Effects of dietary energy and protein dilution and time of feed replacement from starter to grower on broiler chickens performance

Behrooz AZIZI[1], Ghorbanali SADEGHI, Ahmad Karimi, Fakhradin ABED

[1]Department of Animal Science, College of Agriculture, University of Kurdistan, Sanandaj, Iran Postal cod: 66177-15175 Tel: +98-9183717052 Fax: +98-918871660070 Email: gsadeghi@uok.ac.ir and ghorbanalis@yahoo.com

ABSTRACT

An experiment was conducted to study the effects of dietary energy and protein dilution and time of feed replacement from starter to grower on performance of broilers with a 2×3 factorial arrangement in a completely randomized design with 480 day-old broilers from 1-42 day of age. Experimental treatments were 5% energy and protein diluted diets and starter diet was fed to 7, 14 or 21 days and finisher diet was fed beginning at 35 days. Grower diet was fed for variable times depending upon termination of feeding starter diet and initiation of finisher diet.

Dilution of both energy and protein had no ($P>0.05$) significant effect on chicks performance, but significantly ($P<0.05$) increased breast meat yield. Reduction the time of feeding starter diet did not show any significant effects on bird's performance.

From 1-42 days of age, the interaction between dilution of both energy and protein and changing time from starter to grower diets on body weight and feed intake was not significant($P<0.05$). The results from this study suggest that diluting of both energy and protein up to 5% from 1-42 days of age and decreasing the time of starter diet had no adverse effect on broiler chickens performance and it may be beneficial economically.

Keywords: Energy; Protein; Dilution; Broiler; Starter; Grower

Introduction

Due to reduction in growing period, also because of altering the growth pattern of broiler chickens, the length of time that various diets are fed has also tended to change. Changing the diet in proper time could improve flock performance and uniformity. In recent years, there is an enhanced interest to determine the time of ration change for available commercial strains [9, 11, 12, 15]. However, the optimum time to make these dietary changes is depend upon feed cost, diet nutrient content and benefits derived from altering the nutrient content of the feed. Previous studies

has showed that decreasing the time of feeding starter diet from 28 to 7 days has no adverse effect on weight gain, feed intake and feed conversion ratio [10].

Increased growth rate of the broiler chicken is achieved by concomitant increase in feed intake [7]. It is generally assumed that growth rate of modern broiler chickens relates in large part to their voracious appetite. As the broiler chicken gets older, its carcass is composed of progressively less protein and more fat. In this regard, diet dilution of older broilers can be used to reduce carcass fatness, but that carcass weight is adversely affected [7]. Energy restriction during the last days of finishing resulted in increased fat pad weight but had little or no influence on dressing percentage or cooked carcass weight [1]. Excess dietary proteins also increase heat production and water consumption which increase moisture content of litter [8]. 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 has been reported [3]. However, the optimum time to replace starter diet by grower may be affect by diet nutrient content and also, the effect of energy and protein dilution on broiler performance may be affect by the duration of feeding starter, grower and finisher diets. Hence, the objective of this study was to determine the effects of energy and protein dilution (at 5% level) throughout a 42-day growth period and change in feeding program (starter to grower diet) at selected ages on broiler performance and carcass characteristics.

Materials and methods

Bird Husbandry

In this experiment, 480 one-day old broiler (Ross 308) chicks were obtained from a local hatchery. Chicks were randomly assigned to 24 floor pens (20 chicks/pen; pen size =1.75 m2). Each pen equipped with one feeder and one bell drinker. Incandescent lamps were used to supplement natural daylight to provide 23hr light and 1 hr of darkness. Birds had access to feed and water *ad libitum*. Temperature was set at 32˚C in one day of age and then gradually reduced as the birds progressed in age, with a final temperature of 18˚C at 42 d.

Dietary Treatments

This experiment employed 6 treatments administered in a 2×3 factorial arrangement, with two energy and protein level (standard and 5% lower than standard recommendations) and three starter diet feeding times (0 to7, 7 to 14 and 14 to 21 days). Finisher diet was fed beginning at 35 day. Grower diet was fed for available times depending upon termination of feeding starter diet and initiation of finisher diet. Standard diets were formulated to meet NRC (1994) recommendations (Table 1). Diet dilution was achieved by substitution of sand for the major ingredients in the diet. Diluted diets involved 5% dilution of both energy and protein. Other nutrients levels were not changed.

