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## Different Criteria for Feed Formulation Based on Digestible Amino Acids for Broilers

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### ABSTRACT

An experiment was carried out to evaluate different criteria in feed formulation based on digestible amino acids for broilers during the grower phase. Diets were formulated according to the recommendations for digestible methionine, methionine + cysteine, lysine, and threonine. A total number of six hundred Cobb 500 male day-old chicks were distributed in a completely randomized experimental design, with three formulation criteria supplying the recommendations established by Baker & Chung (1992), Degussa (1997), and Rostagno *et al.* (2000), with 4 replicates of 50 birds each. No significant differences were observed for weight gain and feed intake. However, feed conversion ratio improved when birds were fed the diets containing the profiles recommended by Baker & Chung (1992) and Degussa (1997). No difference was observed in terms of leg, wings, back, and head yields. Broilers fed with the profile of Baker & Chung (1992) presented worst breast yield, whereas those fed the Degussa (1997) standard had better carcass yield.

### INTRODUCTION

An important function of animal production is to provide high-quality protein for human consumption. In order to fulfill this role, animals themselves require high-quality protein in correct proportions in their diets. There are many ways to assess the quality of proteins, but nevertheless they are all related to amino acid supply, which thus becomes a key feature in animal nutrition. For many years, poultry feed formulation was based on the concept of crude protein, which often resulted in higher amino acid levels than those required by the birds. Birds are not able to properly utilize this excess of amino acids, which is reduced to nitrogen and excreted as uric acid. Excessive protein levels in the feed do not only mean high formulation costs, but can also affect poultry performance. When synthetic amino acids became commercially available, nutritionists started to formulate lower cost feeds, with a proper level of amino acids, but still used high protein levels. Birds do not require high crude protein in the feed, but merely an amount that ensures sufficient nitrogen reserve for the synthesis of non-essential amino acids. As the number of economically available synthetic amino acids increase, the crude protein level will be increasingly reduced. According to Pack (1995), amino acid requirements must indubitably be expressed on digestible base, instead of total base.

It is known that many factors influence broilers amino acid requirements. However, it is virtually impossible to carry out all the possible combinations in dose-response experiments, and to individually observe the response to essential amino acids. Fernandez *et al.* (1994) showed that these problems can be solved with diets formulated on



the concept of ideal protein. The biggest advantage of using the ideal protein profile is that it can easily be adapted to different circumstances, as the ideal ratios remain relatively stable, regardless the changes of the nutritional plan of amino acids.

The interactions among dietary amino acids must be considered. There will be a response to lysine only if methionine is adequately supplied, showing the importance of providing a well-balanced amino acid profile. Kidd *et al.* (1997) reported an interaction between lysine and threonine on weight gain and lean tissue yield of broilers slaughtered at 54 days of age, where high dietary lysine concentrations, without considering threonine levels, limited performance.

When maintenance requirements are considered, the levels of sulfur amino acids and threonine are higher than those of lysine. This happens once lysine requirements are almost exclusively for body protein production. On the other hand, significant amount of the requirements of sulfur amino acid are for feathering. These requirements substantially increase with bird weight and age. In general, when evaluating total requirements, younger birds require a Met+Cys:Lys of 65:100, which increases to 80:100 in 5 to 6-week-old birds Schutte & Pack (1995b). However, there are little experimental data on the individual use of amino acids, although it is known that lysine is more efficiently used for protein accretion than methionine or other aliphatic amino acids, such as isoleucine (Batterham *et al.*, 1990; Baker, 1991).

Based on broiler growth studies with crystalline amino acids, Baker & Chung (1992) suggested ratios of 72% and 67% for Met+Cys and Thr to lysine. These data are based on the analysis of regression resulting from assays that related protein retention to amino acid intake. Although this is correct, it does not take into account maintenance requirements, which are critical for heavier birds. It must also be remembered that feed efficiency and carcass quality are more important in broilers production than merely growth parameters.

Working with Ross 308 broilers, Schutte & Pack (1995a) investigated the response to lysine and sulfur amino acids during the period of 14-38 days of age, and verified that the best ratio for Met+Cys:Lys is 82:100, when it were evaluated growth rate, feed conversion and breast meat deposition.

The most important parameters to characterize carcass quality are carcass yield, breast meat yield, and carcass fat. Breast meat yield is the carcass component which has the highest financial value, if we consider

the bird as a whole. Within the production cycle, breast meat continuously increases as a percentage of body weight (Acar *et al.*, 1993; Fischer, 1994). If there is any limitation in dietary amino acid supply, breast meat accretion will be the first site of protein synthesis to be affected.

The availability of different nutritional recommendations is a problem in establishing the best nutrition for broilers, as it generates doubts as to which recommendation should be used (Araujo *et al.*, 2002).

