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Effects of Diets Formulation Based on Different Methods of Metabolisable Energy (AMEn & TMEn) and Amino Acids (TAA & DAA) Expression on Performance, Energy and Protein Efficiency Ratio and Productive Efficiency Factor of Broiler Chicks

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ABSTRACT: A total of 720 Arian chicks were used in this study to determine the effects of diets formulation based on different expression systems of energy and amino acids of feeds and requirements on performance, relative efficiency of energy and protein and productive efficiency factor. Four diets were arranged in a 2 × 2 factorial design with 2 systems of energy expression (AMEn and TMEn) and 2 methods of amino acids requirement (TAA and DAA) from 1 to 42 days of age. Each treatment was replicated six times with each replicate consisting of 15 males and 15 females. The results showed that when the feed formulation was based on TMEn increased feed intake and growth rate compared with AMEn ($p<0.05$). Productive efficiency and body weight increased when digestible amino acid were used to expression of amino acid of feeds and requirements. But the feed conversion ratio decreased by AMEn system ($p<0.05$). It is concluded that use of TMEn and DAA methods to feed formulation could improve the performance and productive efficiency in Arian broilers.

Key words: Diets formulation, performance, Arian broilers

INTRODUCTION

Most of the costs in poultry industry is related to nutrition. Among dietary factors, the highest proportion of costs devoted to energy and protein. Therefore, it is necessary pay special attention to expression and supply of energy and protein requirements of poultry. Nutritionists should use all possible ways to improve the nutritional condition, performance and economic efficiency. Among these is the way to choose the appropriate method for diet formulation. Although over feeding, the one hand causing ensure the supply of nutrients to the bird, but on the other hand can reduced performance and economic efficiency. Increase intake of protein or amino acids, leading to reduced yields due to increased blood uric acid, so dissipated the energy. The over feeding of energy, increase production costs and body fat, so reduce efficiency (Leeson and Summers, 2000).

Currently metabolizable energy and amino acid of food expressed on nitrogen corrected apparent metabolizable energy (AMEn) and total amino acids (TAA) (Wolynetz and Sibbald, 1984 and Sibbald, 1989). While it has been suggested that Nitrogen corrected true metabolizable energy (TMEn) and digestible amino acids (DAA) methods, can provide a more accurate estimate for energy and amino acid of food and requirements (Wolynetz and Sibbald, 1984, Sibbald, 1989; Farrell *et al.*, 1999; Jones *et al.*,1986, Parson *et al.*,1986). Total energy and amino acids content in diet are not fully utilized by birds, their availability depend on the species of bird, feed intake, anti-nutritional factors, feed processing, systems of feeding, etc. Therefore, knowledge of the efficiency and the availability of nutrients in each feed is necessary.The purpose of this study was to determine the effects of diet formulation patterns (AMEn, TMEn, TAA and DAA) on productive parameters of Arian broiler chicks in starter (1-21d), grower (22-42d) and total (1-42d) periods.

MATERIALS AND METHODS

A. Experimental Design: This study was carried out at Animal Science Research Institute of Iran. A total of 720 one-day-old Arian broiler chicks were randomly allocated to 4 groups with 6 replicates containing 30 bird (15 males + 15 females).

The experimental diets were formulated with 2 methods of energy expression of diets (Apparent (AMEn) and true (TMEn) metabolizable energy corrected to nitrogen equilibrium) and 2 methods of amino acid requirement expression (Total (TAA) and digestible (DAA) amino acid). Formulation and composition of experimental diets are given in Table 1.

B. Productive parameters determination: Body weight (BW) and feed intake were obtained weekly then daily feed intake (FI), body weight gain (BWG), feed conversion ratio (FCR), productive efficiency factor (PEF) and energy (EER) and protein (PER) efficiency ratio in starter (1-21d), grower (22-42d) and total (1-42d) periodswere calculated from these data.

Table 1. Composition of experimental diets.

