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Performance and Carcass Yield of Broilers Fed with Different Digestible Amino Acid Profiles Recommended by Nutrients Requirements Tables

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ABSTRACT

An experiment was conducted to evaluate the effect of different digestible amino acid profiles on the performance of broilers in two phases: from 1 to 21 days and from 22 to 42 days of age. At the end of the experiment, carcass yield and cut percentages were evaluated. Nine hundred and sixty AgRoss birds were distributed in a randomized block design with four treatments (four digestible amino acid profiles): Rostagno *et al.* (2000), Baker & Han (1994b), Degussa (1997) and those recommended by AgRoss (2000), with six repetitions and 40 birds per repetition (20 males and 20 females). The results showed that the four diets were able to provide the requirements of the birds, since no significant differences were seen among the treatments on the performance in the two phases and on the carcass yield and cuts at 42 days of age. Males had better yields of feet, head and neck, and lower percentage of abdominal fat ($p<0.05$). The best cost/benefit ratio was seen for the profile established by Rostagno *et al.* (2000) when diets were evaluated in an ideal protein situation.

INTRODUCTION

Broiler diet formulation has been based on crude protein requirements for a long time, frequently resulting in diets containing amino acid levels above the real requirements of birds. Nevertheless, any amino acid in excess is inefficiently used by the birds, so that the excess is deaminated and excreted as uric acid. Advances in the knowledge about amino acid requirements, protein metabolism and the possibility of producing economically feasible synthetic amino acids increased the general efficiency of protein utilization. This, in turn, enabled diet formulation containing amino acid levels more appropriate to the animal needs, although protein levels were kept high. In recent years, many studies have directed animal nutritionists to formulate diets based on the ideal protein concept. This is defined as the ideal amino acid balance in the diet, without deficiencies or excesses, providing the requirements of all amino acids needed for maintenance and production of the birds (Baker & Chung, 1992). According to Penz (1996), amino acid should be added in levels that are as close as possible from the requirements of the birds in each production phase and thus, amino acid excess would be minimized in the diets.

Nutritional programs are commonly based on foreign requirement tables such as NRC (1994), ARC (1975), INRA (1984), Rhône Poulenc (1993) and Degussa (1997), and also on Brazilian tables such as Rostagno *et al*. (2000) or the recommendations from feeding or husbandry manuals of commercial strains.

Amino acid and protein requirements in broilers may vary according to the production phase and the expected goals. Thus, it is difficult to

Table 1 – Profile of digestible amino acids expressed as a percentage of lysine suggested by requirement tables for broilers.

Amino acids	Rostagno *et al*. (2000)		Baker & Han (1994b)		Degussa (1997)		AgRoss (2000)	
	1-21 days	22-42 days	1-21 days	22-42 days	1-21 days	22-42 days	1-21 days	22-42 days
Lysine	100 (1.14)	100 (1.06)	100 (1.14)	100 (1.06)	100 (1.14)	100 (1.06)	100 (1.14)	100 (1.06)
Met + Cys[1]	71 (0.81)	70 (0.74)	72 (0.82)	75 (0.80)	77 (0.88)	82 (0.87)	70 (0.80)	74 (0.79)
Threonine	59 (0.67)	56 (0.59)	67 (0.77)	70 (0.74)	60 (0.69)	60 (0.64)	63 (0.72)	65 (0.69)
Tryptophan	16 (0.18)	17 (0.18)	16 (0.18)	17 (0.18)	16 (0.18)	17 (0.18)	18 (0.21)	17 (0.18)

1- Methionine + Cystine

establish the requirements for the birds since they can be affected by a considerable number of factors, such as: metabolizable energy of the diet, age, gender, feed intake and environmental conditions. A diet based on the concept of ideal protein is established by selecting a reference amino acid. Lysine was standardized as the reference since it can be easily evaluated and is available in crystalline form. Besides, lysine has been previously described in studies and has great importance in the protein synthesis.

The aim of this study was to evaluate the applicability of the ideal protein concept according to the recommendations of some broiler nutrients requirements tables, based on the results of carcass yield and cost/benefit ratio.

MATERIAL AND METHODS

Nine hundred and sixty AgRoss chicks were distributed in 24 experimental units with 20 male and 20 females each. Although it is known that male and female requirements are different, sex-mixed birds were used, similar to what is seen in the majority of the commercial poultry farms.