Table1. Ingredient composition of experimental feeds provided to Ross 308 broilers from 1 to 42 d of age

	Standard diets			Diluted diets		
	Starter	Grower	Finisher	Starter	Grower	Finisher
Ingredient,%						
Corn	57.29	60.31	66.01	58.51	65.94	71.36
Soybean meal(44% CP)	34.79	29.91	24.60	31.75	26.23	21.21
Fish meal	3.00	3.00	3.00	3.00	3.00	3.00
Soybean oil	1.46	3.48	3.27	0.00	0.36	0.15
Dicalcium phosphate	1.15	1.20	1.17	1.19	1.23	1.20
Calcium carbonate	1.19	0.95	0.93	1.19	0.96	0.94
Sodium chloride	0.31	0.31	0.30	0.31	0.30	0.30
DL-Met	0.15	0.15	0.07	0.20	0.22	0.17
L-Lys.HCL	0.17	0.19	0.14	0.5	0.27	0.17
Mineral premix[1]	0.25	0.25	0.25	0.25	0.25	0.25
Vitamin premix[2]	0.25	0.25	0.25	0.25	0.25	0.25
Sand	0.00	0.00	0.00	3.10	1.00	1.00
Calculated analysis						
AME,kcal/kg	2910	3075	3125	2764	2921	2968
CP, %	22.21	20.33	18.38	21.10	19.32	17.46
Calcium, %	0.97	0.88	0.85	0.97	0.88	0.85
Available phosphorus, %	0.44	0.44	0.42	0.44	0.44	0.42
Met, %	0.53	0.52	0.46	0.53	0.54	0.46
Lys, %	1.33	1.21	1.02	1.33	1.21	1.02
Met+ cys, %	0.88	0.85	0.76	0.88	0.85	0.76

[1]Vitamin premix include per kilogram of diet: Vit.A, 3600000 IU; Vit.D, 800000 IU; Vit.E, 7200 IU; Menadion, 800 mg; Vit.K3, 800 mg; Thiamine, 720 IU; Riboflavin, 2640 mg; Niacin, 4000 mg; Pyridoxine, 12000 mg; Vit.B12, 6 mg; D-Pantothenic acid,16000 mg; Folic acid, 400 mg; Biotin, 40 mg; Choline chloride, 100000 mg; Antioxidant, 40000 mg
[2]Mineral premix include per kilogram of diet: Manganese, 40000 mg; Zinc, 33880 mg; Iron, 20000 mg; Copper, 4000 mg; Iodine, 400 mg; Choline chloride, 10000 mg; Se, 80 mg.

Measurements

Weight gain, feed intake and feed conversion ratio were measured weekly on a pen basis from 1-42 days period. Mortality was recorded daily; birds that died were weighted and the weight used for calculating the feed conversion ratio. At 42 d, two birds per pen were randomly selected, weighted, subjected to 6-hr feed withdrawal, and processed with manual evisceration to determine dressing percentage, abdominal fat pad, and parts yield.

Statistical analysis

Experiment was conducted as a completely randomized design with a 2×3 factorial arrangement. Experiment had 4 replicated pens per treatment. Data were analyzed using the General Linear Models (GLM) procedure of SAS. When differences among means were found, means were separated using Duncan's Multiple Range Test.

Results and discussion

Dilution of both protein and energy in the diets had no ($P>0.05$) significant effect on body weight in different ages (Table 2). During the first 21 d of age, diet energy and protein dilution resulted to a significant increase ($P<0.05$) in feed intake. The energy content of diet is a key factor to control feed intake in poultry, as broiler chickens eat to their energy requirement [8]. Thus, lower feed intake in this group could be described by lower energy content of diet. However, from 21 to 42 and 1 to 42 d of age the feed intake were not statically different in chicks fed with standard or diluted

Table2. Effect of changing time of feeding starter and grower diets and diet energy and protein dilution on live performance responses of broilers.

