Asian Journal of Poultry Science

ISSN 1819-3609

Academic Journals Inc.

www.academicjournals.com

Asian Journal of Poultry Science 5 (1): 35-40, 2011
ISSN 1819-3609 / DOI: 10.3923/ajpsaj.2011.35.40

The Effects of Different Levels of Dietary Protein, Energy and Using Fat on the Performance of Broiler Chicks at the end of the Third Weeks

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ABSTRACT

The purpose of this study was to assess and compare the different levels of energy, protein and using fat in diet on the performance of broiler at the end of the third week. A total of 2000 one-day-old male broilers (Ross 308) were randomly assigned in a 2×2×2 factorial design according to the following factors: the amount of protein (23 and 21 percent CP), the amount of energy (3200 and 3000 kcal kg^{-1} ME) and using fat (limiting or non-limiting dietary fat). During the first third week, significant independent effects of dietary protein levels on Bodyweight (BW) and energy levels on Feed Conversion Rate (FCR) were observed. There was no significant difference between energy and bodyweight at all weeks. The significant difference observed between protein and bodyweight in 1st and 2nd weeks ($p<0.001$) and 3rd week ($p<0.05$). There was no significant difference between using unlimited fat diet and limited one on both BW and FCR. In 0-7 day old, feeding diets didn't show any significant difference in feeding conversion but in 7-21 day old chicks, feeding diets with higher energy level significantly decreased FCR especially at the 2nd and 3rd week ($p<0.001$) but there was no significant difference in FCR with higher and lower levels of protein. There was no significant interaction effect between any of the parameters except for "energy×fat" (BW: 1st and 2nd weeks: $p<0.001$, 3rd week: $p<0.01$; FCR: 1st, 2nd and 3rd weeks: $p<0.05$) and protein×fat (just the FCR in 1st week: $p<0.05$). So using the soybean oil with the diet containing 3200 kcal kg^{-1} and 21% CP is suggested in 0-21 day old broiler chickens.

Key words: Broiler, nutrient density, soybean oil, bodyweight, feed conversion rate, metabolizable energy, crude protein

INTRODUCTION

Broiler industry is growing rapidly throughout the developing countries. There have been a notable increase in growth rate and feed efficiency in commercial broiler chickens in last 20 years. It is well recognized that feed represents the most significant cost of broiler production. Most production costs estimates range from 60-80% as being feed cost (Durunna *et al*., 2005).

Energy and protein are very important nutrients for broilers like other living creatures. Energy is required for body functioning and protein is an essential constituent of all tissues of animal body. Protein having major effect on growth performance of the bird is the most expensive nutrient in broiler diets (Kamran *et al*., 2004). It is a widely accepted principle in poultry nutrition that dietary energy and the essential nutrients must be considered as an entity.

Fats or oils are as energy rich feeds. Fats also provide varying quantities of the essential nutrient linoleic acid (Leeson *et al.*, 2001). Another important role of fats in diet is its inhibition from de novo lipogenesis in broiler chickens (Wongsuthavas *et al.*, 2011) that could increase energy efficiency in diets. Dietary fat also may interact with other nutrients in the diet. Successful broiler development is dependant on optimal feed intake and it is dependant on a number of factors such as environmental temperature, physical feed quality, diet nutrient density and level of protein in diet and its ratio to energy. Reduction in feed efficiency and production of leaner bird in diets with excess dietary CP and increasing fat accretion in broilers fed with a diet with low protein content reported by Buyse *et al.* (1992). These researchers found that broilers reared on a 15% protein diet increased their feed intake in an attempt to meet their protein and amino acid requirement. The results of Rosebrough *et al.* (1999) experiment with broilers showed that the level of dietary CP must be considered when dietary fat is used to decrease de novo lipogenesis. They showed that dietary fat addition to diets containing low CP levels did not decrease lipogenesis to the degree noted when added to a diet containing a higher level of CP. Other researchers noted that fat accretion will increase when the energy to protein ratio of broiler diets increase (Kita *et al.*, 1993; Nieto *et al.*, 1997; Collin *et al.*, 2003).

