



# The Effects of Early Feed Restriction on Growth Performance, Internal Organs and Blood Biochemical Indicators of Broilers

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**Abstract:** The growth rate of broiler chickens has increased greatly due to enhancement in genetics, nutrition and management. However, the high growth rate of broilers has caused many health problems. To avoid those problems, feed restriction was used as a management strategy to prevent excessive growth during early period. This study accessed the effects of early feed restricted on growth performance, internal organs and blood biochemical indicators of broilers. A total of 180 male Arbor Acres broilers were obtained and randomly assigned to 2 treatment groups. The treatments included control group (basal diet and feed restricted group (dietary energy and protein levels were diluted by 10%). At 14 d, two birds of each replicate were randomly chosen, wing vein blood samples were taken for blood biochemical indicators determination, then slaughtered to measure internal organs. The result showed that birds fed diluted feed had lower ( $P<0.05$ ) body weight at 14 days. There was no significant difference in body weight between restricted and control groups at 42 days. No changes were observed in feed intake and feed conversion ratio between groups. Feed restriction also had no significant effects on internal organs, intestine and serum biochemical indicators. Taken together, this study suggested that dietary protein and energy diluted by 10% from 8 to 14 d is a suitable feeding program.

**Keywords:** Early Feed Restriction, Broilers, Growth Performance

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## 1. Introduction

Constant improvement in genetic selection and nutrition has led to a rapid growth rate of modern broilers. These advances have brought better production indexes, but on the other hand, many unexpected results occurred which included body fat deposition, high mortality and high incidence of metabolic disorders and bone diseases [1]. Thus feed restriction in broilers was used as a management strategy to prevent excessive growth during early period and thereby to solve those health issues. Previous studies have found that feed restriction could reduce considerably the incidence of ascites syndrome, sudden death syndrome and legs disease and other metabolic disease in broilers, but also can reduce abdominal fat deposition ([2], [3], [4]).

Limiting feed is artificially reducing the nutritional intake of

chickens from quantity or quality, which will restrain or even suspend the growth of animal body, so that the body grew with a slow growth speed. A large number of studies have shown that early quantitative feed restriction of broilers could improve the feed conversion ratio with no adverse effects on growth performance ([5], [6]). In addition, quantity or timing feed restriction was demonstrated to be suitable as management means to slow down the speed of initial growth under the premise of not damaging the final performance of male and female Cobb broilers [7]. But, some scholars suggested that quantitative feed restriction may also result in a reduction in other aspects of welfare, thus the development of alternative solutions and modifying the current feed restriction plan is the key to improve the welfare of broiler [8]. Extensive experiments based on dietary nutrition dilution in broilers were conducted. Dietary energy restricted by 30% could caused a

significant increment in the body weight gain and feed conversation ratio of broilers at later period, and decreased abdominal fat deposition [9]. However, there are few researches about restricting energy and protein simultaneously have been covered. This study, therefore, carried out to evaluate the effect of early feed restriction programs via decreasing the level of energy and protein by 10% on growth performance, internal organs and blood biochemical indicators of broilers.

## 2. Materials and Methods

### 2.1. Experiment Design and Diet

Our trial was conducted in the experimental base of the Yangzhou institute of poultry science, in Yizheng city, China. In this study, 180 AA male broilers were obtained and randomly allocated into 2 treatments with 6 replicates in each treatment and per replicate consisted of 15 birds. Treatments were applied from 8 to 14 d as follows: control group (T1: without feed restriction); feed restricted group (T2: energy and protein levels were diluted by 10%). Feed and water were free for all chicks during the whole trial period.

This experiment included two stages of 1-21 day (starter) and 22-42 day (grower), basal diets were formulated to meet the nutrient demand for chickens. The composition and nutrition level of the test diets are shown in Table 1.

