacturer's instructions.

Body weight:

Chick weight was calculated every five days by randomly selecting 7 chicks from each group and dividing the total weight of each group by the number of weighted chicks to obtain the average chick weight.

Weight gain:

To estimate body weight gain at 7, 14, 21, 28, and 35 days old, the following equation was used:

The difference between the final and early bird weights during each of the weighing periods (10).

Ratio of feed conversion (FCR):

During the experiment, feed conversion was estimated for each group using the following equation: weight increase rate (gm) / feed consumption rate (gm).

Efficiency of feed conversion (FCE):

The calculation was done in accordance with (10) using the equation below: feed conversion efficiency: Feed consumption rate/weight increase rate (gm/kg)

Statistical analysis:

A one-way analysis of variance (ANOVA) test was performed on the gathered data with a 0.05 significant threshold in order to compare the mean and SE. A statistical analysis method (11) was employed to compare the mean and SE.

Ethical Approval: This study was approved by the ethical and research committee of collage of Veterinary Medicine, University of Baghdad.

Results:

Immunity:

Ten blood samples were taken to determine the maternal immunity (IgG) by ELISA test that revealed a good immunological response, with a mean value (7654±345). The findings of the ELISA antibody titer were shown in Tab.1. At 7 days, all groups showed a reduction in maternal immunity. However, at 21 and 28 days, the antibody titer in the third group increased significantly ($P \leq 0.05$) and the fourth group increased modestly. However, compared to the fourth group, the third group increased in antibody titer significantly ($P<0.05$). At 28

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and 35 days, there was a moderate increase (P≤0.05) in IgG titer in (G3 and G4) in comparison to the second group, while the first group had no titer. However, G3 was the best recorded result of all.

Table 1. Effect of feed restrictions and light restrictions on (IgG) titers in broiler chicks at various times.

Periods	7 days	21 days	28 days	35 days
Groups	Antibody titre Means ± Standard error			
G1	1066.2±122.2 C	433.2±128.4 C	295.2±223.8 C	0±0 C
G2	1587.4±146.3 B	1689.8±211.1 AB	2205.8±210 B	3014.4±333 B
G3	1879.2±161.3 A	2578±233 A	3627±225 A	4706.3±289.3 A
G4	1523.4±146.3 B	1822.8±211.1 B	2587.8±210 B	3244.4±333 B
LSD	212.28	424.49	694.36	603.66

There were five samples. At the level of (P≤0.05), capital letters signify a significant difference.

Histological changes:

Histological sections of liver appeared in the third group. There is moderate hepatic cell swelling with evidence of sinusoid occlusion accompanied with portal mononuclear (MNCs) infiltration (Fig. a), while in group fourth was shown multifocal MNCs aggregation forming granuloma like lesion with prominence of kupffer cells with evidence of perivascular MNCs aggregation (Fig. b). the histological sections of kidney was shown in all groups no clear pathological changes except scattered presence of basophilic cortical tubules, while in fourth group was shown mild cellular swelling of convoluted tubules with prominence basophilic cortical tubules (Fig. c). The histological section of the spleen of the third group showed prominence of lymphoid follicle with evidence of lymphoid hyperplasia (Fig. d), while in the fourth and second groups it shows mild congestion of splenic sinus and red pulp tissue with mild lymphoid follicular hyperplasia of white pulp (Fig. e). with respect to histological sections of intestine of third group was shown no clear pathological alteration, while in fourth and second groups shows moderate necrotic findings of intestinal villi associated with villous elongation and fusion (Fig. f).

