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Response of Broilers to Practical Diets with Different Metabolizable Energy and Balanced Protein Concentrations

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ABSTRACT

Experiment was conducted to study the effect of Metabolizable Energy (ME) and Balanced Protein (BP) on the performance of 1- to 35-day-old male and female Hubbard x Hubbard broilers. Set in a factorial arrangement, dietary treatments involved 3 levels of ME (2650, 2750, or 2850 kcal per kg diet) and 4 levels of Balanced Protein (expressed as 8.4, 9.0, 9.6, or 10.2 g Standardized Ileal Digestible lysine per kg). Each diet was fed to 5 replicate pens of 17 chicks. Dietary ME and BP did not interact for any of the parameters studied (p>0.05). The main effect of ME was significant (p<0.05) for feed intake, body weight, and feed conversion ratio at all ages. Highest ME (2850 kcal) resulted in 35 day feed intake and feed conversion ratio that was significantly (p<0.05) low compared with those fed on lower levels of ME; while 35 day body weight was significantly (p<0.05) high at 2850 kcal compared with 2650 kcal ME. Feed intake and body weight improved linearly (p<0.05) with increasing BP from 8.4 to 10.2 g per kg, while the BP did not have any effect on feed conversion ratio. Dietary combinations of ME and BP to optimize body weight and feed conversion ratio are suggested on weekly basis.

INTRODUCTION

Broilers have a remarkable capacity to achieve certain weight gain according to age by modifying voluntary feed intake when offered an array of dietary energy contents (ME; NRC 1994; Leeson *et al*., 1996). In this context, the decision regarding 'optimum' dietary level of ME seems merely a function of the price of energy sources and the premium achieved for improved Feed Conversion Ratio (FCR).

The requirements of broilers for various amino acids during different growout phases have been extensively studied. In general, two methodologies have been used to study the responses to individual amino acids: graded supplementation (Mack *et al*., 1999; Baker *et al*., 2002; Aftab *et al*., 2007) and diet dilution (Gous & Morris 1985). The common aspect between these two techniques is that, except for the amino acid under investigation, amino acids are supplied in large excess. In commercial feed formulation, the luxury of oversupplying amino acids is not justified. For instance, a typical broiler diet formulated with crystalline methionine, lysine, and threonine with no minimum Crude Protein (CP) often contains a balance, suggesting that the four or five most 'critical amino acids' are equally limiting. In current study, the response of amino acids in terms of Balanced Protein (BP) was evaluated with an idea that it conforms more closely to the commercial dietary conditions where large excess of essential and non-essential amino acids is avoided.

MATERIALS AND METHODS

General

A total of 2000 male and female day-old chicks (Hubbard x Hubbard) were obtained from a commercial hatchery. After provided free access to drinking water for four hours, chicks were individually weighed and distributed into three weight categories. Out of the intermediate-weight category, discarding the lower and higher weight groups, a total of 1020 chicks were randomly distributed to 60 floor pens (17 chicks per pen), maintaining similar cumulative body weight and range among all pens. Rice husks were used as litter (2-inche depth). Each pen was equipped with a bell drinker and a tube feeder. Feed and water were supplied ad libitum, and 24 hours of light was provided throughout the experimental period. All birds were submitted to a vaccination program (New Castle Disease, Infectious Bronchitis, Infectious Bursal Disease, and Hydropericardium Syndrome) scheduled according to the local practice.

Diets and experimental design

Experimental diets were least-cost formulated using current ingredient prices (November 2008). Each feed ingredient was individually mixed in a batch mixer (2 tons) in order to ensure constant quality of the ingredients across experimental diets. Two basal diets were formulated to contain BP levels of 8.4 (low) or 10.2 (high) Standardized Ileal Digestible (SID) lysine and 2650 kcal ME per kg. All other EAA (essential amino acids) were set to meet or exceed the Ideal Ratios relative to lysine (Baker & Han 1994). Higher ME levels (2750 and 2850 kcal) were achieved by a two-step replacement of half or all wheat bran by sunflower oil (on weight basis), resulting in six diets (Table 1). Within each ME level, intermediate levels of BP (9.0 and 9.6 g) were prepared by blending 8.4 and 10.2 g BP diets

Table 1 - Composition (%) of low and high balanced protein diets at different levels of metabolizable energy.