To ensure maximum utilization of energy, protein and every nutrient of the diet, a right proportion of these nutrients are necessary to optimum growth of the birds and to minimize the surplus use of vital dietary component and because the first few days after hatch now represent a greater percentage of a broiler's life span than any time in history, it is critical that the bird be given every opportunity to get off to a good start (Nir *et al.*, 1993). The study was therefore, conducted to investigate the effect of different levels of fat, energy and protein on the performance of broilers in starter period upon the broilers performance. In order to use the best ratio of energy and protein and fat of diet in nutrition of broiler was determined.

MATERIALS AND METHODS

This research project was conducted from 02/01/2010 to 09/10/2010 in Amin-Abad Research Institute and Department of Animal and poultry Health and Nutrition, Faculty of Veterinary Medicine, University of Tehran.

Two thousands one-day-old male chicks (45±1 g chick^{-1}) randomly divided into eight treatment groups. According to the treatment groups, the chicks were arranged as 2×2×2 factorials in completely randomized design with the following factors: the amount of protein (23 and 21% dietary protein), the amount of energy (3200 and 3000 kcal kg^{-1} ME) and using fat (limiting dietary fat with 2% of soybean oil or non-limiting dietary fat). Each treatment group consisted of 5 replicates of 50 chicks per experimental unit and the stocking density was 16 birds m^{-2}. The light was provided 24 h daily at 0-21 days of age. Temperature and management were maintained according to conventional rearing practice. Eight experimental diets were formulated to provide similar nutrients content according the broilers nutrients requirement suggested by NRC (1994), except protein, energy and fat levels. Formulations and composition of the diets are given in Table 1. The experimental diets in mashed form were based on corn, soybean meal and in some treatments fishmeal and the gluten of corn and wheat were used to adjust the levels of protein and energy contents.

Statistical analysis: The data were analyzed by two-way analysis of variance using the General Linear Model (GLM) procedure described by Cody and Smith (1997) and ANOVA. Data were tested

Table 1: Feed ingredients and compositions of experimental diets suggested by NRC (1994) (except protein, energy and fat)

	Unlimited fat diet				Limited fat diet (2%)			
Items	1	2	3	4	5	6	7	8
Ingredients (g/100 g)								
Corn	48	52.4	54.3	58.8	65.5	58.7	68.9	61.5
Soybean meal	40	39.2	36.6	33.8	10.8	29.6	10.7	29.7
Vegetable fat	7.44	3.8	6.45	2.75	2	2	2	2
Monocalcium phosphate	1.45	1.45	1.5	1.45	1	1	1	1.3
Limestone	1.7	1.7	1.7	1.7	1.3	1.3	1.35	1.5
Salt	0.4	0.4	0.4	0.4	0.32	0.31	0.31	0.4
Methionine	0.32	0.31	0.32	0.31	0.15	0.26	0.18	0.29
Lysine	0.19	0.2	0.23	0.24	0.43	0.13	0.36	0.21
Vit and Min Premix[1]	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Fish meal	-	-	-	-	8	6.2	8	2.6
Corn gluten	-	-	-	-	5	-	3	-
Wheat gluten	-	-	-	-	5	-	3.7	-
Calculated composition								
Crude protein (%)	23	23	21	21	23	23	21	21
ME (kcal/kg)	3200	3000	3200	3000	3200	3000	3200	3000
Fat (%)	10	6.5	9	5.4	5.4	5.4	5.5	5.1
Calcium (%)	1	1	1	1	1	1	1	1
Av. Phosphorus (%)	0.45	0.45	0.45	0.45	0.45	0.45	0.45	0.45
Fiber (%)	3.7	3.7	3.5	3.5	2.2	3.3	2.2	3.3
Sodium (%)	0.18	0.18	0.18	0.18	0.18	0.18	0.18	0.18
Methionine (%)	0.65	0.65	0.62	0.62	0.64	0.66	0.62	0.63
Lysine (%)	1.35	1.35	1.25	1.25	1.35	1.35	1.25	1.25
Methionine + cystine (%)	1	1	0.95	0.95	1	1	0.95	0.95

[1]Each kg of premix provided, vitamin A 10000 IU: vitamin D3L, 2500 IU: vitamin K, 2.4 mg: vitamin E, 44 IU; biotin, 0.1 mg; folic acid, 2.0 mg; niacin, 25 mg; calcium pentothenate, 14.32 mg; pyridoxine, 3.10 mg; riboflavin, 5 mg; thiamin, 1.2 mg; vitamin B12, 10.5 μg; Fe, 85 mg; Mn, 125 mg; Cu, 7.8 mg; Se, 0.09 mg; Zn, 60 mg; choline chloride, 5.5 mg

for being normally distributed before analysis of variance. The differences among treatment means were determined using Duncan's new multiple-range test.