**Table 1.** Ingredients and nutrient levels of experimental diet.

Ingredients, %	T1 (8-14d)	T2 (8-14d)	1-7d, 15-21d	22-42d
Corn	57.13	55.50	57.13	62.20
All soybean meal	32.54	28.23	32.54	28.30
Corn protein meal	3.45	1.10	3.45	2.00
Soybean oil	2.40	0.46	2.40	3.52
Wheat bran	0.10	10.24	0.01	0.00
Limestone	1.25	1.25	1.25	1.25
Calcium hydrogen phosphate	2.00	2.00	2.00	1.65
DL-Met	0.17	0.17	0.17	0.10
98% Lys	0.08	0.08	0.08	0.08
NaCl	0.35	0.35	0.35	0.35
50% Choline chloride	0.26	0.26	0.26	0.20
Aureomycin	0.10	0.10	0.10	0.10
Antioxidant	0.03	0.03	0.03	0.03
Microelement <sup>o</sup>	0.20	0.20	0.20	0.20
Vitamine <sup>#</sup>	0.03	0.03	0.03	0.02
Tatol	100	100	100	100
Nutrient levels, MJ/kg				
Metabolic energy	2952	2681	2952	3051
Crude protein	21.51	19.45	21.51	19.00
Crude fiber	2.89	4.47	2.89	2.74
Lys	1.11	1.02	1.11	1.00
Met	0.50	0.46	0.50	0.39
Ca	1.16	1.17	1.16	1.04
Total phosphorus	0.83	0.84	0.83	0.73
Non-phytate phosphorus	0.59	0.59	0.59	0.51

Met, methionine; Lys, lysine; ME, metabolizable energy; CP, crude protein; nPP, non-phytate phosphorus; TP, total phosphorus; Ca, calcium. Values are expressed on air-dry basis. The microelement provided per kilogram of diet: iron,

80 mg; copper, 8 mg; manganese, 100 mg; zinc, 80 mg; iodine, 0.70 mg; selenium, 0.30 mg. <sup>#</sup>The vitamins provided per kilogram of diet: vitamin A, 8000 U; vitamin D3, 1000U; vitamin E, 20 U; vitamin K3, 0.5 mg; vitamin B1, 2 mg; vitamin B2, 8 mg; vitamin B6, 3.5 mg; vitamin B12, 10 µg; nicotinic acid, 35 mg; calcium pantothenate, 10 mg; folic acid, 0.55 mg; biotin, 0.18 mg.

### 2.2. Sample Collection and Analytical Determination

At 7, 14 and 42 d, individual body weights were measured to determine body weight (BW), average daily feed intake (ADFI), and feed conversion ratio (FCR). At 14 days old, two birds were randomly selected from each replicate of each treatment, and 2.5 ml of blood was collected from the wing vein for blood clinical chemistry. Then the birds were dissected and internal organs weight were measured.

Animal care use and protocols were approved by the Yangzhou University Animal Care and Use Committee.

### 2.3. Feeding and Management

During the experiment, the daily illumination and immunization program is carried out in accordance with the routine management of broiler. The temperature of the room was maintained at 30 to 32°C at the first week and then was reduced to 2°C every week until the house temperature was 25°C. Lighting via incandescent lighting and hours of light was 24h in the first four days, the next 5 d of 20 h of light, 10-15 d of 18 h of light, and 16 h of light for the remained of the experiment. Utilized natural light to illuminate during the day time and used incandescent to prolong lighting time in the night. The birds were housed in the main compartment, in floor pens fitted with electrical heaters. Humidity was maintained at least at 55 to 65% in the early growing period.

### 2.4. Statistical Analyses

Data gathered during the trials were organized in Excel data sheets and the statistical analyses were performed with SPSS version 17.0 software. Significant differences among treatment means were determined at  $P < 0.05$  by Independent-Samples T Test. Results were given in mean  $\pm$  standard error of mean ( $\bar{x} \pm \text{SEM}$ ).

## 3. Result

### 3.1. Growth Performance

From 8 to 14 d, body weight of the restricted birds was lower than that in control group (Table 2). Significant different in body weight was observed at 14 days ( $P = 0.01$ ), the restricted group was significantly lower than that of the control group. There was no significant difference in ADFI and FCR ( $P > 0.05$ ).

