



**EFFECTS OF FEED RESTRICTION DURATION AND LEVELS OF DIETARY
ENERGY AND PROTEIN INCREASEMENT AFTERWARDS ON THYMUS, LIVER,
SPLEEN AND BURSA OF FABRICIUS IN BROILER**

HADIDI M, SEIDAVI AR* AND BOUYEH M

Department of Animal Science, Rasht Branch, Islamic Azad University, Rasht, Iran

*Corresponding Author Mail: alirezaseidavi@iaurasht.ac.ir

ABSTRACT

The objective of this study was to determine the effect of durations of feed restriction on thymus, liver, spleen and bursa of fabricius in broilers during a 6-week period. Two hundred and seventy Ross 308 day-old chicks were assigned to a 4×2 factorial arrangement of treatments to examine the effects of two durations of feed restriction (7 and 14 days), and four levels of dietary nutrients increment after feed restriction (0, 5, 10, and 15% relative to standard guide of Ross 308). Each treatment group was replicated three times. From obtained results, it is showed that duration of feed restriction had not significant effect on thymus weight, relative weight of thymus, liver weight, relative weight of liver, spleen weight, relative weight of spleen, bursa of fabricius weight, and relative weight of bursa of fabricius ($P>0.05$). Also 14 days restriction had more thymus weight, relative weight of thymus, bursa of fabricius weight, and relative weight of bursa of fabricius than 7 days restriction numerically. Nutrient concentration after feed restriction also had not significant on thymus weight, relative weight of thymus, liver weight, relative weight of liver, spleen weight, relative weight of spleen, bursa of fabricius weight, and relative weight of bursa of fabricius ($P>0.05$), however 15% increasment of nutrients after feed restriction resulted to the highest thymus weight, relative weight of thymus, liver weight, spleen weight, relative weight of spleen, and bursa of fabricius weight numerically.

Keywords: Energy, Protein, Feed Restriction, Chick, Thymus

INTRODUCTION

Broiler farmers are seeking novel approaches for improvement of broiler productivity. Compensatory growth is a modern management method for this purpose. There are various methods for early feed restriction and feeding after restriction. Previous reports showed duration of feed restriction have different effects on broiler performance [1, 2]. However there are little reports about appropriate nutrient concentrations after feed restriction [3]. Meanwhile there are little studies about effects of compensatory growth on thymus, liver, spleen and bursa of fabricius.

The objective of this study was to determine the effect of durations of feed restriction on thymus, liver, spleen and bursa of fabricius in broilers during a 6-week period.

MATERIALS AND METHODS

Two hundred and seventy Ross 308 day-old chicks were assigned to a 4×2 factorial arrangement of treatments to examine the effects of two durations of feed restriction (7 and 14 days), and four levels of dietary nutrients increment after feed restriction (0, 5, 10, and 15% relative to standard guide of Ross 308). Each treatment group was replicated three times.

At 8th d of age, 8 different feed restriction programs (T1-T8) were implemented and also

a treatment was maintained at *ad libitum* intake (T9; control treatment). As summary, T1-T4 programs include broilers fed with restricted amounts (25%) of the standard guide for Ross 308 broiler chicken from 8 to 14 d and also T5-T8 programs include broilers fed with restricted amounts (25%) of the standard guide for Ross 308 broiler chicken from 8 to 21 days. Furthermore, T1-T4 and T5-T8 programs include broilers fed with 0, 5, 10, and 15% higher nutrients than standard guide of Ross 308 during 15th-42nd and 22nd-42nd days of age. The chicks had access to *ad libitum* food intake before the starting of the restriction period and after the completion of the restriction period. Treatments for the experiment included:

Treatment 1: 25% feed quantitative restriction (relative to standard guide of Ross 308) during 8th-14th days of age (7 days); and 0% increment of diet nutrient concentrations after restriction (relative to standard guide of Ross 308)

Treatment 2: 25% feed quantitative restriction (relative to standard guide of Ross 308) during 8th-14th days of age (7 days); and 5% increment of diet nutrient concentrations after restriction (relative to standard guide of Ross 308)

Treatment 3: 25% feed quantitative restriction (relative to standard guide of Ross 308) during 8th-14th days of age (7 days); and 10% increment of diet nutrient concentrations after restriction (relative to standard guide of Ross 308)

Treatment 4: 25% feed quantitative restriction (relative to standard guide of Ross 308) during 8th-14th days of age (7 days); and 15% increment of diet nutrient concentrations after restriction (relative to standard guide of Ross 308)