	Starter (1-21 day old)				Grower (22-42 day old)			
	AMEn		TMEn		AMEn		TMEn	
Ingredients (%)	TAA	DAA	TAA	DAA	TAA	DAA	TAA	DAA
Corn	54.34	54.80	54.56	54.37	56.47	56.85	57.86	58.55
Soybean meal	37.55	36.78	37.34	36.20	33.27	32.54	32.49	31.53
Wheat	-	-	-	-	2.50	2.50	4.00	4.00
Wheat meal	-	-	2.21	2.96	-	-	-	-
Fish meal	1.75	2.36	1.25	2.05	0.75	1.25	0.85	1.55
Vegetable oil	2.94	2.80	1.12	1.10	3.86	3.74	1.25	1.00
DL-Methionine	0.24	0.16	0.25	0.17	0.13	0.15	0.13	0.13
L-Lysine	0.12	0.14	0.13	0.15	0.12	0.13	0.12	0.11
Oyster shell	0.89	0.90	0.92	0.93	0.90	0.91	0.97	0.98
Dicalcium phosphate	1.35	1.25	1.39	1.25	1.22	1.13	1.43	1.25
Salt	0.32	0.31	0.33	0.32	0.28	0.30	0.40	0.40
Vitamin mix [1]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Mineral mix [2]	0.25	0.25	0.25	0.25	0.25	0.25	0.25	0.25
Calculated composition of diets (%)								
AMEn(kcal/kg)	3050	3050	-	-	3150	3150	-	-
TMEn(kcal/kg)	-	-	3050	3050	-	-	3150	3150
Crude Protein	22	22	22	22	20	20	20	20
Methionine	0.46	0.40	0.46	0.40	0.38	0.33	0.38	0.33
Methionine+Cystine	0.85	0.73	0.85	0.73	0.81	0.70	0.81	0.70
Lysine	1.25	1.07	1.25	1.07	1.15	1.00	1.15	1.00
Threonine	0.79	0.67	0.79	0.67	0.74	0.64	0.74	0.64
Tryptophan	0.21	0.18	0.21	0.18	0.17	0.15	0.17	0.15
Arginine	1.31	1.12	1.31	1.12	1.15	1.00	1.15	1.00
Valine	0.76	0.65	0.76	0.65	0.55	0.48	0.55	0.48
Leucine	1.21	1.04	1.21	1.04	0.87	0.76	0.87	0.76
Isoleucine	0.68	0.58	0.68	0.58	0.52	0.45	0.52	0.45
Calcium	1.00	1.00	1.00	1.00	0.90	0.90	0.90	0.90
Available Phosphorus	0.50	0.50	0.50	0.50	0.45	0.45	0.45	0.45
DCAB [3](meq/kg)	250	205	250	250	225	225	225	225

[1] Vitamin mix provided the following (per kg of diet): thiamin-mononitrate, 2.4 mg; nicotinic acid, 44 mg; riboflavin, 4.4 mg; D-Ca pantothenate, 12 mg; vitamin B12 (cobalamin), 12.0 mg; pyridoxine HCL, 4.7 mg; D-biotin, 0.11 mg; folic acid, 5.5 mg; menadione sodium bisulfate complex, 3.34 mg; choline chloride, 220 mg; cholecalciferol, 27.5 mg; transretinyl acetate, 1892 mg; all-rac α tocopheryl acetate, 11 mg; ethoxyquin, 125 mg.

[2] Trace mineral mix provided the following (per kg of diet): manganese (MnSO4-H2O), 60 mg; iron (FeSO4-7H2O), 30 mg; zinc (ZnO), 50 mg; copper (CuSO4-5H2O), 5 mg; iodine (ethylene diaminedihydroiodide), 0.15 mg; selenium (NaSe03), 0.3 mg

[3] Dietary cation-anion balance

C. Statistical analysis: Measurements of productive were subjected to analysis of variance for completely randomized 2 × 2 factorial design that including 2 dietary energy expression patterns (AMEn and TMEn) and 2 amino acid requirement patterns (TAA and DAA), using ANOVA-General linear method (SAS User's Guide: Statistics Version 7.0). Significant differences between treatment means were identified by Duncan's multiple range, with 5% probably.

