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Effect of Early Feed Restriction with or without Enzyme Supplementation on Performance, Nutrients Digestibility and Blood Biochemical Parameters of Broiler Chickens

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Abstract: This study was conducted to determine the effect of early feed restriction with or without enzyme supplementation on performance, nutrients digestibility and some blood parameters in broiler chickens. About 360, 1 day old mixed sex broilers (ROSS-308) were randomly selected and distributed to 8 experimental groups. Treatments were assigned in a completely randomized design with factorial arrangement (2×4) including 2 levels of enzyme (with and without supplement) and 4 levels of feed restriction (0, 10, 20 and 30%) which adopted from 7-14 days of broilers age. The performance parameters including gain, feed intake and feed conversion ratio were recorded at the end of each week. Blood sampling was done at 14 days of age to determine the blood biochemical characteristics after the restriction period. In order to determination of nutrients digestibility birds fed with experimental diets which included with chromic oxide as an indigestible marker and ileal digesta was collected at 21 days of age. At the end of experiment (42 days of age) carcass analysis was done for 3 birds per each pen. The results of this experiment indicated that the effects of treatments on broilers performance and carcass characteristics were not statistically significant ($p>0.05$). The result showed that the feed restriction with enzyme had an increasing effects on crude protein and crude fat digestibility ($p<0.05$). Besides, feed restriction had a significant effect on glucose and cholesterol ($p<0.05$) however, it did not affect blood triglyceride ($p>0.05$). By referring to the results of this experiment, it can be adopted feed restriction in broiler training without decrease in broiler performance.

Key words: Broiler, digestibility, feed restriction, enzyme, blood parameters, Iran

INTRODUCTION

The growth rate of broilers has increased considerably over the last decades. The feeding cost is one of the important factors which affected broiler production in Iran. Broilers consume feed *ad libitum* to achieve their requirements. Some studies have demonstrated the broilers potential for early restriction followed by full-feeding to compensatory growth (Leeson and Zubair, 1997; Zhan *et al*., 2007; Rincon and Leeson, 2002). Feed restriction has been adopted in broiler production to avoid rapid growth rate which is associated with ascites, lameness, mortality and poor reproductive results (Zhan *et al*., 2007). Some researchers demonstrated that although, early feed restriction reduces growth performance; compensatory growth in the refeeding period will be attained to accelerate organism growth to reach the weight of animals (Hornick *et al*., 2000; Pinheiro *et al*., 2004). The literature indicates that the age at which feed restriction programs are applied and their duration and intensity have not been optimized for compensatory growth of feed-restricted birds (Camacho *et al*., 2004). Ozkan *et al*. (2006) reported that restriction the ME intake for a short period early in broilers resulted in less carcass fat without negative effects on growth performance to 56 days of age. Leeson and Zubair (1997) indicated that feed restriction programs in improving feed efficiency and allowing full body weight recovery has been attributed to a number of factors such as reduced of maintenance ME requirements related to lower body weight and metabolic and digestive adaptation. Sequential feeding is a feeding program which might significantly reduce feed cost (Bouvarel *et al*., 2008). Bizeray *et al*. (2002) demonstrated that sequential feeding improves welfare by reducing the occurrence of leg abnormalities. Numerous studies of exogenous enzyme supplementation in broiler diets have been carried out. Supplementation with enzymes can help to eliminate the effects of anti nutritional factors and improve the utilization of energy and amino acids (Yu *et al*., 2002). The

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level of improvement of energy availability is related to enzyme type and dosage (Zhou *et al*., 2009). So, the aim of the current experiment was to study the effects of early feed restriction with or without enzyme supplementation on performance, carcass characteristics, nutrients digestibility and blood parameters of broiler chicks.

MATERIALS AND METHODS

A corn-soybean meal based diets (for starter and grower periods) were prepared and formulated to meet or exceed the nutrient requirement for chickens recommended by the NRC (1994). The ingredient and calculated nutrients profile of the experimental diets are shown in Table 1. The enzyme preparation used in this experiment was a commercial multi-enzyme complex (Rovabio™) which produced as an extract from the fermentation of the fungal organism *Penicilium fummiculosum* and contained 2200, 500, 2200, 1000 and 15 units xylanase, β-glucanase, cellulase, pectinase and protease, respectively.

Three hundred and sixty male and female chicks were obtained from a commercial hatchery and fed with experimental diets until the age of 42 days. The experiment was carried out in a completely randomized design with 2×4 factorial arrangement including 2 levels of enzyme (with and without enzyme supplementation) and 4 levels of feed restriction (0, 10, 20 and 30%) which adopted from 7-14 days of broilers age. Each treatment was represented by three replicates and fifteen birds were randomly assigned to each pen. Birds in the full-fed control group consumed experimental diets *ad libitum* throughout the experimental period of 1-42 days of age. In the other three treatments (10, 20 and 30% restriction) birds received about 90, 80 and 70% of the control group feed intake at 7-14 days of age. Then, all birds in experimental groups (10, 20 and 30% restriction) consumed diets *ad libitum* after restriction period till 42 days of age. Feed intake and body weight gain of each pen was measured at the same time intervals. Feed conversion ratio for each pen was calculated by dividing feed intake to body weight gain. Mortality was checked daily and weighed for adjusting feed intake and feed conversion ratio.

