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Research article

PRODUCTIVE AND SERUM BIOLOGICAL RESPONSES OF BROILER CHICKS TO USE OF DIFFERENT PATTERNS OF DIET FORMULATION

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ABSTRACT: A total of 720 one-day-old Arian broiler chicks were used to determination of effects of different feed formulation patterns on productive and serum biological responses. These birds were randomly allocated to 4 group with 6 replicates containing 30 bird (15 males + 15 females). Measurements were subjected to analysis of variance for completely randomized 2×2 factorial design that including 2 dietary energy expression patterns (Apparent (AMEn) and true (TMEn) metabolizable energy corrected to nitrogen equilibrium) and 2 amino acid requirement patterns (Total (TAA) and digestible (DAA)). Productive parameters (body weight (BW), live weight gain(LWG), feed intake (FI) and feed conversion ratio (FCR)) were determined via weekly weighing and serum biological parameters (amylase, lipase and protease activity and glucose, triglyceride and total protein of serum) were measured by standard kit. The results showed that formulation diets based on TMEn and DAA pattern increased BW, BWG and FI so decreased FCR (P□0.05). Amylase activity, glucose and total protein were decreased by use of AMEn and TAA pattern, however lipase activity and triglyceride were increased by these patterns (P□0.05). It is suggested that to improve physiological and productive responses of broiler chicks use the TMEn and DAA patterns to diet formulation.
Key words: Diet formulation, Productive, Serum biological parameters

INTRODUCTION

Farming sustainably means growing crops and livestock in ways that meet three objectives simultaneously: Economic profit, Social benefits to the farm family and the community Environmental conservation [34]. It is a system of agriculture that will maintain its productivity over the long run. Sustainable farming could be Organic farming, biodynamic, perm culture, agro ecological systems and low input [25].The goal of sustainable agriculture is to minimize adverse impacts to the immediate and off-farm environments while providing a sustained level of production and profit. Sustainable agriculture is influenced by environmental climate, soil types and the various crops, types of farm practices employed and Nutritional systems [25]. 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. It has been suggested that proper nutrients is supplied through regulation of diets based on digestible amino acid (DAA) method compared to total amino acid (TAA). Formulation of diets based on Apparent (AMEn) and true (TMEn) metabolizable energy corrected to nitrogen equilibrium pattern, provide different levels of energy for broilers so make different productive and metabolic responses [6, 13, 17, 24, 30 and 38].

Diets formulation in poultry industry are mainly done based on productive parameters such as growth rate, rate of egg production, feed intake and feed conversion ratio, so does not consider the physiological responses [5]. Shown that blood indices are reflect of physiological responses resulting from internal (strain, sex, age, etc.) and external factors (feeding, rearing conditions, welfare, etc.) [10, 28 and 29]. Blood parameters as metabolic intermediates provide information on metabolism and health of animals.

Through checking the changes in blood parameters can be observed and interpreted effects of diets and feeding systems on body [27 and 37]. Total protein, glucose and triglyceride as most common indicators for the detection body homeostasis and energy metabolism, can provide useful information for assessing the physiological condition [27].

Enzymatic digestion capacity needs to match the diet switch by: (a) having a fixed high constitutive level of the pancreatic and intestinal enzyme pool needed for to breakdown all foodstuffs or, (b) changing the level of enzymes activity in a positive relationship with the substrate that is being digested [2]. Pancreatic secretion is mainly excreted in response to volume of incoming chymouse to duodenum and its composition is partially influenced by the type of feed. While the intestinal enzyme secretion is largely regulated through contact stimulating and local neural reflexes [9]. Therefore dietary factors through effect on level of feed intake or provide different amounts of nutrients for poultry, can alter the secretion of digestive enzymes [9].
The purpose of this study was to determine the effects of diet formulation patterns (AMEn, TMEn, TAA and DAA) on productive and serum biological parameters of broiler chicks.

MATERIALS AND METHODS

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 group with 6 replicates containing 30 bird (15 males+15females). The experimental diets were formulated with 2 methods of energy expression of diets (Apparent and true metabolizable energy corrected to nitrogen equilibrium) and 2 methods of amino acid requirement expression (Total and digestible amino acid). Formulation and composition of experimental diets are given in table 1.

