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Yield and Carcass Composition of Broilers Fed with Diets Based on the Concept of Crude Protein or Ideal Protein

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ABSTRACT

Two experiments were conducted to evaluate the effect of diets formulated using the criteria of crude protein (CP) and ideal protein (IP) on the yield and carcass composition of male and female broilers. Birds of two broilers strains (Hybro G and Hybro PG) were reared from 1 to 42 days of age during the summer, with average temperatures of 26°C. A completely randomized experimental design was used in a 2 *x* 2 factorial arrangement, with 6 replicates and 20 birds per pen. On day 42, four birds from each experimental unit were killed and carcass yield and composition were determined. Breast yield was higher in males and females fed the IP-based diet than in birds fed the CP-based diet. Abdominal fat pad and carcass crude protein were statistically similar between the two protein criteria and between strains. Carcass amino acid levels evidenced higher levels of Met, Lys, Met+Cys and Thr in the males fed IP-based diets. No differences were seen between the two criteria for the females. Diets formulated according to IP resulted in better carcass and breast yield, both for males and females.

INTRODUCTION

Synthetic amino acids are used aiming to decrease nitrogen excretion, since this element is considered one of the greatest environments pollutants. Besides, profitability can be increased by measures that reduce feeding costs, since feeding represents the major costs in poultry production. Therefore, synthetic amino acids are also used to decrease production costs because they result in better amino acid balance and crude protein levels in the diets may be reduced. Some procedures result in higher efficiency in poultry production such as the fulfillment of nutritional requirements, the formulation of minimal cost diets, and the use of feedstuffs of known composition and adequate feeding programs (Bellaver, 1994). Currently, amino acid levels are no longer expressed as total amino acids (TAA), but in terms of digestible amino acids (DAA); therefore, the requirements are not of protein, but rather requirements of specific amino acids and non-specific N for the synthesis of non-essential amino acids (Suida, 2001).

Amino acid requirements for females have been shown to be lower than requirements for males. Higher amino acid levels are necessary for strains selected for fast growth and birds selected for higher percentage of lean meat (Zaviezo, 1998). Besides, it is also known that broiler performance and carcass quality are affected by dietary levels of protein, lysine, methionine and methionine + cystine, and also by the energy:protein ratio in the diet (Summers *et al.*, 1992; Baker *et al.*, 1996).

The major sources of body fat in chickens are the skin, the abdominal fat pad and the fat deposits in the thighs. According to Vieira & Moran (1998), abdominal fat can vary up to 20% among different commercial broiler strains and the proportion of fat deposits is higher in females than in males.

The present study evaluated carcass composition and performance data in male and female birds from two strains that were reared separately during the summer and fed diets formulated according to the crude protein concept (TAA) or the ideal protein concept (DAA).

MATERIAL AND METHODS

Two trials were carried out simultaneously at the poultry facility of UFSM during the summer (14/02 to 28/03/2001), with mean environment temperature of 26°C. Four hundred and eighty birds of one day old were used in each experiment, half of each strain, i.e., Hybro G (strain A) and Hybro PG (strain B). Male birds were used in the first trial and females in the second trial, distributed in an experimental poultry house (10 m *x* 30 m), with 20 birds in each of the 48 pens (1.5 m *x* 1.5 m).

A completely randomized experimental design was used in both trials, in a 2 *x* 2 factorial arrangement, with two protein concepts and two strains, and 6 repetitions with 20 birds.

Standard management procedures were used during rearing. Diets were formulated according to the IP concept (Han & Baker, 1994) or based on the CP concept and the recommendations of NRC (1994), without amino acid supplementation. Protein levels were 5% lower for females, and they were decreased in 10% for both protein concepts between the rearing phases. Metabolizable energy (ME) levels were similar in both trials (Table 1).

All birds were weighed at 42 days old and the mean body weight per pen was calculated. Four birds with body weight similar to the mean body weight of the experimental unit were chosen, individually identified and slaughtered.

The following carcass characteristics were assessed: carcass yield (CY), breast yield (BY), abdominal fat pad (AF), moisture (MOI), crude fat (CF), carcass crude protein (CCP) and amino acid levels (Met, Met+Cys, Lys, Thr).

Carcasses were stored for 24 hours in a cold chamber after the slaughter. On the following day, the abdominal fat pad was separated, the cuts were made and the yield of breast with bone was assessed. Carcass yield was calculated and expressed in percentage: carcass weight *x* 100 / live weight.