Table 1: The ingredients and chemical composition of basal diets

	Basal diets (%)	
Ingredients	Starter	Grower
Corn grain	57.89	65.50
Soybean meal	36.79	30.22
Corn oil	1.60	2.00
DCP	1.56	1.05
Limestone	1.26	1.35
Common salt	0.20	0.32
Mineral premix	0.25	0.25
Vitamin premix	0.25	0.25
DL.Met	0.20	0.06
Calculated analysis (%)		
Metab energy (kcal kg^{-1})	2900.00	3005.00
Crude protein	21.00	18.78
Calcium	0.94	0.84
Phosphorous, available	0.42	0.32
Sodium	0.17	0.14
Met+Cys	0.82	0.67
Lysine	1.26	0.98

At 14 days of age 3 birds per each pen selected and transferred to metabolic cages to study the nutrient digestibility of experimental diets in all treatments. The diets of these chicks were supplemented with 0.3% chromic oxide as an indigestible marker. After 4 days due to acclimatization, chicks received diets with marker and were killed by cervical dislocation at day 21st of age. The ileum was removed and the 15 cm terminal ileal digesta was sampled. Samples were oven dried and then ground through 1 mm sieve grinder for laboratory analysis of dry matter, crude protein, crude fat and chromic oxide concentration. Apparent digestibility of nutrients was calculated as follows:

$$\text{Digestibility (\%)} = 100 - [100 \times \left(\frac{\text{Marker}_{\text{diet}}}{\text{Marker}_{\text{ileum}}}\right) \times (N_{\text{ileum}}/N_{\text{diet}})]$$

where, N is concentration of nutrient in samples. Blood sampling of three birds per each pen was done at 35 days of age. Samples were left for 3 h at room temperature to coagulate the blood and then Serum was isolated by centrifugation (3000 g, 15 min) to blood chemistry measurements. Serum triglyceride, total cholesterol and glucose were analyzed using Enzymatic Colorimetric kits (Pars Azemon, Iran).

On day 42nd, eight randomly selected birds from each treatment were killed. The weight of the live bird, intestinal tract, breast, tight, pancreas and abdominal fat were recorded. The carcass data were analyzed base on percentage of live weight. Statistical analysis was carried out using General Linear Model (GLM procedure) to evaluate the effects of restriction and enzyme on performance, nutrients digestibility, carcass characteristics and serum biochemical parameters of broilers using SAS Institute (1990). Statistical significance of differences among treatments was assay using the Duncan multiple test at ($p<0.05$).

RESULTS AND DISCUSSION

The results of treatment effects on broilers performance are shown in Table 2. Effects of feed restriction and enzyme supplementation on body weight

gain, feed intake and feed conversion ratio were not statistically significant ($p>0.05$). However, fedd conversion ratio was improved 6 and 7% in the birds of 20 and 10% restriction groups, respectively. Results of Table 3 show that carcass characteristics did not affected by treatments ($p>0.05$). The results of nutrients digestibility and blood chemical parameters are shown in Table 4. Results indicated that the effects of treatments had no significant effect on dry matter digestibility ($p>0.05$) whereas crude protein and crude fat digestibility were affected by either feed restriction or enzyme supplementation ($p<0.05$). Results show that enzyme supplementation increased both crude protein and crude fat digestibility. The crude protein and crude fat digestibility were higher in 20 and 10% feed restriction, respectively. Table 4 shows the effects of experimental groups on blood chemical parameters such as serum triglyceride, total cholesterol and glucose. The blood serum triglyceride of broilers was not affected by treatment ($p>0.05$) in contrast with glucose and cholesterol ($p<0.05$). Blood cholesterol concentration was influenced by restriction groups and birds fed base on the 30% feed restriction treatment had the highest serum cholesterol. Enzyme supplementation had no effect on cholesterol concentration ($p>0.05$). Blood glucose concentration was affected by either feed restriction or enzyme supplementation ($p<0.05$). Results of Table 4 indicated that glucose content of blood was higher in birds fed with control group.

Feed restriction causes to increase of enzyme activity in broilers digestive tract and this mechanism is one of the important factors which improve the compensatory growth in chicks (Zhan *et al*., 2007). Teguia and his colleagues (Teguia *et al*., 2004) reported that use of feed restriction in broilers decline body gain in restriction phase which is similar to the results.

However, the body gain of birds improves after the restriction period (in compensatory phase). Zhan *et al*. (2007) indicated that final weight of birds fed base on feed restriction was similar to those fed *ad libitum*. The results of this experiment show that birds on feed restriction had a compensatory growth in growing phase, so the final weight of them had no significant difference to control group.