Mean body weight of one-day-old chicks was 38.0g. They were housed in a randomized block design, with four treatments (four digestible amino acid profiles, according to Table 1) and six repetitions. The evaluations were performed in the initial phase (1 to 21 days), grower phase (22 to 42 days) and total period (1 to 42 days).

The basal diet and the amino acid lysine were established according to "Tabelas Brasileiras para Aves e Suínos" (Rostagno *et al.*, 2000). Lysine levels were fixed and other amino acid profiles were established as a percentage of lysine. Birds were fed isocaloric and isoproteic diets in all treatments (Tables 2 and 3).

At the end of each phase, weight gain (WG), feed intake (FI), feed conversion (FC), mean daily weight gain (DWG), energy conversion (EC), protein conversion (PC) and mortality rate were evaluated. Productive efficiency index (PEI) was also evaluated for the total period (1 to 42 days). At the end of the trial, the birds were weighed, male and female mean body weight were determined for each experimental unit. Afterwards, in each experimental unit, one male and one female with body weight similar to the mean were killed in order to evaluate the yield of the carcass and commercial cuts.

For economical analysis, the cost of the diet per kg of live bird was considered for each digestible amino acid. Diet cost was calculated and expressed in US$/kg (Tables 2 and 3). All results were statistically analyzed using the software SAEG (UFV, 1997).

RESULTS AND DISCUSSION

No effect of treatment was seen on weight gain (WG), feed intake (FI), feed conversion (FC), mean daily weight gain (DWG), energy conversion (EC) and protein conversion (PC) from 1 to 21 days and from 22 to 42 days (Table 4).

Few data are available about the different profiles of digestible amino acids in broiler chickens based on lysine nutritional requirements, which is used as a reference for establishing the levels of the other amino acid. For instance, Conhalato *et al*.(1999) evaluated the effect of different levels of digestible lysine (0.84, 0.93, 1.02, 1.11 and 1.20%) for broiler chickens and the best weight gain was obtained with the predicted levels of approximately 1.02%, with 33% of methionine, 61% of threonine and 15% of tryptophan. These levels are similar to ideal levels established by Baker & Han (1994a), i.e., 36% of methionine, 67% of threonine and 16% of tryptophan.

The percentage of digestible lysine was 1.06% from 22 to 42 days of age. This is very similar to the level of 1.07% reported by Valério *et al*. (2000) showing better performance and carcass characteristics, with similar

Table 2 – Composition (%) and cost (US$) of the experimental diets (1 to 21 days).

Ingredients %	Treatments			
	Rostagno *et al.* (2000)	Baker & Han (1994b)	Degussa (1997)	AgRoss (2000)
Corn	65.57	65.59	65.53	65.20
Soybean meal	22.00	21.97	21.85	24.83
Corn gluten	3.35	3.00	4.00	2.50
Feather meal	1.85	3.00	2.51	2.00
Meat meal	3.90	3.00	2.00	2.00
Dicalcium phosphate	0.52	0.79	1.14	1.15
Limestone	0.50	0.65	0.80	0.79
Soybean oil	0.00	0.00	0.00	0.10
Salt	0.45	0.45	0.45	0.45
Inert	0.87	0.49	0.65	0.00
DL-methionine	0.06	0.06	0.12	0.05
L-lysine	0.43	0.43	0.45	0.33
L-threonine	0.00	0.07	0.00	0.03
Tryptophan	0.00	0.00	0.00	0.07
Vitamin mineral premix + additives[1]	0.50	0.50	0.50	0.50
Total	100 (US$ 12.46)	100 (US$ 12.88)	100 (US$ 12.78)	100 (US$ 13.21)
Calculated composition				
Metabolizable energy (kcal ME/kg)	3,000	3,000	3,000	3,000
Crude protein, %	21.5	21.5	21.5	21.5
Ca, %	0.96	0.96	0.96	0.96
Available phosphorus, %	0.45	0.45	0.45	0.45
Digestible lysine, %	1.14	1.14	1.14	1.14
Digestible Met + Cys, %	0.81	0.82	0.88	0.80
Digestible tryptophan, %	0.18	0.18	0.18	0.21
Digestible threonine (%)	0.67	0.77	0.69	0.72

1- Vitamin, mineral and additive, level per kg: vit. A – 1,620,000 IU; vit. D3 – 324,000 IU; vit. E – 3,600 mg; vit. K – 450,288 mg; vit. B1 – 360,032 mg; vit. B2 – 1,080 mg; vit. B6 – 540,005 mg; vit. B12 – 2,160 mg; folic acid –179,999 mg; nicotinic acid – 6,300 mg; calcium pantohtenate – 2,880.083 mg; biotin – 10,800 mg; choline – 69,960 mg; iron – 10,000 mg; copper – 1,600 mg; manganese – 14,000 mg; cobalt – 40,040 mg; zinc –11,000 mg; iodine – 200,384 mg; selenium – 60,001 mg; antioxidant – 20,180 mg; avilamicin – 1,500 mg; olaquindox 10,000 mg; nicarbazin – 7,999.590 mg; narasin – 8,000 mg; synthetic methionine – 285,120 mg.

