

Effect of Various Levels of Protein in Diet Based on Total and Digestible Amino Acids on Performance of Cobb Strain Broilers

Research Article

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ABSTRACT

In order to study the effects of various levels of protein in diet based on total and digestible amino acids on performance and carcass traits of broilers, an experiment was conducted as a completely randomized design with 288 broiler chicks from Cobb 500 strain in 6 treatments, each treatment consist of 3 replicates with 16 chicks per replicate. Treatments were the diets as follow: 1) diet formulated based on digestible amino acids which has 1% less crude protein (CP) than Cobb 500 recommendation (2006); 2) diet formulated based on digestible amino acids with CP similar to Cobb 500 recommendation; 3) diet formulated based on digestible amino acids with 1% higher CP than Cobb 500 recommendation; 4) diet formulated with total amino acids with one level lower than suggested protein level in Cobb 500 recommendation; 5) diet formulated with total amino acids with suggested protein level in Cobb 500 recommendation and 6) diet formulated with total amino acids with one level lower than suggested protein level in Cobb 500 recommendation. The metabolizable energy was considered constant and diets were fed to birds during 42 days of experiment. Daily weight gain, feed consumption, feed conversion ratio, breast meat yield and abdominal fat content were measured. At the end of experiment, 4 chickens (2 males and 2 females) from each treatment was randomly selected and killed and their carcasses were analyzed. Results indicated that formulating ration's protein based on total amino acids for Cobb 500 broilers shows better performances than digestible amino acids.

KEY WORDS

broiler, Cobb 500, digestible amino acids, performance, protein levels, total amino acids.

INTRODUCTION

It is well known that not all of the amino acids in feed stuffs are digested by the bird and become available for protein synthesis. It is also known that there is considerable variation between and often within, protein sources of individual amino acids within a feedstuff may differ considerably. The vegetable proteins are the major protein source in poultry feed. Their inclusion to poultry feed is 28% and accounts for about 33.5% of the total feed cost in commercial poultry (Sarwar *et al.* 2002). Thus, it is important to know which level of dietary protein is suitable for broiler performance.

There have been a number of papers demonstrating the advantages of using digestible rather than total amino acids to formulate broiler diets. These have generally used poor quality ingredients in large amounts, such as cottonseed meal (Fernandez *et al.* 1995), or over-processed meals (Fernandez and Parsons, 1996) to demonstrate an advantage. There are very few published papers that have demonstrated a significant improvement in practical diets for layers and for broilers formulated on the basis of digestible amino acids when several conventional dietary ingredients have been combined (Dari *et al.* 2005; Ayasan *et al.* 2009). The purpose of this experiment is to test the hypothesis that

the use of amino acid digestibility values of feedstuffs gives a significant improvement in biological response and / or economic response compared to ingredients using total amino acids to formulate practical broiler diets using a range of feedstuffs. In the present study, we aim to compare effect of low, average and high levels of protein with digestible amino acid (DAA) and total amino acid (TAA) according to the suggested pattern of Cobb 500 broiler strain recommendation on the performance of Cobb 500 broilers.

MATERIALS AND METHODS

This experiment was conducted using 288 one-day-old Cobb 500 broilers with the same initial weight (35 ± 2 g) for 42 days. The experiment was according to a completely randomized design with 6 treatments, 3 replicates, each contained 8 males and 8 females. From day 1, the chicks were given one of the 6 different experimental diets. Referring that Cobb 500 broiler has suggested just one level of protein for formulating diets in the catalogue so we use one level (as 1 percent) lower and one level higher than this protein. The diets were formulated based on: 1) digestible amino acids with one level lower than suggested protein level; 2) digestible amino acids with suggested protein level; 3) digestible amino acids with one level higher than suggested protein level; 4) total amino acids with one level lower than suggested protein level; 5) total amino acids with suggested protein level and 6) total amino acids with one level lower than suggested protein level.

The diets were formulated and fed in 3 different phases: starter (day 0-11), grower (day 12-24), finisher (day 25-42). They all formulated by UFFDA program and based on [NRC \(1994\)](#) feedstuff chemical analyzes. Conditions of rearing chicks were based on Cobb 500 user's manual.