Table 1. Composition of experimental diets

Ingredients (%)	Starter (1-21 day old)				Grower (22-42 day old)			
	AMEn		TMEn		AMEn		TMEn	
	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 diamine dihydroiodide), 0.15 mg; selenium (NaSe03), 0.3 mg
[3] Dietary cation-anion balance

Productive and serum biological parameters determination: Body weight (BW) and feed consumption were obtained weekly then daily feed intake (FI), body weight gain (BWG) and feed conversion ratio (FCR) were calculated from these data. At end of the sixth week, 6 birds from each treatment were selected randomly and used for blood sampling. To serum separation, the blood samples centrifuged at 3000 rpm for 15 minutes. The serum preserved at -20˚C until use. Glucose, triglyceride, total protein, amylase and lipase activity were measured in serum by Pars'Azmoon standard kit based on colorimetric analysis. Protease activity was assayed according to modified method of Anson [1 and 8]. The substrates used to assay of amylase, lipase and protease activity were EPS-G7 (4, 6-ethylidene (G7)-p-nitrophenyl (G1)-alpha-D-maltoheptaoside), DGGR (1, 2-o-dilauryl-rac-glycero-3-glutaric acid-(6'-methyl resorufin) ester) and casein respectively.
Statistical analysis: Measurements of productive and serum biological parameters 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 (Minitab reference manual release 9.1) [22]. Significant differences between treatment means were identified by Duncan's multiple range [3], with 5% probably.

RESULTS AND DISCUSSION

The results of productive and serum biological parameters are presented in table 2 and 3 respectively. The final BW, BWG and FI were affected significantly by both diet formulation methods (P□0.05). The diets that regulated based on TMEn and DAA patterns have greater final BW, BWG and FI. The FCR decreased significantly when used the DAA pattern to diet regulation compared to TAA. There were significant interactions between diet formulation methods on BW and BWG but not on FI and FCR. Lower BW and BWG observed in treatment that fed diet regulated based on AMEn×TAA pattern (P□0.05).
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 [18]. 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 [7 and 23]. 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 [4] and Kamran et al [15], they found that FI decreased during consuming the high-energy diets. In various reports, such as Smith and Pesti [31] stated that reducing energy of diet will cause increasing FI to access more energy. Khaksar and Golian [16] 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 [20] reported that diet formulation based on total amino acid has no effect on feed intake and weight gain. Similar to this trial, Zaghari [39] reported that diet formulation based on DAA method compared to TAA can be accurately supply the amino acid requirements and improved FCR of broilers. When used the TMEn method to diet formulation, amylase activity, glucose and total protein levels of serum increased but lipase activity and triglyceride level decreased (P□0.05). Protease activity was not affected by energy expression pattern (P□0.05). Amino acid requirement patterns had significant effect on lipase activity, glucose and total protein level but not on amylase and protease activity and triglyceride level of serum. Lipase activity, glucose and total protein levels decreased when used TAA pattern to diet regulation compared to DAA pattern (P□0.05). There were significant interactions between diet formulation methods on lipase activity, glucose and total protein levels of serum but not on amylase and protease activity and triglyceride level. Highest lipase activity and lowest glucose and total protein levels observed in treatment that was fed diet regulated based on AMEn×TAA pattern (P□0.05).
Increasing feed intake stimulates physiological processes that causes more accessible to nutrients. It is known that increasing feed consumption increase the activity of pancreatic amylase, lipase, trypsin and intestinal maltase and sucrose [26]. So rising of enzyme activity will increase serum metabolic such as glucose, triglyceride and total protein. In the present study, formulation diets accordingly toTMEn and DAA increased FI so enzyme activity and metabolic parameters of serum. Although Malheiros [21] has announced that blood glucose levels is not affected by diet composition, this situation was attributed to the strong regulation of carbohydrate metabolism. There is a direct correlation between dietary protein and total protein of serum [35 and 36]. The concentration of total protein in serum, reflecting the level of dietary amino acids and can be used in the estimation of the essential amino acid requirements [33]. In agreement with result obtained by Liukkonen [19], more protein provided through the circulatory system to birds when their diet regulation based on DAA pattern, this is an indication of the optimal digestion and metabolism of dietary protein. This pattern provide a more accurate estimation of amino acid requirements of broilers compared to TAA pattern.