	Body Weight (g)			Feed Intake (g)			Feed Conversion Ratio		
	0-21d	21-42 d	1-42d	0-21d	21-42 d	1-42 d	0-21 d	21-42 d	1-42d
Diet									
Diluted	523.42	1469.73	1993.15	785.79a	2563.96	3349.74	1.50	1.74b	1.68
Standard	508.40	1439.66	1948.06	742.97b	2617.93	3360.90	1.46	1.81a	1.72
Days of starter diet change									
7	518.59	1478.21	1996.81	768.22	2672.90	3441.10	1.48	1.81	1.72
14	503.62	1428.32	1931.93	755.08	2518.72	3273.80	1.49	1.76	1.69
21	525.52	1457.56	1983.07	769.84	2581.20	3351.00	1.46	1.77	1.69
SEM*	6.130	16.885	20.162	9.196	36.767	42.216	0.014	0.017	0.012

a-b: Means in columns with different superscripts are significantly different ($P<0.05$)
*Standard Error of Means

diets, and birds seems to adapt such that energy and protein dilution after 21 day of age. Although from 1 to 21 and 1 to 42 d of age no significant differences were observed for feed conversion ratio (FCR) between birds fed with standard or diluted diets, the FCR data shows that birds offered diets with lower energy and protein responded by being significantly ($P<0.05$) more efficient in term of feed utilization between 21 to 42 d of age (Table 2).

The effects of changing time of feeding starter to grower diet on performance of broilers grown to 42 days of age are shown in Table 2. Feeding the starter diet for 7, 14 or 21 days of age had no significant effect on body weight, feed intake and FCR, however, there was numerically greater growth, feed intake and FCR for birds subjected to starter diet for 7 days (Table 2). In agreement with our findings, Salari [10] showed that decreasing the time of feeding starter diet from 28 to 7 days had no significant effect on body weight gain. However, Saleh et al. [12] showed that increasing the length of starter diet feeding from 7 to 21 days of age increase total feed intake.

Table3. Effect of interaction among changing time of feeding starter and grower diets and diet energy and protein dilution on live performance of broilers.

Diet	Days of starter diet change	Body Weight (g)			Feed Intake (g)			Feed Conversion Ratio		
		0-21 d	21-42 d	1-42 d	0-21 d	21-42 d	1-42 d	0-21 d	21-42 d	1-42 d
Diluted	7	516.68	1499.11	2015.79	796.92	2630.90	3427.80	1.54a	1.75ab	1.70ab
	14	518.16	1471.50	1989.66	782.92	2584.00	3366.90	1.51ab	1.75ab	1.69ab
	21	535.44	1438.57	1974.01	777.52	2477.00	3254.50	1.45ab	1.72b	1.65b
Standard	7	520.51	1457.31	1977.82	739.52	2714.90	3454.40	1.42b	1.86a	1.74a
	14	489.08	1358.14	1874.21	727.24	2453.50	3180.70	1.48ab	1.76ab	1.69ab
	21	515.60	1476.54	1922.14	762.16	2685.40	3447.60	1.48ab	1.82ab	1.73ab
SEM*		6.468	15.050	18.850	9.033	35.023	41.033	0.013	0.015	0.011

a-b: Means in columns with different superscripts are significantly different ($P<0.05$)
*Standard Error of Means

There was no interaction between the diet energy and protein dilution and time of feeding starter diet on body weight and feed intake (Table 3). However, FCR was affected significantly. Birds offered standard diet and received starter diet for 7 days had lower ($P<0.05$) FCR from 1 to 21 days of age, although from 21 to 42 and 1 to 42 days of age, birds offered diluted diet and received the starter diet for 21 days had lower ($P<0.05$) FCR than others (Table 3).

Energy and protein intakes were reduced ($P<0.05$) in response to the dilution of the diet (Table 4) and this reduction in energy and protein intake was associated with no significant change in body weight. The results show that birds fed lower energy and protein diets were much more efficient in converting energy and protein to body weight gain. Changing the time of feeding starter to grower diet had no significant effect on energy and protein intakes. The interaction effect of diet energy and protein

dilution and time of feeding starter diet on energy and protein intake was significant (P<0.05). Birds fed with diluted diet for 21 days had lower (P<0.05) energy and protein intake than those fed with standard diet for 21 days of age (Table 5). This is well coincidence with lower feed intake in this group.

At 42 d of age, energy and protein dilution of diet could not affect the weight of thigh, small intestine, gizzard, liver, pancreas and abdominal fat pad, although abdominal fat pad was numerically lower in birds that offered diluted diet (Table 6). Carcass and breast weight were significantly (P<0.05) heavier in birds offered diets of lower energy and protein (Table 6). The starter diet contains more lysine than the grower and finisher diets (Table 1), and higher feed intake in starter period in birds fed with diluted diets may be resulted to higher lysine intake in this group. Some researchers have shown that an additional lysine intake increase breast meat accretion [2, 4, 5, 6].