At 42 days, body weight of feed restriction group was higher than that of control group (Table 3), ADFI and FCR of feed restriction group were lower compared to the control group, but the data both showed no significance ( $P > 0.05$ ).

**Table 2.** Effects of early feed restriction on growth performance in broilers from 8 to 14 days.

Items	BW of 7 d (g)	BW of 14 d (g)	ADFI (g)	FCR
T1	180.63 ± 0.41	472.48 ± 5.62 <sup>a</sup>	56.99 ± 1.13	1.38 ± 0.04
T2	180.53 ± 3.83	448.26 ± 5.23 <sup>b</sup>	56.38 ± 0.33	1.44 ± 0.03
P-value	0.862	0.010	0.612	0.228

BW, body weight; ADFI, average daily feed intake; FCR, feed conversion ratio.

<sup>a-b</sup> Values within a column with no common superscript differ significantly ( $P < 0.05$ ).

**Table 3.** Effects of early feed restriction on growth performance in broilers at 42 days.

Items	BW of 42 d (g)	ADFI (g)	FCR
T1	2821.07 ± 72.15	155.42 ± 1.92	1.70 ± 0.06
T2	2856.78 ± 21.67	152.90 ± 0.42	1.65 ± 0.01
P-value	0.646	0.229	0.345

BW, body weight; ADFI, average daily feed intake; FCR, feed conversion ratio.

<sup>a-b</sup> Values within a column with no common superscript differ significantly ( $P < 0.05$ ).

### 3.2. Growth of Internal Organs

The effects of early feed restriction on growth of internal organs of broilers from 8 to 14 d are summarized in Table 3. No significant effects were observed on the index of heart, liver, spleen, proventriculus and gizzard between two groups ( $P > 0.05$ ).

**Table 4.** Effects of early feed restriction on internal organ index in broilers from 8 to 14 days.

Items	Heart index	Liver index	Spleen index	Proventriculus index	Gizzard index
T1	0.71 ± 0.02	2.80 ± 0.06	0.08 ± 0.01	0.69 ± 0.02	2.37 ± 0.08
T2	0.70 ± 0.03	2.79 ± 0.06	0.08 ± 0.01	0.70 ± 0.02	2.43 ± 0.06
P-value	0.726	0.950	0.568	0.881	0.500

### 3.3. Growth of Small Intestine

The effects of early feed restriction on growth of small intestine of broilers from 8 to 14 d are showed in Table 4. There were no significant difference in small intestine weight and length at 14 d between the broilers of two dietary treatments ( $P > 0.05$ ).

**Table 5.** Effects of early restriction on growth of small intestine in broilers from 8 to 14 days.

Item	Duodenum weight (g)	Jejunum weight (g)	Ileum weight (g)	Caecum weight (g)	Rectum weight (g)	Duodenum length (cm)	Jejunum length (cm)	Ileum length (cm)	Caecum length (cm)
T1	4.16 ± 0.18	7.81 ± 0.23	5.93 ± 0.23	2.25 ± 0.12	1.18 ± 0.07	18.15 ± 0.58	45.3 ± 1.06	50.38 ± 1.18	9.88 ± 0.26
T2	4.01 ± 0.17	7.88 ± 0.21	5.78 ± 0.16	2.18 ± 0.09	1.14 ± 0.07	18.67 ± 0.44	49.31 ± 2.55	49.31 ± 1.47	9.91 ± 0.28
P-value	0.553	0.829	0.595	0.654	0.741	0.483	0.797	0.576	0.948

### 3.4. Serum Biochemical Indicators

The effects of early feed restriction on serum biochemical indicators of broilers from 8 to 14 d are showed in Table 5. Dietary treatments were observed to have no significant effects on TP, ALB, GLB, A/G and ALP levels in serum of broilers at 14 d ( $P > 0.05$ ).