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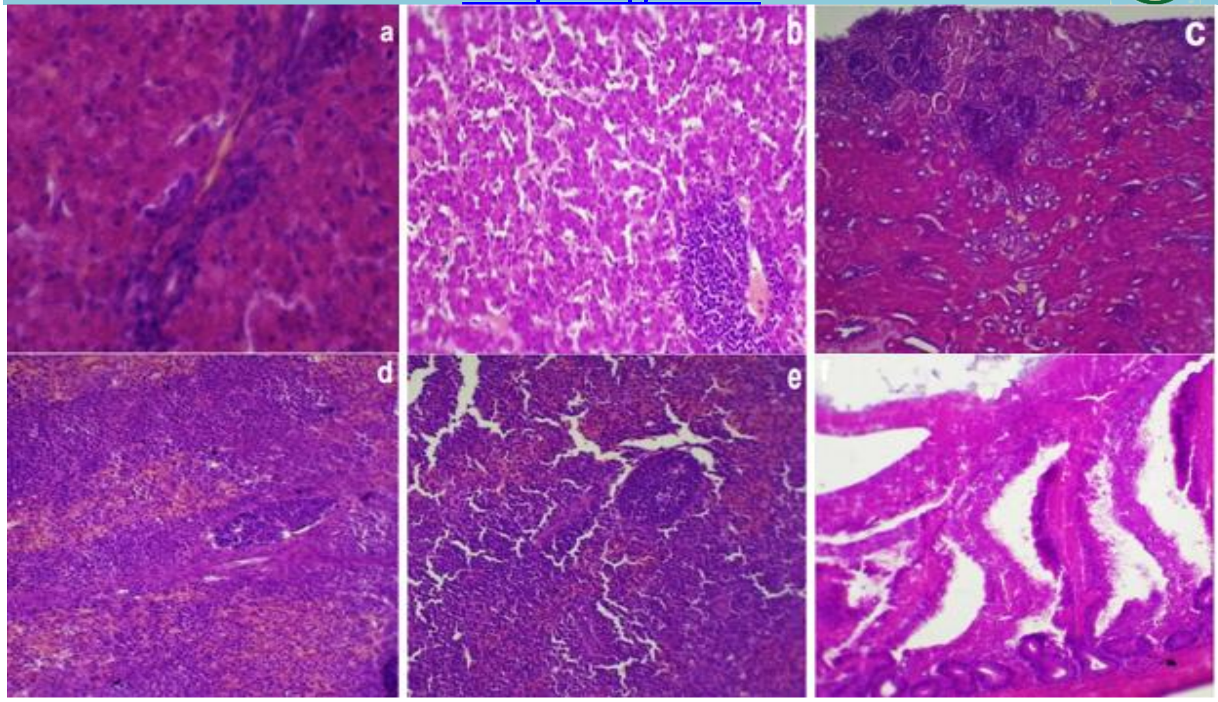

Figure (1): **a.** histipathological section in liver shows moderate hepatic cell swelling with evidence of sinusoid occlusion accompanied with portal mononuclear (MNCs) infiltration. **b.** liver shows multifocal MNCs aggregation forming granuloma like lesion with prominence of kupffer cells with evidence of perivascular MNCs aggregation. **c.** mild cellular swelling of convoluted tubules with prominence basophilic cortical tubules. **d.** spleen appares prominence of lymphoid follicle with evidence of lymphoid hyperplasia. **e.** spleen shows mild congestion of splenic sinus and red pulp tissue with mild lymphoid follicular hyperplasia of O.P. **f.** shows moderate necrotic findings of intestinal villi associated with villous elongation and fusion.

Weight gain and final weight:

The average body weight of all groups was 45 grams on the same day, and measurements of average body weight gain showed significant differences between the feed restriction and light restriction groups and the control group at the level ($P \leq 0.05$). over the course of seven days (7, 14, 21, 28, and 35). Feed restriction of the third group showed significant differences at level ($P \leq 0.05$), with the fourth and second groups, in contrast to the first group, which showed a significant decrease in weight gain. The third group had the highest body weight, followed by the fourth group, whereas the first and second (negative and positive control) groups had the lowest body weight.

Table (2). Weight gain and Body weight (grams) (Mean±SE) of different groups at different time.

Groups	7 days	14 days	21 days	28 days	35 days	Final weigh
G1	157.4±17**B**	241.4±22**C**	236.2±62**C**	697.6±55**C**	776.4±52 **C**	2154±211.3**C**
G2	156.8±14**B**	241±26 **C**	285.2±17**C**	701±62 **C**	765±65.6 **C**	2194±274.5**C**
G3	195.4±26**A**	374±17.2**A**	470.4±28**A**	894.8±41**A**	900.4±85.5**A**	2880±265 **A**
G4	166.8±14**B**	281±26.5**B**	385.2±67**B**	741±27 **B**	805±38.6 **B**	2424±268.1**C**

At the level of (P≤0.05), capital letters signify a significant difference.

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Feed conversion ratio and feed conversion efficiency:

The results of feed conversion efficiency showed results that were in line with those of the feed conversion ratio which revealed a significant difference at level (P≤0.05) in feed conversion ratio among treated third and fourth groups compared to the first and second groups , as follows (1.56, 1.74, , 2.26 and 2.11) respectively. However, the results of feed conversion efficiency revealed a significant difference in feed conversion efficiency among third and fourth groups compared to the first and second groups at level (P≤0.05), although third group is statistically greater than fourth group as follows (0.63, 0.57, 0.44, 0.47) respectively. (Tab.3) .