Feed and water were given *ad libitum*. Birds were weighed at 11 days of age and again at 24 and 42 days of age.

Feed intake was recorded weekly and feed conversion ratio was calculated. On day 42, 2 males and 2 females of each treatment per dietary treatment (16 males and 16 females totally) were randomly selected for carcass analysis. Carcass composition (fat and protein in the whole body of chicken) was determined and calculated as follow:

Daily weight gain (g/day) = (body weight gain (g)/hen day)

Breast meat yield (%) = (breast meat weight with bone (g)/ body weight) \times 100

Abdominal fat content (%) = (abdominal fat weight/ body weight) \times 100

The data was analyzed by [SAS \(1996\)](#). Superscripts were used in tables to indicate statistical differences between

means (means were compared by Duncan procedure). The significant level was set at $P < 0.05$.

RESULTS AND DISCUSSION

As shown in Table 4, there was a significant effect of diet on feed intake in the whole time of culturing process ($P < 0.05$). Feed intake of birds fed diet 4 (based on total amino acid formulation and low level of protein) was significantly higher than birds fed diet 2 (based on digestible amino acids formulation and average level of protein). However, feed intake in birds given diet 1, 3, 5 and 6 was not significantly different.

[Han and Baker \(1993\)](#) reported that increasing lysine from 0.52 to 1.12 in diet, would cause increasing feed intake. They realized in lack of lysine, chicks will answer equally but with increasing lysine to required level and above that the males consumes more feed and had faster growth than females. Birds fed the higher protein diets yielded more total white meat (breast meat) compared to birds fed the lower protein diets. This is similar to results reported by many other investigators ([Waibel et al. 1995](#); [Bartov and Plavnik, 1998](#); [Corzo et al. 2005](#)). As you can see, in females, there was not a significant effect of diet formulation on carcass weight whereas, we notice that there is some significant effects in males. The highest percentage belongs to diet 6 and the lowest was diet 1. According to these results we can say that, increasing of diet's protein, specially by reason of increasing lysine and methionine, caused increase of breast meat and by decreasing protein in diets it decreased the breast meat ([Ayasan et al. 2009](#)). Also treatments fed with diets based on total amino acids, due to higher density of amino acids, had a better carcass weight thus, these two amino acids reduces the body fat as well. There was a significant effect of diet formulation on abdominal fat ($P < 0.05$), in male chicks, in diet 2, 5 and 6 we had a lower percentage of body fat than the others and in females diet 5 has the lower percentage. It seems that the abdominal fat content is higher in diets with high digestibility compare to diets with low digestibility. Early researches has shown that birds fed low levels of crude protein, Simultaneously had more feed intake and increase of abdominal fat ([Fancher and Jensen, 1989](#)) and ([Rosebrough and McMurtry, 1993](#)). In contrast, another research shows that broilers fed with high digestible rations compare to low digestible rations had more abdominal fat ([Widyaratne and Drew, 2011](#)). Due to high density of protein in diet 4 compare to the other diets, it is expected to have more feed intake and weight gain and with chicks aging and consuming more feed, this difference seems greater and because of the higher protein in diets formulated based on total protein the more compact diet (diet 6) shows more weight gain.

Table 1 Starter diet (day 0-11)

Ingredients (%)	Treatments					
	1	2	3	4	5	6
Corn	0.5831	0.5843	0.6188	0.6200	0.6534	0.6557
Soybean meal 44%	0.3104	0.3102	0.2806	0.2803	0.2509	0.2505
Fish meal 65%	0.05	0.05	0.05	0.05	0.05	0.05
Di- calcium phosphate	0.0164	0.0164	0.0167	0.0167	0.0171	0.0171
Limestone	0.0114	0.0114	0.0114	0.0114	0.0114	0.0114
Soy bean oil	0.0183	0.0183	0.0119	0.0119	0.0054	0.0054
Salt	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
Mineral supplement	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
Vitamin supplement	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
DL-methionine	0.0015	0.0005	0.0017	0.0008	0.002	0.0011
L-lysine hydro chloride	0.00	0.00	0.00	0.00	0.0008	0.00