**Table 6.** Effects of early restriction on serum biochemical indicators in broilers from 8 to 14 days.

Item	TP (g/L)	ALB (g/L)	GLB (g/L)	A/G	ALP (U/L)
T1	22.97 ± 0.85	8.81 ± 0.33	14.16 ± 0.53	0.62 ± 0.01	6220.25 ± 554.39
T2	24.17 ± 0.52	9.30 ± 0.21	14.87 ± 0.35	0.63 ± 0.01	5529.67 ± 668.71
P-value	0.240	0.222	0.271	0.837	0.435

## 4. Discussion

### 4.1. Growth performance

Our results indicated that the BW of birds in the feed restricted group decreased significantly compared to control group at 14 d, this result showed that tested chicks could not get enough nutrition to achieve the normal weight when dietary energy and protein were reduced. This finding was

consistent with Teimouri [10], who found that different level of dietary dilution from 8 to 14 days could affect body weight of broilers, with increasing dilution rate the weight gain of broilers was significantly decreased compared with control group. Some reports also indicated that energy and protein dilution on broiler chickens can decreased growth rate of broilers ([11], [12]). A result showed that nutrient density decreased by 28% has caused a significant reduction in body weight gain and live weight at 45d [13], Urdanetarincon and Leeson conducted a experiment with different feed restriction

types and levels to evaluate that the effect of diets dilution on the performance of male broilers, results from qualitative feed restriction treatment stated that body weight has a significant difference between control group and restricted group [3].

In our study, there was no significant difference in body weight between unrestricted and restricted chicks at 42 days. Broilers could show compensatory growth after feed restriction. This is in agreements with the findings of Tumova *et al.*; Lee and Leeson ([14], [15]).

The data of our study showed that ADFI of restricted group was lower than that of control group, but the difference were not significant. At present, there are many related experiments showed that feed restriction can affect the daily feed intake of broilers, but the results are different. Sharma [12] reported that feed intake was reduced significantly in whole grain added diets, this finding supported the findings of Shi *et al.* [16]. These results are contrary to those of others researches ([11], [17]). They considered that it is possible to increased feed intake because of broiler chicks try their best to absorb more feed while in low dietary energy, so as to satisfy the demand of the high growth rate. In general, early dietary energy and protein dilution have significant effect on growth performance.

#### 4.2. Growth of Internal Organ

Statistical analysis showed that early feed restriction had no significant effects on the relative weight of internal organ of broilers ([18], [19]). Similar founding was also observed in the present experiment. On the other hand, chicks preferentially developed their supply organs such as the stomach when the feed was diluted [12]. Onbaşilar mentioned that there were no significant association on other examined organs except heart among groups [20]. Accordingly, the reason for no significant difference on internal organs in present study could be the degree of dilution and diluted material were varied.

#### 4.3. Growth of Small Intestine

At present, there are few researches about the effect of restricted feeding on the growth and development of small intestine in broilers. In this experiment, no significant differences were found in small intestine weight and length between the broilers of two treatments, this results were consistent with previous studies. Wijten carried out a study to investigated the effect of dietary feed restriction in early life, then they observed that energy dilution had no effect on the weight and length of small intestine [21], Similar results were found in other studies [22]. As the case stands, it is not clear about the mechanisms of limited feeding on growth of small intestine and further studies are needed.

#### 4.4. Blood Biochemical Indicators

Blood metabolites reflect the immediate nutritional status of birds. By decreasing dietary energy may lead to dramatic changes to the plasma biochemistry. In the presented study, there are no significant effects on the blood contents of total protein, albumin, globulin, and alkaline phosphatase of chicks.

These results are support to those of Azis *et al.* [23]. Previous studies in poultry have indicated that dietary dilution can improved the plasma levels of hormones. Data gathered in a study conducted by Jahanpour showed that quantitative feed restriction was related to changes in plasma metabolite concentrations [24]. The results of this study are supported by Rajman *et al.* [25], who reported that quantitative feed restriction significantly decreased TG in broiler breeder chickens at 58 and 100 d.

## 5. Conclusion

This study suggested that dietary protein and energy reduced 10% from 8 to 14 d of age could improved bird growth, and have no side influence on other indexes in broilers. It proved that dietary protein and energy reduced 10% is a suitable feeding program, which can implied in the production of broilers.

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