Table 3. Results of different groups in feed intake, feed conversion ratio, and feed conversion efficiency (Mean±SE).

Groups	final weigh	Feed consumption	FCR	FCE
G1	2154±211.3 **C**	4870.6±8.84 **A**	2.26±0.01 **A**	0.44±0.001 **C**
G2	2194±274.5 **C**	4639.6±10.3 **B**	2.11±0.003 **B**	0.47±0.002 **C**
G3	2880±265 **A**	4500.8±9.07 **C**	1.56±0.006 **D**	0.63±0.002 **A**
G1	2154±211.3 **C**	4870.6±8.84 **A**	2.26±0.01 **A**	0.44±0.001 **C**

Number of samples: 5. Capital letters mean significant difference at level of (P≤0.05).

Discussion:

In general, all feed restrictions and light restrictions in the third and fourth groups showed an increase in antibody titers at 21 and 28 days old, respectively, in comparison to the second group. These findings seem to have a positive effect on immune response during fast periods; it could be due to an increase in some cytokines such as IL-4 or iNOS that enhance immunity (12). On the other hand, Trocino and others displayed that, a significant interaction between age and feeding system was seen for plasma corticosterone (p ≤0.05), which steadily declined with age (13); other physiological changes reported previously showed a decrease in insulin levels, as well as concentrations of alanine, urea, and uric acid, and higher levels of the fat-catabolizing substances free fatty acids and hydroxybutyrate, as shown by (14, 15). Feed restriction is also associated with delayed weight loss; high levels of hydroxybutyrate and free fatty acids in the blood, along with low levels of glucocorticoids to suppress proteolysis, show a substantial reliance on lipid catabolism (16, 17). In the current study, intermittent feeding schedule significantly improved broiler productivity by increasing weight gain and body weight and enhancing FCR and FCE. Other intermittent fasting impacts recorded include increasing serving sizes, reducing food competition, and reducing the tension and violence that result from mealtimes. (18, 19). However, some studies have even linked it to an increase in obesity (20). Under feed restriction conditions, both broilers (15) and broiler breeders (21, 22) exhibit significant swings in mass, glycogen, and lipid content. Regarding histological effects on the liver, It is well known that the liver plays a key role in the initial metabolic response of chickens to dietary changes (23). These obvious physiological effects coexist with significant alterations in hepatic transcription; it has been studied how the chicken liver transcriptase reacts to acute fasting (24), although mild changes were found in liver sections. The lack of significant effects of feed limits could be attributable to the gradual physiological adaptation to various feeding regimens, which likely enhanced the efficiency of feed

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conversion. In comparison to the second group, the largest body weights with low feed consumption were seen in the feed and light restriction groups. These findings support the findings of Ji *et al.* (25) and Brickett *et al.* (26), who claim that fasting reduces fat formation. Two basic mechanisms can account for this reduction: Feed limitation decreases the activity of hepatic acetyl-CoA carboxylase, a rate-limiting enzyme in fatty acid synthesis (25). This may minimize fat buildup in the body by limiting hepatic triglyceride synthesis, resulting in lower serum triglyceride levels. Rezaei and colleagues confirmed that the qualitative feed limit in broiler chickens decreased body fat accumulation (27). Studies on limited lighting, which consists of extended blocks of light and darkness, have found that as the duration of darkness grows, so does body weight and feed conversion (25). As a result, broilers exposed to various decreased lighting programs will consume less feed, and this program can be included in the definition of feed limitation. However, the feed conversions of the broilers receiving continuous light were significantly lower than those of the broilers receiving 12 hours of light and 12 hours of darkness. In addition, chickens in light pens moved around significantly more than those in dark pens. (28), Rodrigues and Choct, however, demonstrated that birds involved in anticipatory eating activity before the protracted period of darkness and that their feeding behavior increased once the light was restored. (29). Buyse et al. (30), who showed the effects of continuous and intermittent (step-up and step-down programs) lighting on the performance of female broilers, significantly improved feed conversion while lowering cumulative feed consumption.

Conclusions:

The current study found that a feeding limit program of one hour every three hours was far superior to light restriction in terms of improving immune response and increasing performance (body weight, feed conversion ratio, and feed conversion efficiency). In addition, there are a few histological alterations in the liver, spleen, kidney, and intestine.

Acknowledgements:

The author are highly acknowledgment to those who contributed to presenting this study in its final form

Conflict of Interest:

The author declares no conflicts of interest regarding the publication of this paper.

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