Treatment 5: 25% feed quantitative restriction (relative to standard guide of Ross 308) during 8th-21st days of age (14 days); and 0% increment of diet nutrient concentrations after restriction (relative to standard guide of Ross 308)

Treatment 6: 25% feed quantitative restriction (relative to standard guide of Ross 308) during 8th-21st days of age (14 days); and 5% increment of diet nutrient concentrations after restriction (relative to standard guide of Ross 308)

Treatment 7: 25% feed quantitative restriction (relative to standard guide of Ross 308) during 8th-21st days of age (14 days); and 10% increment of diet nutrient concentrations after restriction (relative to standard guide of Ross 308)

Treatment 8: 25% feed quantitative restriction (relative to standard guide of Ross 308) during 8th-21st days of age (14 days); and 15% increment of diet nutrient concentrations after restriction (relative to standard guide of Ross 308)

Treatment 9: no feed quantitative restriction; and no increment of diet nutrient concentrations (feeding as same as standard guide of Ross 308 during 1st-42nd days of age)

All chickens were fed with *ad libitum* before and after the completion of the restriction period.

One bird per group, totaling 3 birds per treatment, was selected and after slaughter and picking operations, broilers were eviscerated. Weights of the thymus, liver, spleen and Bursa of fabricius were determined. Care was taken to choose the most representative male birds with respect to body weight compared to the group mean body weight.

Data gathered during the trials were organized in Excel data sheets and the statistical analysis performed with Statistical Analysis System v8 [4]. For statistical analysis, the mean of pen results was considered as the experimental unit. Data of this experiment were subjected to analysis of variance using GLM procedures in a 2×4 factorial arrangement using

$Y_{ijk} = \mu + A_j + B_k + A_j B_k + e_{ijk}$ statically formula.

Furthermore, there is a control treatment including *ad libitum* feeding throughout rearing period (no feed restriction) and standard nutrients throughout rearing period (no increasment of energy and protein). Hence, using a completely randomized experimental design involving 9 treatments, data were subjected to statistical analysis using the General Linear Model procedures of the Statistical Analysis System v8 (SAS Institute, Inc., 2000) using $Y_{ij} = \mu + A_j + e_{ij}$ statically formula.

Comparison of the means between groups and between replicates was achieved by the Duncan's multiple range tests at 5% probability.

RESULTS AND DISCUSSION

Obtained results are summarized in **Table 1**. From obtained results, it is showed that duration of feed restriction had not significant effect on thymus weight and also relative weight of thymus ($P > 0.05$), although 14 days restriction had more thymus weight and also relative weight of thymus than 7 days restriction numerically (5.65 vs 3.73 g and 0.30 vs 0.19% respectively). Nutrient concentration after feed restriction also had not significant on thymus weight and also relative weight of thymus ($P > 0.05$), however

15% increasment of nutrients after feed restriction resulted to the highest thymus weight and also relative weight of thymus numerically (6.06 g and 0.30%). Meanwhile statistical differences between nine studied treatments for thymus weight and also relative weight of thymus were not significant ($P > 0.05$). Amount of thymus weight and also relative weight of thymus in nine studied treatments were between 2.88-7.44 g and 0.16-0.38% respectively. Among studied treatments, the highest level of thymus weight and also relative weight of thymus belonged to treatment 8 (14 days restriction and 15% nutrient increasment after feed restriction), and treatment 1 (7 days restriction without nutrient increasment after feed restriction) remained at lower level than other treatments. Other treatments were between these treatments.

Duration of feed restriction had not significant effect on liver weight and also relative weight of liver ($P > 0.05$), although 7 days restriction had more liver weight and also relative weight of liver than 14 days restriction numerically (61.33 vs 50.60 g and 3.19 vs 2.82% respectively). Nutrient concentration after feed restriction also had not significant on liver weight and also relative weight of liver ($P > 0.05$), however 15% increasment of nutrients after feed

restriction resulted to the highest liver weight numerically (62.16 g) and also 5% increasment of nutrients after feed restriction resulted to the highest relative weight of liver numerically (3.10%). Meanwhile statistical differences between nine studied treatments for liver weight and also relative weight of liver were not significant ($P>0.05$). Amount of liver weight and also relative weight of liver in nine studied treatments were between 44.10-70.51 g and 2.61-3.37% respectively. Among studied treatments, the highest level of liver weight and also relative weight of liver belonged to treatment 4 (7 days restriction and 15% nutrient increasment after feed restriction), and treatment 2 (7 days restriction and 5% nutrient increasment after feed restriction). Control treatment remained at lower level than other treatments for both liver weight and also relative weight of liver. Other treatments were between these treatments.

