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Effect of Feeding Programs on Broilers Cobb and Arbor Acres plus Performance

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Abstract: The main objective of this study was to determine the effects of various feeding programs (with different energy protein levels) and strain on broiler performance. Three hundred ninety six day old chicks were used in this study. The treatments groups were designed in a 2 x 3 factorial with two commercial strains (Cobb and Arbor Acres Plus) and three dietary programs 1) NRC regimen 2) Single diet (S) and 3) Phase Feeding Regimen (PF). Traits such as fed intake, feed conversion ratio, body weight, production index, mortality and growth rate were recorded for strains and feeding programs. At the end of period there were no significant effects between strains in mentioned traits. But for NRC and PF feed intake was significantly lower than S diet ($p<0.05$). Also NRC and PF diets significantly increased growth rate and average body weight comparing to S diet ($p<0.05$). NRC regimen, production index and feed conversion ratio were significantly better than PF and S diets ($p<0.01$). Except to feed conversion ratio at 42 days of age there were no significant interaction between strains and diets ($p>0.05$). S diet caused to decrees performance and economical efficiency. Decreasing diet cost and increasing economical efficiency were obtained by PF diet without any response in performance. It was concluded that better performance appeared by Arbor Acres Plus strain in regarding of NRC diet.

Key words: Broiler, single feeding, phase feeding

INTRODUCTION

In poultry production dietary protein provision is expensive part of diet formulation. Recently more attempts were made on reduction of dietary protein without any declining broilers performance.

Two main diet nutrients are energy and protein. Energy is required for growth, egg production, vital activities and body temperature maintenance. This is provided from carbohydrates, lipids and protein metabolism (Leeson and Summers, 2001). Rations with high level of energy increase growth rate and body weight (Scott *et al*., 1947). Also rations with high energy and similar protein levels have better effects on chick's performance (Leeson *et al*., 1991). Diet energy increasing induces an improvement in feed conversion ratio (Holsheimer and Veerkamp, 1992; Gonzalez and Pesti, 1993). Using of high level energy diets increases abdominal fat and dressing percentage (Lei and Van Beek, 1997). Body stores were destroyed and vital body activities were ceased by decreasing diet energy. In this occurrence after glycogen protein and finally adipose tissue were disrupted. Therefore protein tissue losses rather than adipose tissue losses quickly led to decreasing body weight since almost 80% of protein tissue was comprised from water. Growth rate and reduction adipose tissue were occurred by increasing too much levels of energy. This is related to reducing feed intake and therefore reduction of protein, amino acids, mineral and vitamin intake. Although in this state growth absolutely ceases but birds may be appear fattish. Bird ability for protein reserving is affected by energy availability; this means that diet energy enhancement increases body protein tissue (Lesson and Summers, 2001).

In broiler feed formulate reheating to maximum benefit and performance is very vital. Protein is one of important feedstuff in poultry feeding. Practical protein feeding in broiler production is based on diet's amino acids and biological usability of them (Leeson and Summers, 2001). Generally diet protein enhancing increases growth rate and body weight (Fancher and Jensen, 1989a,b,c; Olomu and Offiong, 1980). Protein levels of diet affects on feed intake. According to various studies with diet protein increasing feed intake decreases (Nakhata and Anderson, 1982; Parsons and Baker, 1982; Pesti and Fletcher, 1984; Moran *et al*., 1992) so feed conversion ratio improves (Smith and Pesti, 1998). Although protein decreasing, reduces growth rate and enhances feed conversion ratio but could be assumed some profits such as price reducing, environmental contamination decreasing and reducing of stress, moisture and ammonia in poultry houses.

National research council has divided broiler nutritional period into 3 phases: starting, growing and finishing (NRC, 1994). In this program protein and amino acids requirements gradually decrease. Now this manner is more common in many poultry farms. In single feeding program only one diet is used in all of the period. In this feeding program protein and energy requirements respectively lower and higher than the NRC recommended regimen (Skinernobel *et al*., 2001). Phase feeding program has been comprised from continuous rations with protein and amino acid levels are decreased weekly with aging. This program was

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more common in laying and breeder flocks but recently has been named for broilers. Emmert and Baker (1997) replaced NRC regimen with this program. They predict digestible amino acid requirements by regressive equations calculated by Baker and Han (1994); Baker (1997). These equations have been calculated based on the best levels of digestible Lysine and sulfur amino acids for starting, growing and finishing phases and including:

$$Y = 1.22-0.0095X \quad (1)$$

(Y: Digestible Lysine, X: Age)

$$Y = (0.88-0.0063X)/2 \quad (2)$$

(Y: Digestible Methionine and Cystine)

$$Y = 0.8-0.0054X \quad (3)$$

(Y: Digestible Threonine, X: Age)

Since in these equations age has been included we can predict amino acid requirements for upper of 42 days of age. This is a merit for phase feeding program. In this program in addition to reduction of expenses, nitrogen intake and thus nitrogen excretion decreases because protein decreasing, so this may has positive effects on environment condition. The aim of this study is to evaluation of various diets with different energy and protein levels to obtain best broiler performance and cheapest price of their diet.