Table4. Effect of changing time of feeding starter and grower diets and diet energy and protein dilution on energy and protein intake of broilers at 42 days of age.

	Energy Intake(kcal)	Protein Intake(g)
Diet		
Diluted	9853b	638.31b
Standard	10380.8a	672.62a
Days of starter diet change		
7	10388.9	664.1
14	9870.1	637.34
21	10091.6	664.94

a-b: Means in columns with different superscripts are significantly different (P<0.05)

Time of feeding starter diet had no significant effect on measured carcass parameters (Table 6). However, the abdominal fat pad was decreased numerically as time of feeding starter diet increased, that this is in agreement with findings of Saleh et al. [12].

The interaction effect of diet dilution and changing time of feeding starter to grower diet on the carcass, breast, small intestine and liver weight were significant (Table 7). Birds that fed with standard diet and received starter diet for 7 days had greater (P<0.05) carcass weight than others. Birds that offered diets of lower energy and protein content and received starter diet for 7 days had greater (P<0.05) breast weight and lower (P<0.05) intestine and liver weights (Table5).

Table5. Effect of interaction among changing time of feeding starter and grower diets and diet energy and protein dilution on energy and protein intake of broilers at 42 days of age.

Diet	Days of starter diet change	Energy Intake(kcal)	Protein Intake(g)
Diluted	7	10074.2ab	644.0ab
	14	9922.2ab	641.0ab
	21	9562.6b	629.7b
Undiluted	7	10003.7ab	684.1ab
	14	9818.1ab	633.5b
	21	10620.5a	700.1a
SEM*		140.06	9.04

a-b: Means in columns with different superscripts are significantly different (P<0.05)

*Standard Error of Means

Table6. Effect of changing time of feeding starter and grower diets and diet energy and protein dilution on carcass characteristics responses of broilers.

	Carcass	Breast meat	Thigh	Small intestine	Gizzard	Liver	Pancreas	Abdominal fat
Diet								
Diluted	74.76a	24.90a	22.98	2.49	1.49	2.18	0.22	1.75
Undiluted	72.24b	22.54b	22.81	2.70	1.75	2.22	0.22	1.88
Days of starter diet change								
7	74.12	24.71	23.34	2.42	1.44	2.10	0.21	1.92
14	72.43	22.96	22.33	2.72	1.49	2.14	0.23	1.78
21	73.97	23.48	23.03	2.63	1.57	2.37	0.23	1.75
SEM*	0.680	0.443	0.304	0.068	0.032	0.059	0.009	0.067

a-b: Means in columns with different superscripts are significantly different (P<0.05)
*Standard Error of Means

Table7. Effect of interaction among changing time of feeding starter and grower diets and diet energy and protein dilution on carcass characteristics responses of broilers.

Diet	Days of starter diet change	Carcass	Breast meat	Thigh	Small intestine	Gizzard	Liver	Pancreas	Abdominal fat
Diluted	7	73.52ab	25.91a	22.96	2.36b	1.44	2.09b	0.19	1.69
	14	73.72ab	24.54ab	22.69	2.46b	1.41	1.95b	0.23	1.73
	21	72.66ab	24.24ab	23.31	2.64ab	1.63	2.52a	0.26	1.82
Undiluted	7	74.71a	23.51ab	23.71	2.49b	1.44	2.11b	0.23	2.15
	14	71.12b	21.38b	21.97	2.98a	1.57	2.30ab	0.23	1.82
	21	70.90b	22.72ab	22.76	2.63ab	1.52	2.22ab	0.20	1.69
SEM*		0.633	0.449	0.269	0.059	0.030	0.052	0.008	0.061

a-b: Means in columns with different superscripts are significantly different (P<0.05)
*Standard Error Means

Conclusion

In conclusion it can be suggested that: 1) dilution of diet energy and protein up to 5% from 1-42 days of age had no adverse effect on broiler chickens performance, however, dilution of energy and protein up to 5% could not be used to reduce of excess accumulation of carcass fat.

2) Decreasing time of starter diet up to 7 days had no adverse effect on broiler chickens performance and based on cost differences between standard and diluted diets or between starter, grower and finisher diets, dilution of diet energy and protein and/or changing diets at earlier ages seems to be beneficial economically.

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