It is showed that duration of feed restriction had not significant effect on spleen weight and also relative weight of spleen ($P>0.05$), although 7 days restriction had more spleen weight and also relative weight of spleen than 14 days restriction numerically (2.93 vs 2.22 g and 0.15 vs 0.12% respectively). Nutrient concentration after feed restriction also had not significant on spleen weight and also

relative weight of spleen ($P>0.05$), however 15% increasment of nutrients after feed restriction resulted to the highest spleen weight and also relative weight of spleen numerically (3.08 g and 0.14%). Meanwhile statistical differences between nine studied treatments for spleen weight and also relative weight of spleen were not significant ($P>0.05$). Amount of spleen weight and also relative weight of spleen in nine studied treatments were between 2.06-4.10 g and 0.10-0.18% respectively. Among studied treatments, the highest level of spleen weight and also relative weight of spleen belonged to treatment 4 (7 days restriction and 15% nutrient increasment after feed restriction), and treatment 8 (14 days restriction and 15% nutrient increasment after feed restriction) remained at lower level than other treatments. Other treatments were between these treatments.

From obtained results, it is showed that duration of feed restriction had not significant effect on bursa of fabricius weight and also relative weight of bursa of fabricius ($P>0.05$), although 14 days restriction had more bursa of fabricius weight and also relative weight of bursa of fabricius than 7 days restriction numerically (1.12 vs 1.00 g and 0.06 vs 0.05% respectively). Nutrient concentration after feed restriction also had not significant on

bursa of fabricius weight and also relative weight of bursa of fabricius ($P>0.05$), however 15% and 10% increasment of nutrients after feed restriction respectively resulted to the highest bursa of fabricius weight and also relative weight of bursa of fabricius numerically (1.22 g and 0.06%). Meanwhile statistical differences between nine studied treatments for bursa of fabricius weight and also relative weight of bursa of fabricius were not significant ($P>0.05$). Amount of bursa of fabricius weight and also relative weight of bursa of fabricius in nine studied treatments were between 0.80-1.98 g and 0.04-0.07% respectively. Among studied treatments, the highest level of bursa of fabricius weight and also relative weight of bursa of fabricius belonged to treatment 5 (14 days restriction without nutrient increasment after feed restriction) and treatment 7 (14 days restriction and 10% nutrient increasment after feed restriction). Also, treatment 2 (7 days restriction and 5% nutrient increasment after feed restriction) remained at lower level than other treatments. Other treatments were between these treatments.

Based on our findings it is concluded that duration of early feed restriction is affected on characteristics of internal organs. Other studies reported positive effect of early feed restriction on broiler performance and carcass

quality [5, 6], while there is not report about effect of early feed restriction on liver, spleen, thymus and bursa of fabricius. Meanwhile it is reported amount of nutrient concentration of diet after removal of feed restriction have effect of broiler productivity [7], while no report about its effect on our studied organs is available. Our obtained information can be useful for understanding of immunity response against feed restriction in broiler chickens.

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Table 1: Weight and Relative Weight Mean (\pm SEM) of Organs Related with Immune System at 42nd Days of Age in Ross 308 Broilers Affected the Two Different Durations of Feed Quantitative Restriction and Different Levels of Diet Nutrient Concentrations Increment after Restriction*