MATERIALS AND METHODS

Three hundred sixty nine day old chicks with 40.70±2.38g average body weight were randomly distributed in 18 litter pens for 42 days. The experimental arrangement consisted of a 2 x 3 factorial design (two strains and three feeding programs) with 4 replications and 22 chicks in each. Strains included Cobb and Arbor Acres Plus. Feeding programs comprised from 3 rations in different stages. NRC regimen formulated based on NRC (1994) recommendations and were offered in 2 phases (0-21 and 21-42 days). Single diet contained 2899 kcal/kg metabolizable energy and 18.6% crude protein that were offered for all of the period (0-42). Phase feeding regimen included 3 starter diets (0-7, 7-14 and 14-21 days of age) and 3 grower diets (21-28, 28-35 and 35-42 days of age). Metabolizable energy was assigned 3100-3200 kcal/kg and crude protein was decreased weekly. House temperature was 32 to 34 at first week and decreased as level as 3°C per week. At the end of 3th and 6th weeks traits such as body weight, feed intake, feed conversion ratio, growth rate, production index, diet cost, diet cost per live body weight ($/kg) and mortality were recorded. Feed and water were given *ad libitum*. Ingredients and chemical composition of diets are shown in Table 1. For calculating of lysine and methionine Baker and Han (1994) equations were used.

Table 1: Ingredients and chemical composition of diets

	NRC			PF[2]					
	Starter	Grower	S[1]	Starter			Grower		
Ingredients	0-21	21-42	0-42	0-7	7-14	14-21	21-28	28-35	35-42
Corn	56.00	56.10	58.00	51.00	53.00	55.00	58.50	62.00	63.00
Wheat	-	11.20	12.00	7.00	9.00	11.00	11.70	12.00	14.80
Fish meal	5.00	4.80	3.00	5.00	5.00	3.50	3.50	2.00	1.50
Soybean meal	30.00	21.50	21.50	29.00	25.00	23.00	19.00	17.40	14.00
Vegetable oil	5.00	3.50	-	4.00	42.00	3.00	3.00	2.00	2.00
Lysine	0.30	0.01	0.15	0.30	0.20	0.25	0.15	0.20	0.20
DL-methionine	0.40	0.04	0.35	0.40	0.30	0.30	0.30	0.30	0.30
Dicalcium phosphate	1.00	0.90	1.50	1.20	1.20	1.45	1.45	1.50	1.70
Oyster shell flour	1.60	1.15	2.50	1.30	1.30	1.50	1.40	1.60	1.50
NaCl	0.20	0.30	0.50	0.30	0.30	0.50	0.50	0.50	0.50
Vitamin-mineral premix[3,4]	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50	0.50
Chemical analysis (DM basis)									
Dry matter	91.23	91.70	91.61	91.61	90.90	90.60	90.60	91.10	90.20
ME (kcal/kg)	3200	3203	2899	3134	3183	3114	3156	3110	3134
Crud protein %	23.69	20.25	18.60	23.40	21.80	20.80	18.40	17.80	15.90
Calcium %	0.98	0.99	0.96	1.23	1.12	1.00	1.09	1.24	1.01
Phosphorus %	0.72	0.63	0.69	0.72	0.74	0.72	0.72	0.70	0.68
Diet cost ($)	2.65	2.33	2.16	2.58	2.51	2.37	2.33	2.21	2.16
Protein digestibility	80.66	75.56	66.99	79.7	74.8	72.9	69.7	66.3	63.5

[1]Single diet, [2]Phase feeding, [3]Per kg vitamin premix provided the following: vitamin A, 7.2 g; vitamin D, 7 g ; vitamin E, 14.4 g; vitamin K_3, 1.6 g; thiamin, 0.72 g; riboflavin, 3.3 g; pantothenicacid, 12 g; niacin, 12160 mg; pyroddixine, 6.2 mg; cobalamin, 0.6 g; biotin, 0.2 g; cholinchloride, 440 mg. [4]per kg mineral premix provided the following: Mn, 64 g; Zn, 44 g; Fe, 100 g ; Cu, 16 g ; I, 0.64 g; Co, 0.2 g; Se, 8 g

Chemical analysis: Chemical analysis of diets was conducted to determine dry matter, crude protein, crude fat, crude fiber, ash, calcium and phosphorus percentages.