Table 3 – Composition (%) and cost (US$) of the experimental diets (22 to 42 days).

Ingredients %	Treatments			
	Rostagno *et al.* (2000)	Baker & Han (1994b)	Degussa (1997)	AgRoss (2000)
Corn	68.28	67.37	67.43	66.37
Soybean meal	21.76	21.97	21.96	22.79
Corn gluten	0.80	1.00	1.00	1.00
Feather meal	1.00	2.00	2.00	2.22
Meat meal	3.97	2.00	2.00	2.00
Dicalcium phosphate	0.30	0.94	0.94	0.93
Limestone	0.40	0.72	0.72	0.72
Soybean oil	2.10	2.44	2.41	2.52
Salt	0.45	0.45	0.45	0.45
DL-Methionine	0.07	0.11	0.19	0.09
L-Lysine	0.37	0.38	0.38	0.36
Tryptophan	0.005	0.005	0.005	0.00
L-Threonine	0.00	0.12	0.02	0.05
Vitamin mineral premix + additives[1]	0.50	0.50	0.50	0.50
Total	100 (US$ 12.58)	100 (US$ 13.59)	100 (US$ 13.21)	100 (US$ 13.00)
Calculated composition				
Metabolizable energy (kcal ME/kg)	3,150	3,150	3,150	3,150
Crude protein %	19.5	19.5	19.5	19.5
Ca %	0.87	0.87	0.87	0.87
Available phosphorus %	0.41	0.40	0.40	0.40
Digestible lysine %	1.06	1.06	1.06	1.06
Digestible Met + Cis %	0.74	0.80	0.87	0.79
Digestible tryptophan %	0.18	0.18	0.18	0.18
Digestible threonine (%)	0.59	0.74	0.64	0.69

1 - Vitamin, mineral and additive, level per kg: vit. A – 1,687,536 IU; vit. D3 – 337,507.200 IU; vit. E – 3,750.080 mg; vit. K – 468,790 mg; vit. B1 – 375,042 mg; vit. B2 – 1,125.024 mg; vit. B6 – 562,517 mg; vit. B12 – 2,250 mg; folic acid –187,502 mg; nicotinic acid – 6,562.640 mg; calcium pantothenate – 3,000.150 mg; biotin – 11,250 mg; choline – 62,550 mg; iron – 12,500.025 mg; copper – 2,000 mg; manganese – 17,500.015 mg; cobalt – 50,050 mg; zinc – 13,750.125 mg; iodine – 250,480 mg; selenium – 75 mg; antioxidant – 25,187.504 mg; avilamicin – 1,875 mg; olaquindox 12,500 mg; Salinomicin – 15,000 mg; Synthetic methionine – 272,250 mg.

Table 4 – Performance of broilers fed with different profiles of digestible amino acid suggested by requirements tables.

Treatments	Weight Gain (g)	Feed Intake (g)	Feed Conversion (g/g)	Mean Daily Weight Gain (g)	Caloric Conversion (kcal/kg)	Protein Conversion (g/g)
1 - 21 days						
Rostagno *et al.* (2000)	799[1]	1,104	1.382	36.3	4,143	29.7
Baker & Han(1994b)	788	1,099	1.394	35.7	4,182	30.0
Degussa(1997)	800	1,114	1.392	36.3	4,178	29.9
AgRoss(2000)	800	1,109	1.386	36.3	4,155	29.8
CV (%)	1.86	1.96	1.28	1.95	1.30	1.25
22 - 42 days						
Rostagno *et al.* (2000)	1,515	2,869	1.894	70.4	5,967	36.9
Baker & Han (1994b)	1,549	2,906	1.876	72.0	5,912	36.6
Degussa (1997)	1,559	2,941	1.886	72.5	5,940	36.8
AgRoss(2000)	1,560	2,901	1.859	72.5	5,857	36.3
CV (%)	2.82	2.34	2.09	2.89	1.12	1.09

1 - Values not different (p > 0.05) by Newman-Kreuls test.