This study aimed to evaluate performance and carcass yield of broilers fed according to different feed formulation criteria, based on digestible amino acids for the period of 22 to 42 days of age.

## MATERIAL AND METHODS

The performance and the carcass yield of broilers fed according to different feed formulation criteria, involving digestible methionine, methionine + cysteine, lysine and threonine as recommended by Rostagno *et al.* (2000), Baker & Chung (1992), and Degussa (1997), were evaluated for the period of 22 to 42 days of age. Amino acid profiles of each formulation criteria are shown in Table 1.

A total number of six hundred Cobb 500 male day-old chicks were distributed in a completely randomized experimental design, with 3 treatments (3 feed formulation criteria) and 4 replicates per treatment, with 50 birds each.

During the starter period (1 to 21 days), broilers were raised under the management described by Gomes *et al.* (1996), and fed a commercial diet for broilers (ME 3.000 kcal/kg; CP 21%). After that period, birds were selected, weighed, and distributed to the experimental treatments in a completely randomized experimental design. Feed and water were available *ad libitum*. Birds were housed in a conventional broiler house, measuring 30 x 6.65 m. The roof was oriented in the north-south direction, with a height of 2.5 m and had no roof air pipe, and asbestos tiles. The sides were covered by a yellow plastic curtain with a mobile system for the control of the internal house environment. The house was divided in pens measuring 3.15 x 1.50 m.

The experimental diets were formulated based on corn, soybean meal, corn gluten meal, soybean oil, dicalcium phosphate, limestone, common salt, synthetic amino acids (DL-methionine, L-lysine, and L-threonine), and mineral and vitamin supplements. The basal diet (Table 2) contained the lysine level recommended by Rostagno *et al.* (2000), and it is shown in Table 3. The



diet variables were the amino acid profiles of each evaluated profile. Diets were isoproteic and isocaloric. When profiles were compared, digestible lysine levels remained constant.

**Table 1** - Digestible amino acids profiles, expressed as a percentage of lysine, according to different feed formulation criteria from 22 to 42 days of age.

Amino acids	Criterion					
	Rostagno <i>et al.</i> 2000		Baker & Chung 1992		Degussa 1997	
	%	DAA	%	DAA	%	DAA
Lysine	100	1.08	100	1.08	100	1.08
Methionine	39	0.42	37	0.40	49	0.53
Met+Cys	70	0.76	75	0.81	82	0.89
Threonine	56	0.61	70	0.76	60	0.65

**Table 2** – Composition of experimental diets.

Ingredientes	Criterion		
	Rostagno <i>et al.</i> 2000	Baker & Chung 1992	Degussa 1997
Corn	60.37	56.60	59.22
Soybean meal	27.96	33.09	29.67
Corn gluten	3.47	1.02	2.35
Soybean oil	4.16	5.33	4.62
Dicalcium phosphate	1.68	1.66	1.68
Limestone	1.03	1.00	1.02
Salt	0.40	0.40	0.40
DL-Methionine	0.15	0.24	0.30
L-Lysine	0.28	0.16	0.24
Vit. mineral premix <sup>A</sup>	0.50	0.50	0.50
Total	100.00	100.00	100.00

A – Supplied per kilogram of diet: Vitamin A – 8,000 UI; Vitamin D<sub>3</sub> – 2,000 UI; Vitamin E – 50 mg; Vitamin K<sub>3</sub> – 3 mg; Vitamin B<sub>1</sub> – 1.5 mg; Vitamin B<sub>2</sub> – 4 mg; Vitamin B<sub>6</sub> – 0.12mg; Vitamin B<sub>12</sub> – 15mcg; Folic acid – 0.6 mg; Pantothenic acid – 10 mg; Niacin – 30 mg; Biotin – 0.1 mg; Choline chloride – 300 mg; Iron – 50 mg; Copper – 10 mg; Zinc – 70 mg; Manganese – 100 mg; Iodine – 1 mg; Selenium – 0.3 mg; ethoxyquin – 50 mg.

**Table 3** – Calculated composition of experimental diets.

Nutrients	Criterion		
	Rostagno <i>et al.</i> 2000	Baker & Chung 1992	Degussa 1997
Energy (kcal ME/kg)	3,200	3,200	3,200
Crude protein (%)	20.00	20.00	20.00
Calcium (%)	0.91	0.91	0.91
Non-phytate phosphorus (%)	0.42	0.42	0.42
Sodium (%)	0.20	0.20	0.20
Dig. Lysine (%)	1.08	1.08	1.08
Dig Methionine (%)	0.42	0.40	0.53
Dig Met and Cys (%)	0.76	0.81	0.89
Dig Theonine (%)	0.61	0.76	0.65

The evaluated performance traits were weight gain, feed intake, and feed conversion ratio. Weight gain (WG) was determined by the difference between final weight and initial weight of the broilers in each treatment. Feed intake (FI) was obtained by the difference between the feed fed at the beginning of

the experiments and the feed residue of each replicate at the end of the experimental period. Feed conversion ratio (FCR) was determined by the ratio between feed intake during the each experimental period by weight gain during the respective period.