RESULTS

The results of this study are included in Tables 2 to 4.

A. Feed intake (FI): Review of main effects of diet formulation methods indicate that treatments had received rations formulated by TMEn and DAA methods had consumed significantly more feed ($p<0.05$). Interaction effects shown that the lowest FI belonged to AMEn × TAA pattern ($p<0.05$).

B. Body weight (BW) and body weight gain (BWG): The final BW and BWG were affected significantly by expression systems of energy and not affected significantly by amino acids expression systems ($P<0.05$). The diets that regulated based on TMEn pattern have greater final BW, BWG. There were significant interactions between diet formulation methods on BW and BWG. Lower BW and BWG observed in treatment that fed diet regulated based on AMEn × TAA pattern ($P<0.05$).

C. Feed conversion ratio (FCR): The final FCR was affected significantly by expression systems of energy while not affected significantly by amino acids expression systems ($P<0.05$). The diets that regulated based on AMEn pattern have lowest FCR. There were significant interactions between diets formulations methods on FCR, greatest FCR observed in treatment that fed diet regulated based on TMEn × DAA pattern ($P<0.05$).

Table 2. Effects of feed formulation methods on feed intake and body weight gain of Arian broiler.

Main Effects[1]	Feed Intake (g/bird/day)			Body Weight Gain (g/bird/day)		
	1-21d	22-42d	1-42d	1-21d	22-42d	1-42d
AMEn	44.2 [b]	147.7 [b]	96.0 [b]	34.4 [b]	63.4 [b]	48.8 [b]
TMEn	49.7 [a]	165.1 [a]	107.4 [a]	37.6 [a]	67.3 [a]	52.5 [a]
P.value	<0.001	<0.001	<0.001	<0.001	0.014	<0.001
TAA	45.3 [b]	156.0	100.7 [b]	35.0	65.2	50.1
DAA	48.8 [a]	161.7	105.2 [a]	35.5	68.9	52.2
P.value	0.028	0.079	0.038	0.053	0.068	0.095
Interaction Effects						
AMEn × TAA	40.8 [b]	145.4	93.1 [b]	31.3 [c]	59.8 [b]	45.6 [b]
AMEn × DAA	48.3 [a]	159.4	103.8 [a]	34.3 [b]	63.1 [a]	48.7 [b]
TMEn × TAA	49.8 [a]	166.7	108.2 [a]	38.0 [a]	64.4 [a]	51.2 [a]
TMEn × DAA	49.4 [a]	163.9	106.6 [a]	34.8 [b]	64.8 [a]	50.8 [a]
P.value	0.009	0.122	0.022	<0.001	0.023	<0.001
SEM	1.29	3.88	2.52	0.91	1.62	0.57

[1] Means within Colum with different superscripts are significantly different ($p<0.05$)

Table 3. Effects of feed formulation methods on feed conversion ratio body weight and productive efficiency factor (PEF) of Arian broiler.

Main Effects[1]	Feed Conversion Ratio			Body Weight (g)		PEF
	1-21d	22-42d	1-42d	21d	42d	
AMEn	1.28	2.35 [b]	1.97 [b]	731.1 [b]	2088 [b]	245
TMEn	1.33	2.46 [a]	2.05 [a]	830.9 [a]	2245 [a]	255
P.value	0.083	0.036	0.009	<0.001	<0.001	0.137
TAA	1.29 [b]	2.40	2.01	776.2 [b]	2145 [b]	244
DAA	1.38 [a]	2.35	2.02	786.3 [a]	2333 [a]	257
P.value	0.002	0.545	0.966	0.015	0.044	0.348
Interaction Effects						
AMEn × TAA	1.30	2.43	2.04 [ab]	699.2 [c]	1955 [b]	214 [b]
AMEn × DAA	1.24	2.35	1.95 [b]	760.4 [b]	2085 [ab]	250 [a]
TMEn × TAA	1.31	2.52	2.06 [ab]	839.0 [a]	2191 [a]	249 [a]
TMEn × DAA	1.42	2.45	2.10 [a]	773.0 [b]	2176 [a]	237 [ab]
P.value	0.388	0.263	0.040	<0.001	<0.001	<0.001
SEM	0.02	0.03	0.02	31.06	47.82	7.47

[1] Means within Colum with different superscripts are significantly different (p<0.05)

Table 4. Effects of feed formulation methods on energy and protein efficiency ratio of Arian broiler.