Determination of in vitro protein digestibility was done according to De Mello (1994) method. Diets viscosity was measured by Shoemaker *et al.* (1981) method.

Statistical analysis: Data were analyzed using the General Linear Models (GLM) procedure of SAS (2000). Means were tested by Duncan's multiple range test.

RESULTS

The results of the experiment performance are summarized in Table 2, 3 and Fig. 1 and 2. NRC and PF diets feed intake were significantly lower than single diet ($p<0.05$). Except to growth rate at 21 days of age which was better in Arbor Acres Plus ($p<0.05$). No significant effects were observed between strains performance during of the rearing period ($p>0.05$). In contrast significant differences were shown by feeding programs in broiler performance at 21 days of age.

Feed conversion ratio was significantly different between groups. This trait in NRC regimen was better than PF and S diet ($p<0.01$) and PF diet was better than single diet ($p<0.01$). NRC and PF diets resulted in higher growth rate comparing to single diet ($p<0.01$). The higher values of body weight were obtained with NRC and PF feeding during of rearing period ($p<0.05$). Best body weight appeared by NRC feeding but not significant comparing to PF diet ($p>0.05$). Production index of NRC and PF diets were similar at 21 days of age but they were better than single diet ($p<0.01$). In this age no responses was observed in interaction of strains and feeding programs ($p>0.05$). Similar reaction was found in mortality percentage by all option in this respect ($p>0.05$).

Except to feed conversion ratio there was no interactions between strains and diets at 42 days of age ($p>0.05$). Feed intake was significantly lower by NRC and PF than S diet. Growth rate and body weight significantly increased in chicks fed NRC diet and PF diet than S diet (Fig. 1). In these diets, feed conversion ratio was also better than others. No differences response was shown

Table 2: Broiler performance at 21 days of age

Treatments								
Strains		Diets	FI[1] (g/d)	GR[2] (g)	FCR[3]	BW[4] (g)	PI[5]	M[6] (%)
Main effects								
Co[7]			1080.20	582.54[b]	1.85	639.87	157.70	6.60
AAP[8]			1081.76	595.96[a]	1.82	653.89	160.91	6.10
		NRC	1045.65[b]	608.27[a]	1.72[c]	663.63[a]	167.61[a]	5.33
		S[9]	1132.71[a]	567.36[b]	2.00[a]	628.38[b]	144.58[b]	6.85
		PF[10]	1064.60[b]	592.11[a]	1.79[b]	645.63[ab]	161.23[a]	5.33
Co	x	NRC	1051.42	596.00	1.77	650.95	161.50	6.10
Co	x	S	1129.59	569.61	1.98	630.40	139.97	6.10
Co	x	PF	1059.60	582.00	1.81	638.26	162.63	7.60
AAP	x	NRC	1039.87	620.55	1.67	682.31	173.71	4.60
AAP	x	S	1135.82	565.11	2.01	626.35	149.18	7.60
AAP	x	PF	1069.59	602.22	1.78	653.00	159.83	6.10
MSE[11]			511.66	166.77	0.002	528.83	70.17	9.08

[a-c]Mean values within a column with no common superscript differ significantly ($p<0.05$). [1]Feed intake, [2]Growth rate, [3]Feed conversion, [4]Body weight, [5]Production index (live body weight average/period duration) x (livability/FCR)/10 5 mortality, [7]Cobb, [8]Arbor acres plus, [9]Single diet, [10]Phase feeding, [11]Mean standard error

Table 3: Broiler performance at 42 days of age

Treatments								
Strains		Diets	FI[1](g/d)	GR[2] (g)	FCR[3]	BW[4] (g)	PI[5]	M[6] (%)
Main effects								
Co[7]		-	3791.77	1829.85	2.08	1924.67	198.41	7.60
AAP[8]		-	3803.37	1841.79	2.07	1954.41	199.09	7.10
Co	x	NRC	3628.54	1896.87	1.91[d]	1960.03	213.10	9.10
Co	x	S[9]	3982.13	1746.23	2.28[a]	1857.32	185.50	6.10
Co	x	PF[10]	3764.31	1846.47	2.04[b]	1956.67	196.65	7.60
AAP	x	NRC	3770.22	1912.31	1.97[c]	2056.67	209.12	7.60
AAP	x	S	3872.63	1726.99	2.24[a]	1864.82	187.66	7.60
AAP	x	PF	3765.25	1886.06	2.00[bc]	1941.73	200.49	6.10
MSE[11]			69.36	13.32	0.001	23.89	89.68	12.38