Analysis results

Apparent metabolizable energy corrected for nitrogen (AMEn) (kcal/kg)	2.988	2.988	2.988	2.988	2.988	2.988
Crude protein (%)	22	21	20	22	21	20
Calcium (%)	1.1	1.1	1.1	1.1	1.1	1.1
Av. phosphor (%)	0.5	0.5	0.5	0.5	0.5	0.5
Sodium (%)	0.22	0.22	0.22	0.22	0.22	0.22
Lysine (%)	1.2945	1.2155	1.2	1.2941	1.2151	1.1362
Methionine (%)	0.5588	0.5741	0.5894	0.4688	0.4814	0.4993
Methionine + cysteine	0.89	0.89	0.89	0.8	0.8	0.8
Threonine (%)	0.9233	0.8831	0.843	0.82	0.79	0.752
Arginine (%)	1.4927	1.4126	1.3327	1.32	1.26	1.2
Tryptophan (%)	0.2819	0.2666	0.2514	0.209	0.2	0.19

Trace mineral mix supplied (mg/kg diet): Iron: 60; Manganese: 100; Zinc: 60; Copper: 5; Iodine: 2; Cobalt: 0.2; Selenium: 0.15 and Choline chloride: 400.

Vitamin mix supplied (per kg diet): vitamin A: 1.000 IU; vitamin D₃: 3.500 IU; vitamin E: 100 mg; vitamin K₃: 3 mg; vitamin B₁: 3 mg; vitamin B₂: 6 mg; vitamin B₆: 5 mg; vitamin B₁₂: 0.03 mg; Niacin: 45 mg; Calcium pantothenate: 15 mg; Folic acid: 1 mg; Biotin: 0.15 mg and Ethoxyquin (antioxidant): 150 mg.

Table 2 Grower diet (day 11-23)

Ingredients (%)	Treatments					
	1	2	3	4	5	6
Corn	0.637	0.6493	0.6721	0.685	0.7064	0.7205
Soy bean meal 44%	0.2542	0.2517	0.2245	0.2219	0.1994	0.192
Fish meal 65%	0.05	0.05	0.05	0.05	0.05	0.05
Di-calcium phosphate	0.0158	0.0157	0.0161	0.0161	0.0164	0.164
Limestone	0.0111	0.0111	0.0111	0.0111	0.0111	0.0111
Soy bean oil	0.0224	0.0135	0.0159	0.007	0.0095	0.0005
Salt	0.0031	0.0031	0.0031	0.0031	0.0031	0.0031
Mineral supplement	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
Vitamin supplement	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
DL-methionine	0.0015	0.0006	0.0018	0.0009	0.0021	0.0012
L-lysine hydro chloride	0.00	0.00	0.0005	0.00	0.0015	0.0001

Analysis results

Apparent metabolizable energy corrected for nitrogen (AMEn) (kcal/kg)	3.0380	3.0380	3.0380	3.0380	3.0380	3.0380
Crude protein (%)	20	19	18	20	19	18
Calcium (%)	1.0560	1.0560	1.0560	1.0560	1.0560	1.0560
Av. phosphor (%)	0.4800	0.4800	0.4800	0.4800	0.4800	0.4800
Sodium (%)	0.1900	0.1900	0.1900	0.1900	0.1900	0.1900
Lysine (%)	1.1427	1.1000	1.1000	1.1384	1.0595	0.9900
Methionine (%)	0.5396	0.5548	0.5701	0.4494	0.4647	0.4799
Methionine + cysteine	0.8400	0.8400	0.8400	0.7500	0.7500	0.7500
Threonine (%)	0.8425	0.8024	0.7622	0.7789	0.74	0.701
Arginine (%)	1.3352	1.2552	1.1753	1.231	1.17	1.108
Tryptophan (%)	0.2519	0.2366	0.2214	0.2	0.19	0.18

Trace mineral mix supplied (mg/kg diet): Iron: 60; Manganese: 100; Zinc: 60; Copper: 5; Iodine: 2; Cobalt: 0.2; Selenium: 0.15 and Choline chloride: 400.