Table 5 – Performance of broilers fed different profiles of digestible amino acid from 1 to 42 days of age.

Treatments	Weight Gain (g)	Feed Intake (g)	Feed Conversion (g/g)	Mean Daily Weight Gain (g)	Caloric Conversion (kcal/kg)	Protein Conversion (g/g)	PEI
Rostagno *et al.* (2000)	2,322[1]	3,995	1.717	54.4	5,325	34.4	313
Baker & Han (1994b)	2,354	4,029	1.711	55.2	5,319	34.3	318
Degussa (1997)	2,370	4,069	1.717	55.5	5,338	34.4	320
AgRoss (2000)	2,364	4,014	1.698	55.4	5,278	34.1	323
CV (%)	2.08	2.07	1.13	2.12	0.935	0.937	3.23

1 - Values not different (p > 0.05) by Newman-Kreuls test.

Table 6 – Carcass and cut yield of sex-mixed broilers fed different profiles of digestible amino acids from 1 to 42 days of age.

Treatments	Carcass yield (%)	Breast meat (%)	Legs (%)
Rostagno *et al.* (2000)	84.25[1]	27.91	25.31
Baker & Han (1994b)	85.11	26.90	25.49
Degussa (1997)	85.03	27.80	25.37
AgRoss (2000)	84.48	27.28	25.59
CV (%)	5.39	6.44	3.76

1 - Values not different (p > 0.05) by Newman-Kreuls test.

ratio among the amino acids.

The evaluation for the total period (1 to 42 days) comprises the effects of each period. There was no effect of treatments on WG, FI, FC, DWG, CC, PC and PEI throughout the rearing period (Table 5), as well as on carcass yield characteristics and on commercial cuts (Table 6).

Rostagno *et al*. (1995) using diets with digestible amino acids for Ross broilers from 1 to 42 days reported 29.59% of breast yield. In the present study, the same amino acid profile resulted in a breast yield of 27.91% for the same broiler strain and age.

No difference was seen in the cost/kg of live weight, even between the treatments Degussa (1997) and Rostagno *et al.* (2000), which showed the highest and the lowest mean weight (difference of 48 g), respectively. Nevertheless, the best cost/benefit ratio ($p<0.05$) was seen when the profile established by Rostagno *et al*. (2000) was used, the profiles of Degussa (1997) and AgRoss (2000) were equivalent and the profile of Baker & Han (1994b) had the worst cost/benefit ratio. This occurred mainly because a lower percentage of digestible amino acids is suggested by Rostagno *et al*. (2000), according to Tables 2 and 3, and because there was no difference in feed conversion among the treatments.

Expressing the values of cost per kilogram of live weight (Table 7) as percentage, it can be seen that the profile of Rostagno *et al*. (2000) resulted in a cost per kg that is 6.01%; 4.16% and 2.77% lower than the profiles Baker & Han (1994b), Degussa (1997) and AgRoss (2000), respectively.

The economic feasibility of a formulated diet is a variable constantly evaluated by nutritionists before adopting the diet. Thus, the great majority of the nutritionists use least cost diet formulation software. However, it should not be given more importance to performance results, such as daily weight gain, feed conversion and the European efficiency index, to the detriment of economic results. Pesti and Miller (1988) suggested that diet formulation aiming least cost should be changed to diet formulation aiming for the maximum economic profitability.

According to the results presented in Table 7, the better performance data does not always represent the best economic decision, and the nutritional balance of a diet is also established so that the highest production profitability can be achieved.

Table 7 – Cost per kilogram of live weight (US$/kg) of broilers fed different digestible amino acid profiles from 1 to 42 days of age.

Treatments	Cost (US$)
Baker & Han (1994b)	0.229 a[1]
Degussa (1997)	0.225 b
AgRoss (20000	0.222 b
Rostagno *et al*.(2000)	0.216 c
CV (%)	1.43

1- Means followed by different letters are different ($p< 0.05$) by the Newman Kreuls test.

CONCLUSIONS

Diets may be formulated based on the concept of ideal protein, using the profiles of digestible amino acids suggested by Rostagno *et al*.(2000), Baker & Han (1994b), Degussa (1997) and AgRoss (2000) so that the same performance and carcass yield are achieved.

The profile of amino acids suggested by Rostagno *et al*.(2000) showed the best economic benefit when diets were formulated based on the ideal protein concept.

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