Researchers have reported that digestibility of dietary protein has an inverse relation with Proteolytic enzymes activity while the relative balance of dietary amino acids improves the efficiency of proteolytic enzymes activity [13 and 32].

However the results show that there was a negative correlation between feed intake and lipase activity and triglyceride level of serum. The oil content of diets that formulated based on AMEn were more than TMEn, for this reason the lipase activity and triglyceride of serum in these treatments were more than treatments that fed diets regulated based on TMEn pattern. These results were agreement with Hulan [11] and Imandy [12], they found that broilers are able to adjust their amylase and lipase activity in relation to diet composition. So it can be said that enzymatic activity and consequently metabolic parameters of serum affected by both amount of feed intake and dietary composition.

Table 2. Effects of feed formulation methods on productive parameters of broiler chicks (1-42d)

Main Effects[1]	BW (g)	BWG (g/bird/day)	FI (g/bird/day)	FCR
AMEn	2122 [b]	49.53 [b]	98.48 [b]	1.99
TMEn	2255 [a]	52.71 [a]	107.43 [a]	2.04
p.value	0.005	0.005	0.001	0.229
TAA	2065 [b]	48.18 [b]	99.87 [b]	2.07 [a]
DAA	2312 [a]	54.06 [a]	106.04 [a]	1.96 [b]
p.value	<0.0001	<0.0001	0.017	0.008
Interaction Effects				
AMEn × TAA	1956 [c]	45.55 [b]	93.10	2.05
AMEn × DAA	2289 [ab]	53.52 [a]	103.86	1.94
TMEn × TAA	2175 [b]	50.82 [a]	106.68	2.09
TMEn × DAA	2335 [a]	54.61 [a]	108.22	1.98
p.value	0.048	0.049	0.067	0.861
SEM	36.31	1.65	0.87	0.022
Means within Colum with different superscripts are significantly different (p<0.05)				

Table 3. Effects of feed formulation methods on serum biological parameters of broiler chicks

Main Effects[1]	Enzyme Activity[2] (U)			Biochemical Indices		
	Amylase	Lipase	Protease	Glucose (mg/dl)	Triglyceride (mg/dl)	Total Protein (g/dl)
AMEn	395.7 [b]	9.50 [a]	0.181	253.3 [b]	116.6 [a]	3.26 [b]
TMEn	485.5 [a]	8.93 [b]	0.184	290.5 [a]	97.79 [b]	3.96 [a]
p.value	0.045	0.016	0.558	<0.0001	0.048	<0.0001
TAA	440.2	9.76 [b]	0.179	260.5 [b]	112.4	3.54 [b]
DAA	441.1	8.67 [a]	0.186	283.3 [a]	101.9	3.68 [a]
p.value	0.984	0.0001	0.271	<0.0001	0.274	0.040
Interaction Effects						
AMEn × TAA	430.8	10.38 [a]	0.175	251.0 [d]	119.1	3.02 [b]
AMEn × DAA	360.6	8.62 [b]	0.187	256.0 [c]	114.1	3.49 [ab]
TMEn × TAA	449.6	9.15 [b]	0.183	270.0 [b]	105.8	4.05 [a]
TMEn × DAA	521.5	8.72 [b]	0.185	311.0 [a]	89.8	3.87 [a]
p.value	0.122	0.006	0.406	<0.0001	0.559	0.0001
SEM	23.74	0.18	0.02	4.96	4.94	0.09

[1] Means within Colum with different superscripts are significantly different (p<0.05)
[2] One Unit of Amylase and Lipase activity expressed respectively as µmole EPS-G7 and DGGR hydrolysed per minute. One Unit of Protease activity expressed as µmole amino acid produced from hydrolysis of casein per minute.

CONCLUSIONS

The results showed that true metabolizable energy corrected to nitrogen equilibrium (TMEn) and digestible amino acid pattern (DAA) supply of energy and amino acid requirements of broiler chicks more accurate than apparent metabolizable energy corrected to nitrogen equilibrium (AMEn) and total amino acid pattern (TAA).

Diets formulation based on these models, improved enzymatic activity, serum metabolic parameters and consequently performance. It is suggested that to improve physiological, performance and consequently economic efficiency of broiler chick use the TMEn and DAA pattern to diet formulation.

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