Vitamin mix supplied (per kg diet): vitamin A: 1.000 IU; vitamin D₃: 3.500 IU; vitamin E: 100 mg; vitamin K₃: 3 mg; vitamin B₁: 3 mg; vitamin B₂: 6 mg; vitamin B₆: 5 mg; vitamin B₁₂: 0.03 mg; Niacin: 45 mg; Calcium pantothenate: 15 mg; Folic acid: 1 mg; Biotin: 0.15 mg and Ethoxyquin (antioxidant): 150 mg.

Table 3 Finisher diet (day 24-42)

Ingredients (%)	Treatments					
	1	2	3	4	5	6
Corn	0.5831	0.5843	0.6188	0.62	0.6534	0.6557
Soy bean meal 44%	0.3104	0.3102	0.2806	0.2803	0.2509	0.2505
Fish meal 65%	0.05	0.05	0.05	0.05	0.05	0.05
Di-calcium phosphate	0.0164	0.0164	0.0167	0.0167	0.0171	0.0171
Limestone	0.0114	0.0114	0.0114	0.0114	0.0114	0.0114
Soy bean oil	0.0183	0.0183	0.0119	0.0119	0.0054	0.0054
Salt	0.0039	0.0039	0.0039	0.0039	0.0039	0.0039
Mineral supplement	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
Vitamin supplement	0.0025	0.0025	0.0025	0.0025	0.0025	0.0025
DL-methionine	0.0015	0.0005	0.0017	0.0008	0.002	0.0011
L-lysine hydro chloride	0	0	0	0	0.0008	0

Analysis results

Apparent metabolizable energy corrected for nitrogen (AMEn) (kcal/kg)	3.176	3.176	3.176	3.176	3.176	3.176
Crude protein (%)	19	18	17.0514	19	18	17
Calcium (%)	0.9900	0.9900	0.9900	0.9900	0.9900	0.9900
Av. phosphor (%)	0.4500	0.4500	0.4500	0.4500	0.4500	0.4500
Sodium (%)	0.1900	0.1900	0.1900	0.1900	0.1900	0.1900
Lysine (%)	1.0590	1.0500	1.0500	0.4349	0.9797	0.9500
Methionine (%)	0.5149	0.5302	0.5446	0.4349	0.4501	0.4654
Methionine + cysteine	0.8200	0.8200	0.8200	0.7400	0.7400	0.7400
Threonine (%)	0.7983	0.7581	0.7200	0.76	0.72	0.68
Arginine (%)	1.3234	1.2435	1.1677	1.192	1.13	1.0672
Tryptophan (%)	0.2475	0.2322	0.2177	0.2	0.19	0.1794

Trace mineral mix supplied (mg/kg diet): Iron: 60; Manganese: 100; Zinc: 60; Copper: 5; Iodine: 2; Cobalt: 0.2; Selenium: 0.15 and Choline chloride: 400.

Vitamin mix supplied (per kg diet): vitamin A: 1.000 IU; vitamin D₃: 3.500 IU; vitamin E: 100 mg; vitamin K₃: 3 mg; vitamin B₁: 3 mg; vitamin B₂: 6 mg; vitamin B₆: 5 mg; vitamin B₁₂: 0.03 mg; Niacin: 45 mg; Calcium pantothenate: 15 mg; Folic acid: 1 mg; Biotin: 0.15 mg and Ethoxyquin (antioxidant): 150 mg.

Table 4 Means of performance traits

Treatments	Feed intake (g)	Weight gain (g)	FCR
1	4072.91 ^{ab}	2073.57 ^b	1.96 ^{bc}
2	3918.29 ^b	2044.57 ^b	1.92 ^{abc}
3	4236.48 ^{ab}	2340.62 ^a	1.82 ^{abc}
4	4453.82 ^a	2270.07 ^a	1.97 ^c
5	4185.66 ^{ab}	2354.94 ^a	1.79 ^a
6	4257.13 ^{ab}	2345.75 ^a	1.80 ^{ab}
SEM	±48.137	±23.746	±0.02
Significant level (P)	0.104	0.005	0.058

The means within the same column with at least one common letter, do not have significant difference (P>0.05).