At the end of the experimental period, after 6 hours fasting, four birds of each replicate were slaughtered to determine carcass yield, considered as the eviscerated carcass weight relative to live weight after fasting, before slaughter. Then, the percentage ratios of weights of breast, legs (leg and thighs), wing, back, head (head + neck), feet and abdominal fat (AF) were calculated relative to the eviscerated carcass.

Abdominal fat was defined as the adipose tissue present around the vent, bursa, and adjacent abdominal muscles, according to Smith (1993).

Statistical analyses were carried out using the software SAS - Statistic Analysis System (SAS, 1996). In order to compare the means, the test of Tukey at a level of 5% was used.

## RESULTS AND DISCUSSION

The performance results of broilers fed diets formulated according to different formulation criteria, based on digestible amino acids, are presented in Table 4. There were no significant differences in weight gain and feed intake among the evaluated treatments ( $p>0.05$ ). There was a trend for lower weight gain for the broilers fed the profile established by Rostagno *et al.* (2000), possibly due to the lower methionine + cysteine and threonine levels recommended by that formulation criterion. For feed conversion, the best results were found in the treatments referring to Baker & Chung (1992) and Degussa (1997).

**Table 4** – Performance of broiler fed diets formulated according to different formulation criteria, based on digestible amino acids, in the period of 22 to 42 days of age.

Criterion	Weight gain (g)	Feed intake (g)	Feed : gain (g:g)
Rostagno <i>et al.</i> , 2000	1,498	2,696	1.80b
Baker & Chung, 1992	1,556	2,725	1.75a
Degussa, 1997	1,539	2,701	1.76a
CV (%)	3.5	2.6	3.3
P value	0,123	0,085	0,043

Means in the same column followed by different letter are different ( $p<0.05$ ) by Tukey test.

For carcass evaluation (Table 5), no differences were found in leg, wing, back, head + neck, feet, and abdominal contents. The standard established by



**Table 5** – Carcass and part yields and abdominal fat percentage of broiler fed with different criteria of formulation, based on digestible amino acids, in the period of 22 to 42 days of age.

Criterion	Parameter						
	Carcass	Breast	Legs	Wings	Back	Head + Neck	Feet
Rostagno <i>et al.</i> 2000	86.05b	26.31ab	27.31	10.43	19.56	8.71	5.19
Baker & Chung, 1992	84.94b	25.75b	27.37	10.50	19.27	9.41	5.27
Degussa, 1997	88.41a	27.35a	26.43	10.56	18.57	8.90	5.11
CV(%)	2.6	4.4	4.2	5.0	7.7	13.5	7.4
P value	0,038	0,029	0,087	0,102	0,153	0,144	0,095

Means in the same column followed by different letter are different ( $p < 0.05$ ) by Tukey test.

Degussa (1997) promoted the best carcass and breast yield, and that recommended by Baker & Chang (1992) produced the worst values for carcass and breast yield. Despite not statistically different ( $P = 0.153$ ), the highest back yield was found in birds fed the standard established by Rostagno *et al.* (2000).

Broilers fed a diet containing 3,000 kcal ME/kg and 1.05% of digestible lysine, during the period of 14 to 35 of age, presented the best performance when digestible lysine:Met+Cys ratio was 100:75 (Huyghebaert & Pack, 1995).

Working with broilers during the period of 33 to 43 days of age, and feeding a diet with 3,250 kcal ME/kg, Shutte & Pack (1995b) observed that, the best digestible Met+Cys level was approximately 75% to 78%, and 68% for threonine as a function of digestible lysine level in the diet, for performance and breast yield.

Araujo *et al.* (2002) worked with different formulation criteria based on digestible amino acids during the starter phase, and reported that the broilers fed the profiles established by Baker & Chung (1992) and Degussa (1997) presented better weight gain and feed conversion ratio than those fed diets with the profile recommended by Rostagno *et al.* (2000). The authors also described that feed intake was not influenced by any of the treatments.

During the finishing phase, using the treatments described in the previous paragraph, Araujo (2001) found better breast yield in birds fed the profiles established by Degussa (1997), which is consistent with the results observed in the present study.

## CONCLUSION

The results of this study allow the following conclusions:

When marketing whole broiler carcasses, the levels established by Degussa (1997) promote the best results for carcass yield and commercial cuts, whereas the results obtained using the levels recommended by Rostagno *et al.* (2000) were intermediate. However,

feed conversion ratio has the worst when broilers were fed with the profile established by Rostagno *et al.* (2000).

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