[c]Mean values within a column with no common superscript differ significantly ($p<0.05$) [1]Feed intake, [2]Growth rate, [3]Feed conversion, [4]Body weight, [5]Production index (live body weight average/period duration) x (livability/FCR)/10 5 mortality, [7]Cobb, [8]Arbor acres plus, [9]Single diet, [10]Phase feeding, [11]Mean standard error

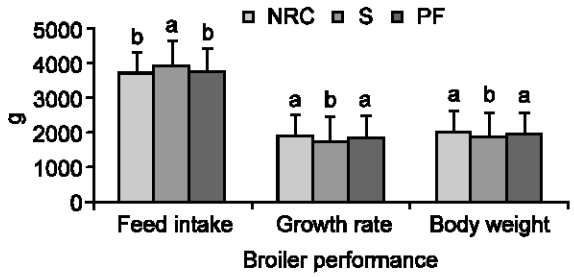

Fig. 1: Effect of feeding program on some broiler performance at 42 days of age

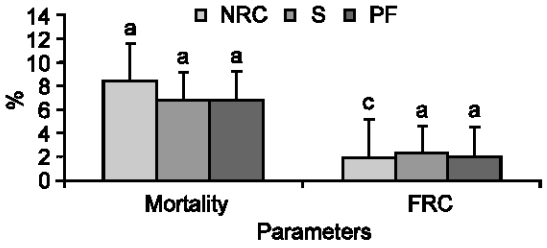

Fig. 2: Effect of feeding programs on mortality and FCR at 42 days of age

in mortality rate between feeding programs at this age ($p>0.05$) (Fig. 2).

The results of diet costs and diet cost per unit of live body weight production were presented in Table 4. Greatest and lowest diet cost was obtained in NRC and S diet at 21 days of age, respectively ($p<0.01$). Lower diet cost were shown by PF and S diet than NRC diet at 42 days of age ($p<0.01$). NRC and PF diets had highest and lowest diet cost per live body weight was which approached at 21 days of age, respectively ($p<0.01$). Diet cost per live body weight significantly different between three diet at 42 days of age which was better in PF diet ($p<0.01$). Diet cost per live body weight significantly were highest and lowest in Cobb strain fed with S diet and Arbor Acres Plus strain fed with PF diet at 42 days of age, respectively ($p<0.05$).

The results of diets viscosity and in-vitro protein digestibility are show in Table 5. Significant lower viscosity were found in NRC starter diet and PF first week diet than fifth and sixth week diet ($p<0.01$). Greatest and lowest in vitro protein digestibility were observed significantly ($p<0.05$) in NRC starter and PF sixth week diet, respectively.

DISCUSSION

Many of researchers reported that feed intake reduced with enhancement of energy levels in diets (Gonzalez and Pesti, 1993; Hussein *et al*., 1996; Leeson *et al*., 1991). In this study NRC and PF consuming which have high levels of energy decreased feed intake. Dietary protein level, or energy and protein ratio has a remarkably effect on their carcasses quality traits such as yields of edible meat, and fat content (Bartov and Plavnik, 1998). Diets with lower in protein that recommended by NRC (1994) reduced the yields of meat (Moran *et al*., 1992) and increased fattening (Bartov, 1996). Diets containing higher protein levels than recommended by NRC have negative effect on the yield of carcass and breast meat, in contrast decreasing fattening (Bartov, 1996). Negative effects on performance were observed when diets containing extremely high protein levels (Holsheimer and Veerkamp, 1992). Feed intake decreased by low protein diets in broiler chicks (Swatson *et al*., 2000). Taking into consideration that the protein levels of PF diet were reduced gradually in this experiment therefore diet protein reduction had no significant effect on feed intake. The feeding programs showed significant differences in regarding of FCR. Better feed conversion ratio was indicated by NRC regimen than others at 42 days of age. This may be due to high rates of energy and protein in diet. Diets in higher

Table 4: Diets cost in feeding periods and live body weight ($)