SEM: standard error of the means.

FCR: feed conversion ratio.

Table 5 Means of carcass characteristic

Treatments	Breast weight (%)		Thigh weight (%)		Abdominal fat weight (%)		Carcass weight (%)	
	Male	Female	Male	Female	Male	Female	Male	Female
1	23.22 ^c	24.29 ^b	21.47	20.82	3.37 ^a	2.99 ^a	73.28 ^b	73.67
2	25.00 ^{bc}	23.78 ^b	21.92	22.00	2.28 ^b	2.55 ^{ab}	75.21 ^{ab}	74.35
3	25.09 ^{bc}	26.13 ^{ab}	22.36	21.47	2.56 ^{ab}	2.75 ^{ab}	75.12 ^{ab}	75.79
4	25.72 ^{ab}	24.70 ^{ab}	22.05	20.82	2.63 ^{ab}	3.14 ^a	75.36 ^a	72.76
5	26.66 ^{ab}	26.77 ^a	21.90	21.34	2.20 ^b	2.14 ^b	76.55 ^a	75.69
6	27.63 ^a	26.04 ^{ab}	22.17	22.05	2.19 ^b	2.42 ^{ab}	77.01 ^a	75.25
SEM	±0.301	±0.297	±0.277	±0.301	±0.114	±0.102	±0.252	±0.473
Significant level (P)	0.019	0.075	0.957	0.745	0.082	0.122	0.016	0.412

The means within the same column with at least one common letter, do not have significant difference (P>0.05).

SEM: standard error of the means.

Thomas *et al.* (2008) suggest that we can reduce amino acid requirements to 5 percent of suggested level for females but there is no such comment for male chicks.

There was also a significant effect of sex on body fat, females had a significantly higher percentage of body fat than males.

This difference is most likely due to the developmental characteristics of these two genders. It seems logical that male broiler would require higher levels of amino acids than females, because male chick's body contain more protein and less fat.

We can see that there was no significant effect of diet formulation on thigh weight in both genders. This could be refer to chick's breed. The best FCR was for diet 5 that was formulated based on total amino acids and suggested protein level.

Maiorka *et al.* (2005) said chicks fed digestible amino acids and higher energy level had higher FCR but their feed intake and weight gain had no difference with chicks fed total amino acids. This improvement in FCR indicates formulating diet on digestible amino acids is more needed when rations have protein sources with low digestible amino acids but rations with high energy density and pellet forming causes more abdominal fat in chicks.

Pertila *et al.* (2002) revealed that final weight and growth rate were highest when digestible lysine based feed formulation was used compared to that based on total lysine. The increase in final weight was largest for diet containing meat and bone meal and formulated based on digestible lysine. In addition, the proportion of breast muscle of total live-weight and weight of breast muscle increased in animals fed diets formulated on the basis of digestible compared to total lysine. However, diet formulation based on digestible lysine impaired feed conversion ratio compared to that of total lysine for birds fed soybean meal as the sole source of supplementary protein compared to diets containing rapeseed or meat and bone meal. Growth rate and final weight were higher in birds fed diets containing soybean meal alone compared to those also containing rapeseed meal and meat and bone meal. In addition, the effect of diet formulation based on digestible lysine on performance results of broilers was more obvious in males than females. The results indicated that formulation of diets based on a digestible lysine was better than that based on total lysine when diets contained protein sources of low amino acid digestibility such as meat and bone and rapeseed meals.

The outcome of the experiment of (Hoehler *et al.* 2006) can be seen as a validation of the standardized ileal digestibility figures given above-at least for the raw materials used in this experiment. Knowledge about amino acid digestibility in raw materials enables the nutritionist to more accurately use critical ingredients and not all essential amino acids are commercially available, it might be useful to consider or at least to monitor them in feed formulation since broiler experiments have consistently shown that the full benefits of the application of the ideal protein concept can only be achieved when all essential amino acids are in bal-

ance (Lemme, 2003). This is of particular importance especially during the early starter and starter phases.

CONCLUSION

The results of this study indicated that use of total amino acids is better than digestible amino acids for diet formulation of Cobb 500 strain.

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