RESULTS

During the first third week, significant independent effects of dietary protein levels on BW (1st and 2nd week: $p<0.001$; 3rd week: $p<0.05$) and energy levels on FCR (2nd and 3rd week: $p<0.001$) were observed. Although, the highest (793 g) and lowest (742 g) BW at 3 weeks of age were observed in chickens fed the diets containing 3200 and 3000 kcal ME kg^{-1} energy and 23 and 21% protein, respectively,(Table 2) but there was no significant difference ($p>0.05$) between energy and BW at all weeks. The significant difference observed between protein and bodyweight in 1st and 2nd weeks ($p<0.001$) and 3rd week ($p<0.05$) (Table 3). The groups that consumed the higher protein, showed the higher bodyweight. There was no significant difference ($p>0.05$) between using unlimited fat diet and limited one on both BW and FCR (Table 3).

There was a significant difference in FCR in chicks fed with different experimental diets in ages 0-21 ($p<0.001$) (Table 2). In 0-7 day old, feeding diets didn't show any significant difference ($p>0.05$) in feeding conversion but in 7-21 day old chicks, feeding diets with higher energy level significantly decreased FCR ($p<0.001$), but there was no significant difference in feed conversion

Table 2: BW and FCR of broiler chickens fed on limited and unlimited fat diets as affected by different levels of Metabolizable Energy (ME) and Crude Protein (CP) at the end of the third week (Mean+SE)*

				BW (g)			FCR		
Treatment	Protein (%)	En(kcal kg^{-1})	Fat**	1st week	2nd week	3rd week	1st week	2nd week	3rd week
1	23	3200	1	163±1.6^{ab}	402±5.3^{ab}	793±12.9^{a}	0.94±0.93^{cd}	1.24±0.023^{bcd}	1.43±0.033^{bc}
2	23	3000	1	156±1.5^{cde}	380±6.3^{cde}	749±17.8^{bc}	0.92±0.87^{d}	1.29±0.022^{ab}	1.48±0.023^{ab}
3	21	3200	1	158±2^{bcd}	388±3.7^{bcd}	781±10.7^{ab}	0.94±0.93^{cd}	1.22±0.003^{d}	1.38±0.013^{c}
4	21	3000	1	150±2.6^{e}	371±6^{e}	739±11.2^{c}	1.00±0.97^{a}	1.33±0.019^{a}	1.51±0.028^{a}
5	23	3200	2	162±1.2^{abc}	392±4.8^{abc}	762±17.1^{abc}	0.99±0.94^{ab}	1.22±0.008^{d}	1.38±0.025^{c}
6	23	3000	2	168±1.7^{a}	404±4.3^{a}	792±5.3^{a}	0.93±0.92^{cd}	1.25±0.007^{bcd}	1.40±0.008^{c}
7	21	3200	2	152±3.2^{de}	374±6de	746±8.8^{c}	0.95±0.91^{bcd}	1.23±0.01^{cd}	1.38±0.008^{c}
8	21	3000	2	156±1.9^{cde}	380±1.2^{cde}	742±6.9^{bc}	0.97±0.95^{abc}	1.27±0.013^{bc}	1.48±0.025^{ab}
p.value				0	0	0.008	0	0	0

Means followed by different superscripts within a column of each parameter are significantly different ($p<0.05$). *Mean of 5 replicates having 50 birds in each replicate **1 = diets with more than 2% fat, 2 = diets with limited fat (2%)

Table 3: The effect of fat, energy and protein and their interactions on the performance of broilers at the end of the third week