Treatments						
Strains		Diets	Diet cost at 21	Diet cost at 42	Diet cost per live body weight at 21	Diet cost per live body weight at 42
Main effects						
Co[1]			2.61357	8.66536	4.42115	4.59517
AAP[2]			2.62434	8.69965	4.33159	4.58661
		NRC	2.77066[a]	8.96[a]	4.55749[a]	4.53221[b]
		S[3]	2.44975[c]	8.4939[b]	4.31829[b]	4.88783[a]
		PF[4]	2.63646[b]	8.3955[b]	4.25334[b]	4.35264[c]
Co	x	NRC	2.78595	8.79702	4.68114	4.46224[c]
Co	x	S	2.44301	8.61235	4.28946	4.93109[a]
Co	x	PF	2.61175	8.5867	4.29287	4.39217[cd]
AAP	x	NRC	2.75536	9.12301	4.43383	4.60217[b]
AAP	x	S	2.45649	8.37554	4.34713	4.84456[a]
AAP	x	PF	2.66116	8.60039	4.21382	4.31311[d]
MSE[5]			2.07782	35.36583	11.69448	5.37782

[a-c]Mean values within a column with no common superscript differ significantly ($p<0.05$).
[1]Cobb, [2]Arbor acres plus, [3]Single diet, [4]Phase feeding, [5]Mean standard error

Table 5: Diets viscosity and *in-vitro* protein digestibility

Diet	Viscosity (cp)[3]	*In-vitro* protein digestibility
S[1]	1.008[ab]	66.99
NRC		
Starter	0.985[c]	80.66
Grower	1.005[ab]	75.56
PF[2]		
0-7 days	0.986[c]	79.71
7-14 days	0.994[bc]	74.82
14-21 days	0.996[bc]	72.85
21-28 days	1.008[ab]	69.72
28-35 days	1.014[a]	66.31
35-42 days	1.014[a]	63.53
MSE[4]	0.0002	

[a-c]Mean values within a column with no common superscript differ significantly ($p<0.05$). [1]Single diet, [2]Phase feeding, [3]Cacti pose, [4]Means standard error

energy rate had better FCR (Hosheimer and Veerkamp, 1992). Smith and Pesti (1998) suggested FCR reduction as the result of protein decreasing. The results of this experiment are in agreement with this suggestion. FCR of PF and single diets which had low protein levels were poorer than NRC regimen. Interaction between feeding programs and strains was significant at 42 days of age and better FCR was found in Arbor Acres Plus strains fed NRC diet. Many studies have shown that growth rate was affected by diet energy and protein levels (Donaldson, 1985; Keshavarz, 1991). But Waldroup *et al.* (1990) considered that growth rate did not affected by diet energy levels. In the present study feeding with NRC and PF diets increased growth rate comparing to single diet. Skinernobel *et al.* (2001) reported that single diet consuming decreased growth rate at the end of period. This finding has supported by this experiment. Energy increasing enhanced average body weight (Holsheimer and Veerkamp, 1992; Lei and Van Beek, 1997). Average body weight was increased by NRC and PF diets in this experiment.

Moran *et al.* (1992) reduced diet protein as level as 3% as NRC recommended levels but did not show any significant difference in broiler performance. Although protein levels of PF diet was reduced in this study but average body weight differences was not significant. NRC and PF diet feeding induced significant effect on production index. According to many studies regarding effects of different levels of energy and protein on broiler performance this is suggested that performance in broilers fed diets with high level energy is better than low energy levels (Donaldson, 1985; Keshavarz, 1991; Waibel *et al.*, 2000). Since there are strong relationship between production index, body weight, and feed conversion ratio, these could be due to energy and protein levels in diets.

Fifth and sixth week diets had higher viscosity than NRC starter and PF first week diets. These reactions probably were due to high levels of wheat which was confirmed by Bedford (1993), who noted that high viscosity is related to cereals. There is probably a direct relationship between feed viscosity and intestinal viscosity. Its means that diet with high level of cereals increase intestinal viscosity and led to decreasing nutrient digestibility. Therefore, in this study, lowest in vitro protein digestibility were observed in PF sixth diet week which had high level wheat. These results already were explained by Bedford (1993). PF diet contains higher levels of wheat rather than other treatment. Because wheat had lower price related to other ingredient in time period excrement, it caused to relatively decreased diet cost and increased economical efficiency.

Conclusion: The results of this study indicated that NRC regimen and Arbor Acres Plus strain had better performance than PF and single diets and Cobb strain. This performance was evidenced by growth rate, feed conversion ratio, body weight and production index. Also PF diet declined diet cost and increased economical efficiency without affected performance

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