AMEn, kcal[1]	----------2650----------		----------2750----------		----------2850----------	
BP, g per kg[2]	**8.4**	**10.2**	**8.4**	**10.2**	**8.4**	**10.2**
Ingredients						
Corn	51.9	43.0	51.9	43.0	51.9	43.0
Rice polishing	12.0	12.0	12.0	12.0	12.0	12.0
Wheat bran	2.6	2.6	1.3	1.3	-	-
Soybean meal, 45% CP	8.0	14.0	8.0	14.0	8.0	14.0
Canola meal, 38% CP	8.0	12.0	8.0	12.0	8.0	12.0
Sunflower meal, 30% CP	13.4	11.1	13.4	11.1	13.4	11.1
Sunflower oil	-	1.35	1.30	2.65	2.60	3.95
Limestone	0.6	0.6	0.6	0.6	0.6	0.6
Bone meal	2.5	2.3	2.5	2.3	2.5	2.3
Salt	0.4	0.4	0.4	0.4	0.4	0.4
l-lysine HCL	0.227	0.233	0.227	0.233	0.227	0.233
dl-methionine	0.038	0.110	0.038	0.110	0.038	0.110
l-threonine	-	0.017	-	0.017	-	0.017
Vit/min premix[3]	0.3	0.3	0.3	0.3	0.3	0.3
Phytase premix[4]	0.1	0.1	0.1	0.1	0.1	0.1
Total	100.1	100.1	100.1	100.1	100.1	100.1
Calculated analysis						
AMEn, kcal per kg	2650	2650	2750	2750	2850	2850
Crude Protein, g per kg	178	206	178	206	178	206
SID lysine, g per kg	8.4	10.2	8.4	10.2	8.4	10.2
SID M+C/lysine	76	76	76	76	76	76
SID threonine/lysine	67	67	67	67	67	67
SID isoleucine/lysine	73	71	73	71	73	71
SID valine/lysine	89	85	89	85	89	85
SID tryptophan/lysine	19	20	19	20	19	20
SID arginine/lysine	125	122	125	122	125	122
Calcium, g per kg	8.0	8.0	8.0	8.0	8.0	8.0
Av. Phosphorus, g per kg	4.0	4.0	4.0	4.0	4.0	4.0
Sodium, g per kg	2.2	2.2	2.2	2.2	2.2	2.2

1 - Difference in ME was achieved essentially by proportionate replacement of wheat bran with sunflower oil keeping all other ingredients unchanged. 2 - Balanced Protein expressed as Standardized Ileal Digestible lysine, where all other essential amino acids were set to meet or exceed the Ideal Ratios (Baker and Han, 1994). Within each ME, intermediate levels of BP (9.0 and 9.6 g) were prepared, respectively by blending 8.4 and 10.2 g BP diets in 67:33 and 33:67 (W/W) proportions. 3 = Provided per kg of diet: vitamin A, 8000 IU; cholecalciferol, 2000 ICU; vitamin E, 30 mg; menadione, 2 mg; riboflavin, 5.5 mg; pantothenic acid, 13 mg; niacin, 36 mg; choline, 500 mg; vitamin B12, 0.02 mg; folic acid, 0.5 mg; thiamin, 1 mg; pyridoxine, 2.2 mg; biotin, 0.05 mg; ethoxiquin, 125 mg; Mn, 65 mg; Fe, 55 mg; Cu, 6 mg; Zn; 55 mg. 4 - Phyzyme XP TPT (Danisco Animal Nutrition, UK) to furnish 500 FTU per kg of finished feed.

in 67:33 and 33:67 (W/W) proportions, respectively. Each diet was fed as coarse mash to 5 replicate pens of 17 chicks from 1 to 35 days posthatch. Feed intake (FI) and Body weight (BW) were recorded weekly on pen basis, and the data was used to calculate FCR (feed conversion ratio). Mortality was recorded on daily basis, and dead weight recorded to correct FCR. The obtained live performance parameters were analyzed by the General Linear Model procedures, using MINITAB release 11.12. Means were compared using Tukey's test.

RESULTS AND DISCUSSION

Dietary ME and BP interaction had no effect on any of the parameters studied (p>0.05). Main effect of ME was significant (p<0.05) for FI, BW, and FCR at all ages. High ME (2850 kcal) resulted in significantly lower 35-day FI and FCR (p<0.05) as compared with low ME level, while 35-day BW was significantly (p<0.05) higher when 2850 kcal was fed as compared with 2650 kcal ME. FI linearly responded to BP increase, where the total difference between BP extremes was about 3% in this phase. BW linearly improved up to the highest level of BP and this effect was consistent across all ages, although the magnitude of effect seemed to decrease with age (Table 3). No effect of BP was apparent on FCR (Table 4). Mortality was lower than 2.6% in all treatments, and no appreciable treatment effect was observed (data not presented).

Table 2 - Effect of dietary treatments on feed intake (g/b) of broilers, 1-35d.