Source	E×P×F	P×F	E×F	E×P	F	P	E
BW(1st week)	NS	NS	***	NS	NS	***	NS
BW(2nd week)	NS	NS	***	NS	NS	***	NS
BW(3rd week)	NS	NS	**	NS	NS	*	NS
FCR(1st week)	NS	*	*	NS	NS	NS	NS
FCR(2nd week)	NS	NS	*	NS	NS	NS	***
FCR(3rd week)	NS	NS	*	NS	NS	NS	

NS = non-significant; * = $p<0.05$; ** = $p<0.01$; *** = $p<0.001$ F: Fat; P: Protein; E: Energy; E*P: Conteraction between energy and protein; E×F: Interaction between energy and fat; P×F: Interaction between protein and fat; E×P×F: Interaction between energy, protein and fat

ratio with higher and lower levels of protein ($p>0.05$). There was no significant interaction effect between any of the parameters except for energy×fat (BW: 1st and 2nd weeks: $p<0.001$, 3rd week: $p<0.01$; FCR: 1st, 2nd and 3rd weeks: $p<0.05$) and protein×fat (just the FCR in 1st week: $p<0.05$) (Table 3). It was observed that at the higher level of energy, the bodyweight of treatments feeding the unlimited fat diet was higher than the treatments feeding the limited fat diet (unlike the lower level of energy). The same response was observed for FCR. It has been shown in Table 2 and 3 that the treatments with 23% CP showed a higher BW but no significant effect on FCR was observed.

There is a significant difference between the different levels of energy on FCR especially at the 2nd and 3rd week ($p<0.001$) (unlike the BW).

DISCUSSION

There was no significant difference between BW and energy at all three weeks ($p>0.05$). This is in agreement with results of some investigators who showed that dietary energy had less effect on the growth performance (Summers *et al*., 1992; Renden *et al*., 1992; Leeson *et al*., 1996a, b). These investigators also showed that the dietary protein had less effect on the growth performance which is in contrast to this study.

The significant difference observed between protein and bodyweight in all weeks(1st and 2nd weeks: $p<0.001$ and 3rd week: $p<0.05$). The result is agreed with several investigators who showed

that increased dietary protein content resulted in improved growth performance (Jackson *et al.*, 1982; Smith and Pesti, 1998; Temim *et al.*, 2000; Nguyen *et al.*, 2010).

It was shown that feeding different levels of soybean oil in chicks fed with a NRC recommended protein level had no significant effect on weight gain in 7-21 (Tabiedian *et al.*, 2005) which is in agreement with this study. But they also showed that in 7-21 day old chicks feeding a diet with 2.5% soybean oil and a protein level 10% more than NRC recommendation resulted to lowest feed conversion. In contrast, Nitsan *et al.* (1997) showed that addition of 3% soybean oil in the diet improved weight gain than the diet containing 0% soybean oil.

It has been shown that the treatments with 23% CP showed a higher BW but no effect on FCR was observed. This result is in accordance with Moravej *et al.* (2006), who showed that increasing diet protein up to 23% improved body weight gain in broiler chickens that fed the diets containing different levels of protein (19, 20, 21, 22 and 23%). This may be because of better diet digestibility and higher levels of energy and amino acid in this diet.

Meanwhile there is a significant difference between the different levels of energy on FCR especially at the 2nd and 3rd week ($p<0.001$) (unlike the BW). This is in agreement with results of Sadeghi and Tabiedian (2005), who showed that in 7-21 day old chicks feeding diets with higher energy level numerically decreased feed conversion ratio. This result also is in accordance with Reginatto *et al.* (2000), who declared in two experiments with different energy to protein ratio, the performance was improved with higher levels of dietary energy. On the other hands, it was shown that protein utilization was improved with higher levels of dietary energy and with lower levels of dietary CP.

CONCLUSION

This study concluded that there is no significant difference between protein and FCR (unlike the energy), using the diet with high energy(3200 kcal kg^{-1}) and moderate level of protein (21%) is suggested. Because of the significant interaction between energy and fat, it's better to use the oil just with the high energy diet for the better performance. So using the oil with the diet containing 3200 kcal kg^{-1} and 21% CP is suggested in 0-21 day old broiler chickens.

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