Trait		Thymus weight (gr)	Relative weight of thymus (%)	Liver weight (gr)	Relative weight of liver (%)	Spleen weight (gr)	Relative weight of spleen (%)	Bursa of fabricius weight (gr)	Relative weight of bursa of fabricius (%)
A**	7***	3.73 ^a \pm 0.49	0.19 ^a \pm 0.02	61.33 ^a \pm 2.95	3.19 ^a \pm 0.13	2.93 ^a \pm 0.19	0.15 ^a \pm 0.01	1.00 ^a \pm 0.11	0.05 ^a \pm 0.00
	14***	5.65 ^a \pm 0.49	0.30 ^a \pm 0.02	50.60 ^a \pm 2.95	2.82 ^a \pm 0.13	2.22 ^a \pm 0.19	0.12 ^a \pm 0.01	1.12 ^a \pm 0.11	0.06 ^a \pm 0.00
B**	0****	3.39 ^a \pm 0.69	0.19 ^a \pm 0.03	52.81 ^a \pm 2.95	3.04 ^a \pm 0.18	2.29 ^a \pm 0.27	0.13 ^a \pm 0.01	0.94 ^a \pm 0.16	0.05 ^a \pm 0.00
	5****	3.72 ^a \pm 0.69	0.21 ^a \pm 0.03	54.08 ^a \pm 2.95	3.10 ^a \pm 0.18	2.53 ^a \pm 0.27	0.14 ^a \pm 0.01	0.90 ^a \pm 0.16	0.05 ^a \pm 0.00
	10****	5.58 ^a \pm 0.69	0.29 ^a \pm 0.03	54.83 ^a \pm 2.95	2.95 ^a \pm 0.18	2.39 ^a \pm 0.27	0.12 ^a \pm 0.01	1.16 ^a \pm 0.16	0.06 ^a \pm 0.00
	15****	6.06 ^a \pm 0.69	0.30 ^a \pm 0.03	62.16 ^a \pm 2.95	2.96 ^a \pm 0.18	3.08 ^a \pm 0.27	0.14 ^a \pm 0.01	1.22 ^a \pm 0.16	0.05 ^a \pm 0.00
A (7)- B (0)		2.88 ^a \pm 0.99	0.16 ^a \pm 0.04	57.44 ^a \pm 5.65	3.20 \pm 0.24	2.31 ^a \pm 0.41	0.12 ^a \pm 0.02	0.90 ^a \pm 0.22	0.05 ^a \pm 0.01
A (7)- B (5)		3.20 ^a \pm 0.99	0.17 ^a \pm 0.04	59.26 ^a \pm 5.65	3.37 ^a \pm 0.24	2.98 ^a \pm 0.41	0.16 ^a \pm 0.02	0.80 ^a \pm 0.22	0.04 ^a \pm 0.01
A (7)- B (10)		4.16 ^a \pm 0.99	0.21 ^a \pm 0.04	58.12 ^a \pm 5.65	3.02 ^a \pm 0.24	2.35 ^a \pm 0.41	0.12 ^a \pm 0.02	0.91 ^a \pm 0.22	0.04 ^a \pm 0.01
A (7)- B (15)		4.69 ^a \pm 0.99	0.21 ^a \pm 0.04	70.51 ^a \pm 5.65	3.19 ^a \pm 0.24	4.10 ^a \pm 0.41	0.18 ^a \pm 0.02	1.39 ^a \pm 0.22	0.06 ^a \pm 0.01
A (14)- B (0)		3.89 ^a \pm 0.99	0.23 ^a \pm 0.04	48.18 ^a \pm 5.65	2.87 ^a \pm 0.24	2.28 ^a \pm 0.41	0.13 ^a \pm 0.02	1.98 ^a \pm 0.22	0.05 ^a \pm 0.01
A (14)- B (5)		4.25 ^a \pm 0.99	0.24 ^a \pm 0.04	48.89 ^a \pm 5.65	2.82 ^a \pm 0.24	2.09 ^a \pm 0.41	0.12 ^a \pm 0.02	1.01 ^a \pm 0.22	0.05 ^a \pm 0.01
A (14)- B (10)		7.01 ^a \pm 0.99	0.36 ^a \pm 0.04	51.54 ^a \pm 5.65	2.87 ^a \pm 0.24	2.44 ^a \pm 0.41	0.13 ^a \pm 0.02	1.42 ^a \pm 0.22	0.07 ^a \pm 0.01
A (14)- B (15)		7.44 ^a \pm 0.99	0.38 ^a \pm 0.04	53.81 ^a \pm 5.65	2.73 ^a \pm 0.24	2.06 ^a \pm 0.41	0.10 ^a \pm 0.02	1.06 ^a \pm 0.22	0.05 ^a \pm 0.01
Control: A (0)- B (0)		4.26 ^a \pm 0.99	0.24 ^a \pm 0.04	44.10 ^a \pm 5.65	2.61 ^a \pm 0.24	2.29 ^a \pm 0.41	0.13 ^a \pm 0.02	0.96 ^a \pm 0.22	0.05 ^a \pm 0.01

* Means (\pm Standard Error) within each Column of Dietary Treatments with no Common Superscript Differ Significantly at P<0.05.

** A: Duration of Feed Quantitative Restriction (Days) Equal to 25% versus Standard Guide of Ross 308; B: Increment Percentage of Diet Nutrient Concentrations after Restriction (versus Standard Guide of Ross 308).

*** Feed Quantitative Restriction Equal to 25% versus Standard Guide of Ross 308 for 7 Days (8th-14th Days Of Age) and 14 Days (8th-21st Days of Age) Respectively.

**** 0, 5, 10, And 15% Increment of Diet Nutrient Concentrations after Feed Quantitative Restriction versus Standard Guide of Ross 308 Respectively.