Leeson and Zubair (1997) reported that nutrient restriction significantly depressed body weight gain from 6-12 days and birds in the full-fed group gained about to 2.5 times more weight than did birds in either restricted groups. In addition, there was not significant difference concerning feed conversion ratio between feed-restricted and *ad libitum* broilers. These results are consistent with previous reports (Zubair and Leeson, 1994; Camacho *et al*., 2004). Results of current study indicated that effects of both early feed restriction and enzyme supplementation on carcass characteristics were not statistically significant. Some researchers demonstrated

Table 2: Gain, feed intake and FCR[1] of treated broilers

Treatments		Parameters		
Restriction (%)	Enzyme	Gain (g)	Feed intake (g)	FCR
0		46.68	90.14	1.94
10		47.97	89.30	1.86
20		47.97	89.64	1.87
30		45.19	88.05	1.95
SEM		1.48	1.57	0.03
	+	46.70	88.83	1.90
	-	47.20	89.73	1.91
SEM		1.05	1.11	0.02
Restriction x Enzyme		NS	NS	NS

$p<0.05$, [1]Feed conversion ratio

Table 3: Carcass yield, abdominal fat and internal organs of treated broilers

Treatments		Parameters (%)				
Restriction (%)	Enzyme	Breast	Thigh	Abdominal fat	Pancreas	Intestines
0		31.49	28.42	3.28	0.35	4.11
10		29.54	28.43	3.12	0.34	3.79
20		30.48	27.83	3.37	0.39	4.27
30		29.33	28.66	3.42	0.33	4.06
SEM		0.93	0.47	0.49	0.02	0.22
	+	30.50	28.12	3.50	0.36	4.01
	-	29.92	28.55	3.07	0.35	4.10
SEM		0.65	0.33	0.35	0.03	0.15
Restriction x Enzyme		NS	NS	NS	NS	NS

$p<0.05$

Table 4: Nutrient digestibility of diets and blood biochemical parameters of treated broilers

Treatments		Parameters (%)			Parameters (mg dL^{-1})		
Restriction (%)	Enzyme	DM[1]	CP[2]	CF[3]	Cholesterol	Tri-glyceride	Glucose
0		77.50	79.16^{a}	73.50^{ab}	137.83^{ab}	44.00	242.82^{a}
10		78.51	78.50^{a}	74.66^{a}	151.83^{ab}	49.33	220.83^{b}
20		80.50	80.00^{a}	74.50^{ab}	132.50^{b}	50.33	218.16^{b}
30		78.83	75.33^{b}	72.01^{b}	170.81^{a}	49.32	214.15^{b}
SEM		1.16	1.51	0.80	10.77	3.97	6.22
	+	77.66	77.16^{b}	71.41^{b}	150.67	50.16	216.41^{b}
	-	79.00	79.33^{a}	75.91^{a}	145.83	46.33	231.58^{a}
SEM		0.84	0.56	0.57	7.76	0.34	4.48
Restriction x Enzyme		NS	NS	NS	NS	NS	NS

Means within columns followed by different letters are significantly different ($p<0.05$), [1]Dry matter, [2]Crude protein, [3]Crude fat

that feed restriction reduced the growth rate of tissues (adipose tissue), carcass yield, breast muscle and fat deposition in abdomen (Hornick *et al*., 2000; Zhan *et al*., 2007).

It might be due to fat mobilization to energy supply, so abdominal fat might be mobilized more easily during a fasting period (Zhan *et al*., 2007). Rincon and Leeson (2002) reported that abdominal fat deposition was not significantly affected by feed restriction however, breast meat percentage was better in broilers fed *ad libitum*. They are indicated that decrease of breast muscle in feed restriction group might be due to lowering amino acid intake linked with decreasing energy intake.

Nutrient digestibility was affected by restriction feeding in this experiment. Leeson and Zubair (1997) demonstrated that from 6-21 days, birds subjected to physical restriction from 6-12 used energy the most efficient. Use of enzyme supplementation improved crude protein and crude fat digestibility in this experiment. Increasing of nutrient digestibility by addition of enzyme supplementation in broilers has been demonstrated in many studies (Josefiak *et al*., 2006; Yamazaki *et al*., 2007; Zhou *et al*., 2009). More of these studied have explained the positive effects of enzymes which eliminate the negative effects of soluble NSP in broilers.

Researchers suggest that use of enzyme in diets improves nutrient digestibility in starter phase than treatments without enzyme and this effect may be due to insufficient secretion of endogenous enzymes at 1-14 days of age. Batal and Parsons (2002) indicated that apparent digestibility of starch and fat increased 6 and 18%, respectively with increasing age to 14 days of age. Ileal nitrogen digestibility increases from 78% at day 4 to nearly 90% at day 21 for broilers because proteolytic activity in the intestines may not be sufficient in the early post hatch period (Noy and Sklan, 1995). As anticipated, nutrients digestibility were better in birds fed diets containing enzyme supplementation. Serum blood glucose of broilers fed diet with enzyme was higher than without enzyme group also there was a linear decrease in blood glucose to response of increase of restriction. A dearth of information exists in terms of blood parameters in poultry therefore, direct comparisons cannot be made.

CONCLUSION

The present investigation demonstrated that feed restriction with and without enzyme supplementation did not affect growth performance of broilers. So, these results may be suitable for broilers farm manager due to decrease of the feed cost.

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