ME, kcal/kg	BP, g/kg	7d	14d	21d	28d	35d
2650	-	157b	572b	1237b	2329b	3602b
2750	-	155b	572b	1231b	2332b	3605b
2850	-	149a	558a	1199a	2267a	3472a
SEM		0.34	0.56	0.79	1.17	1.53
-	8.4	150x	559x	1202x	2264	3507
-	9.0	152x	559x	1215xy	2318	3554
-	9.6	154xy	574y	1237y	2316	3564
-	10.2	158y	577y	1235y	2341	3612
SEM		0.35	0.55	0.80	1.18	1.58
		----------------------------Probability----------------------------				
ANOVA						
ME		0.001	0.020	0.003	0.016	0.006
BP		0.006	0.004	0.022	0.061	0.267
ME x BP		0.281	0.284	0.330	0.200	0.790
Linear						
ME		0.179	0.333	0.240	0.359	0.346
BP		0.017	0.073	0.068	0.092	0.026
Quadratic						
ME		-	-	-	-	-
BP		0.076	0.363	0.254	0.329	0.225

a-z - Means within row for ME and BP with no common superscript differ significantly (p<0.05).

Table 3 - Effect of dietary treatments on body weight (g/b) of broilers, 1-35d.

ME, kcal/kg	BP, g/kg	7d	14d	21d	28d	35d
2650	-	159b	379	699a	1154a	1612a
2750	-	159b	384	710ab	1182b	1665ab
2850	-	155a	382	724b	1205b	1694b
SEM		0.33	0.52	0.72	0.81	1.08
-	8.4	152x	364x	687x	1149x	1633
-	9.0	156xy	380y	708xy	1178xy	1652
-	9.6	158y	386yz	725y	1185y	1664
-	10.2	164z	396z	725y	1208y	1678
SEM		0.30	0.43	0.69	0.81	1.13
		----------------------------Probability----------------------------				
ANOVA						
ME		0.015	0.379	0.014	0.001	0.002
BP		0.001	0.001	0.001	0.001	0.362
ME x BP		0.868	0.595	0.153	0.492	0.512
Linear						
ME		0.333	0.593	0.044	0.036	0.107
BP		0.019	0.018	0.063	0.023	0.005
Quadratic						
ME		-	-	-	-	-
BP		0.155	0.135	0.093	0.202	0.061

a-z Means within row for ME and BP with no common superscript differ significantly (p<0.05).

Table 4 - Effect of dietary treatments on feed conversion ratio (g:g) of broilers, 1-35d.

ME, kcal/kg	BP, g/kg	7d	14d	21d	28d	35d
2650	-	0.986	1.511b	1.770b	2.019b	2.237b
2750	-	0.976	1.492ab	1.737b	1.975b	2.169b
2850	-	0.964	1.464a	1.658a	1.883a	2.051a
SEM		0.028	0.031	0.034	0.034	0.041
-	8.4	0.991	1.535y	1.752	1.974	2.151
-	9.0	0.972	1.473x	1.718	1.969	2.157
-	9.6	0.969	1.489x	1.711	1.954	2.144
-	10.2	0.969	1.461x	1.705	1.939	2.157
SEM		0.028	0.030	0.037	0.039	0.046
		----------------------------Probability----------------------------				
ANOVA						
ME		0.307	0.019	0.001	0.001	0.001
BP		0.503	0.001	0.242	0.505	0.985
ME x BP		0.144	0.287	0.395	0.099	0.507
Linear						
ME		0.033	0.070	0.148	0.128	0.098
BP		0.159	0.180	0.091	0.020	0.896
Quadratic						
ME		-	-	-	-	-
BP		0.158	0.486	0.160	0.082	0.939

a-z Means within row for ME and BP with no common superscript differ significantly (p<0.05).

In general, the data presented herein suggest that the effect of ME and BP on BW was age dependent, as the requirement of ME tended to increase and that of BP to decrease with age. High ME (2850 kcal per kg) resulted in the lowest BW at 7 days posthatch, followed by no effect of ME on BW at 14 days posthatch, and a reverse situation at 35 days of age, when 2850 kcal EM resulted in approximately 5% higher BW as compared with that promoted by 2650 kcal (p<0.01). In contrast, the effect of BP on BW was very pronounced during the first two weeks of age (e.g. about 8.4% difference between 10.2 *vs*. 8.4 g BP). This effect, however, tended to decrease at 21 and 28 days posthatch (about 5.2%) and was further reduced to 2.8% at 35 days posthatch. Increasing BP caused a significant linear increase in FI, an observation that contrasts with the reports demonstrating a slight depression in FI, and hence an improved FCR, in response to increased levels of dietary BP and/or amino acids (Mack *et al*., 1999; Baker *et al*., 2002; Wijtten *et al*., 2004; Lemme *et al*., 2006). Differences in the inclusion of dietary ingredients between diets containing different BP concentrations in our study may partly explain this apparent anomaly.