Main Effects[1]	Energy Efficiency Ratio			Protein Efficiency Ratio		
	1-21d	22-42d	1-42d	1-21d	22-42d	1-42d
AMEn	25.58	13.56	16.25	3.56	2.14 [a]	2.49 [a]
TMEn	26.07	13.64	16.45	3.45	2.05 [b]	2.40 [b]
P.value	0.238	0.360	0.363	0.070	0.023	0.006
TAA	26.05 [a]	13.60	16.31	3.53 [a]	2.09 [b]	2.43
DAA	24.41 [b]	13.88	16.27	3.31 [b]	2.14 [b]	2.41
P.value	0.033	0.621	0.949	<0.001	0.214	0.527
Interaction Effects						
AMEn × TAA	25.30	13.10	16.68	3.51	2.06	2.40 [b]
AMEn × DAA	26.48	13.59	16.41	3.94	2.32	2.71 [a]
TMEn × TAA	26.33	13.38	16.37	3.26	1.85	2.21 [c]
TMEn × DAA	24.32	13.63	16.05	3.21	2.04	2.33 [b]
P.value	0.532	0.247	0.057	0.502	0.209	0.039
SEM	0.35	0.12	0.12	0.09	0.05	0.06

[1] Means within Colum with different superscripts are significantly different (p<0.05)

D. Productive efficiency factor (PEF): Review of main effects of diet formulation methods indicate that there were not significant effects of diet formulation methods on PEF, but Interaction effects shown that the lowest PEF belonged to AMEn × TAA pattern ($p<0.05$).

E. Energy (EER) and protein (PER) efficiency ratio: Main and interaction effects of diet formulation methods did not cause significant changes in EER. While the greatest PER significantly belonged to treatments had received rations formulated by AMEn, DAA and AMEn × DAA methods ($P<0.05$).

DISCUSSION

Studies have shown that broilers are capable of adaptation to diets containing low-energy, if they have enough time to match with these diets, can reach to optimal weight (Lesson *et al.,* 1996). In the present experiment, any negative effect on growth was observed during using the TMEn method (lower energy diets), even the growth rate was significantly increased in comparison to AMEn. The broilers often adjust their feed intake to get the enough energy; it is known that this adjusting is more accurate during the consuming low-energy diets (Fisher and Wilson, 1974., NRC, 1994). In the present study increasing of growth rate during use TMEn system may be due to increasing feed intake. The results of FI in this study were agreement with results of Dozier et al (2007) and Kamran *et al.*, (2007), they found that FI decreased during consuming the high-energy diets. In various reports, such as Smith and Pesti (1998) stated that reducing energy of diet will cause increasing FI to access more energy. Khaksar and Golian (2009) reported that diet regulation based on DAA pattern, significantly increased body weight and use of TAA pattern leads to reduced feed intake. These results are similar to the results of the present study. Although Maiorka *et al.*, (2004) reported that diet formulation based on total amino acid has no effect on feed intake and weight gain. Similar to this trial, Zaghari (2006) reported that diet formulation based on DAA method compared to TAA can be accurately supply the amino acid requirements and improved FCR of broilers. In the present study improvements in performance can be attributed to improved energy efficiency in low-energy diet. In fact, reduced level of dietary energy, increase the energy efficiency (Leeson, 1996).

CONCLUSION

Considering the results of this research can be said that the use of lower energy levels (diet formulation based on TMEn) and amino acid digestibility coefficients applying for regulation of broiler chicken diets, can yield more appropriate productive efficiency. The no improvement of growth of Arian strain with high energy level diets can be attributed to poor genetic potential of this to extracting high energy levels from feeds. Although this hypothesis demands further genetic and nutritional research.

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