The results of present study demonstrated that the impact of BP on BW was strictly linear, and no apparent plateau was reached up to the highest BP level, suggesting that the 'requirement' of broilers for BP could have been even higher than those observed in the current study. Conversely, our previous experiments using similarly low ME basal diets, but making use of the conventional graded-supplementation approach, suggested that digestible lysine requirement for BW was 0.85 and 0.75% of diet, respectively during the starter and grower/finisher phase (Aftab *et al*., 2007). In this respect, findings of the current study seems to agree with those reported by Wijtten *et al*. (2004), who demonstrated that broiler weight gain broilers responded to higher dietary Ideal Protein (or BP) levels than would be expected from single lysine requirement studies in literature. In contrast, when comparing graded-supplementation (only the concentration of amino acid in question is changed) *vs*. diet-dilution techniques (complete range of essential and non-essential amino acids is changed), D'Mello (1982) concluded that amino acid requirements were independent of the methodology used. It is, however, worthy noting that the diet-dilution technique makes use of large excesses of amino acids (other than one under study), and thus do not supply BP.

The comparison of the response to the 8.4 g digestible lysine treatment in our study with that of 8.5 g digestible lysine in the study of Plumstead *et al*. (2007) suggests that the efficiency of lysine utilization for weight gain was markedly high when offered as a fairly balanced protein (17.8% CP in our study) *vs.* when the same dietary concentration of lysine was fed in the presence of 'excessive/imbalanced' protein (22% CP in Plumstead *et al*., 2007). This finding seems to be consistent with earlier reports suggesting that the efficiency of utilization of first limiting amino acid was depressed in the presence of surplus CP (Morris *et al*., 1999). In view of the arguments presented above, as well as for the purpose of practical applications, it seems more defendable to study the amino acid responses in terms of BP rather than using a graded-supplementation or diet dilution techniques.

CONCLUSION

Dietary ME and BP interaction did not influence any of the studied parameters, and the main effect of ME and BP on BW and FCR was age dependent. Optimum dietary combinations of ME and BP for BW seems to be 2650/10.2, 2650/9.6, 2750/9.0, and 2750/8.4, respectively, for the periods of 1-7, 8-14, 15-21, and 22-35 days of age, whereas for FCR, these combinations are, 2650/8.4, 2750/9.0, and 2850/8.4, respectively, for the periods of 1-7, 8-14, and 15-35 days of age.

REFERENCES

Aftab U, Ashraf M, Mumtaz AS, Jiang Z. Lysine requirement of broiler chickens fed low-density diets under tropical conditions. Asian-Australasian Journal of Animal Science 2007; 20:939-943.

Baker DH, Batal AB, Parr TM, Augspurger NR, Parsons CM. Ideal ratio (relative to lysine) of tryptophan, threonine, isoleucine, and valine for chicks during the second and third weeks posthatch. Poultry Science 2002; 81:485-494.

Baker DH, Han Y. Ideal amino acid profile for chicks during the first three weeks posthatching. Poultry Science 1999; 73:1441-1447.

D'Mello JPF. A comparison of two empirical methods of determining amino acid requirements. World's Poultry Science Journal 1982; 38:114-119.

Gous MR, Morris TR. Evaluation of a diet dilution technique for measuring the response of broiler chickens to increasing concentration of lysine. British Poultry Science 1985; 26:147-161.

Lemme A, Wijtten PJA, van Wichen, Petri A, Langhout DJ. Responses of male growing broilers to increasing levels of balanced protein offered as coarse mash or pellets of varying quality. Poultry Science 2006; 85:721-730.

Lesson S, Caston L, Summers JD. Broiler response to energy or protein dilution in finisher diet. Poultry Science 1996; 75:522-528.

Mack S, Bercovici D, De Groote G, Leclercq B, Lippens M, Pack M, Schutte JB, van Cauwenberghe. Ideal amino acid profile and dietary lysine specification for broiler chickens of 20 to 40 days of age. British Poultry Science 1999; 40:257-265.

Morris TR, Gous RM, Fisher C. An analysis of the hypothesis that amino acid requirements for chicks should be stated as proportion of dietary protein. World's Poultry Science Journal 1999; 55:7-22.

National Research Council. Nutrient requirements of poultry. 9th ed. Washington DC; 1994.

Plumstead PW, Romero-Sanchez H, Paton ND, Spears JW, Brake J. Effects of dietary metabolizable energy and protein on early growth responses of broilers to dietary lysine. Poultry Science 2007; 86: 2639-2648.

Wijtten PJA, Prak R, Lemme A, Langhout DJ. Effect of different dietary ideal protein concentrations on broiler performance. British Poultry Science 2004; 45:504-511.