Table 1 - Levels of metabolizable energy (ME), protein, calcium (Ca), available phosphorus (Av. P) and amino acids used for males and females according to the protein concept.

	1- 21 days		22- 35 days		36- 42 days	
	CP	IP	CP	IP	CP	IP
Males						
Protein (%)	23.00	20.97	20.70	19.61	18.63	18.08
ME (kcal/kg)	3,000	3,000	3,100	3,100	3,200	3,200
Ca (%)	0.90	0.90	0.86	0.86	0.82	0.82
Av. P (%)	0.45	0.45	0.42	0.42	0.39	0.39
Met (%)	0.342	0.551	0.316	0.486	0.292	0.429
Lys (%)	1.274	1.120	1.116	1.008	0.975	0.907
Thr (%)	0.961	0.750	0.864	0.705	0.776	0.656
Females						
Protein (%)	21.85	19.99	19.66	18.65	17.69	17.21
ME (kcal/kg)	3,000	3,000	3,100	3,100	3,200	3,200
Ca (%)	0.90	0.90	0.86	0.86	0.82	0.82
Av. P (%)	0.45	0.45	0.42	0.42	0.39	0.39
Met (%)	0.329	0.551	0.305	0.459	0.282	0.405
Lys (%)	1.193	1.120	1.043	0.957	0.802	0.861
Thr (%)	0.912	0.750	0.820	0.670	0.736	0.623

CP= Crude Protein; IP= Ideal Protein, ME= Metabolizable Energy.

One carcass per repetition per treatment was separated, frozen and later ground, according to AOAC recommendations (1984). A 100-g sample was taken and partially dried in an oven at 60°C for 96h. In order to obtain the dried and defatted meat meal, samples were weighed, defatted with ethyl ether and dried for another 2 h. The samples were re-weighed after this procedure.

The ground material was homogenized and duplicate samples were taken to determine moisture, residual fat and the amino acid levels to determine carcass crude protein.

Moisture and crude fat were determined by the formulas:

Moisture = (wet sample weight – dry sample weight) *x* 100 / sample weight

CF = (dry sample weight – defatted sample weight) *x* 100 / dry sample weight

Carcass crude fat was calculated by the formula:

CCF = CF (DM) *x* percentage of dry matter percentage (%DM).

Crude protein (CP) was determined by NIRS on the dry matter of the de-fatted samples. CP values were then multiplied by the percentages of fat and moisture of the respective sample, in order to obtain the carcass crude protein (CCP).

The results from both trials were submitted to analysis of variance using the software SAS (1997) and the means were compared by tests F and Tukey at 10% of significance.

RESULTS AND DISCUSSION

Trial I- males

There was no interaction for the variables FI, WG and FC (Table 2). The results showed that the IP concept was more efficient than the CP concept for males, evidencing adequate protein level and amino acid balance. These findings corroborate results reported by Penz (1996) and Zaviezo (1998), who stated that the ideal protein or combination of proteins should not have excess of amino acids and also that the amino acid levels in the different production periods should be as close as possible to the requirements for maintenance and maximum protein deposition. Feed intake was higher for strain B, which may be due to the larger body size of these birds.

Table 2 - Feed intake (FI), weight gain (WG) and feed conversion (FC) in male broilers from 1 to 42 days.

	FI	WG	FC
Protein concept			
Crude Protein (CP)	4,639a	2,505	1.853b
Ideal Protein (IP)	4,469b	2,491	1.807a
Strain*			
A	4,448b	2,447b	1.820
B	4,660a	2,549a	1.840
Interaction			
CP/ Strain A	4,540	2,444	1.853
CP/Strain B	4,739	2,565	1.854
IP/ Strain A	4,357	2,449	1.787
IP/ Strain B	4,581	2,534	1.827
Probability			
Protein Concept	0.005	0.566	0.002
Strain	0.001	0.000	0.137
Interaction	0.827	0.428	0.138
CV %	2.87	2.15	1.74

Means followed by different letters in the columns are different by Tukey's Test. *A= Hybro G; B= Hybro PG.

Carcass yield, Breast Yield and Abdominal Fat

Table 3 shows the data of carcass and breast yield and abdominal fat for the independent effects. The IP concept resulted in significantly higher carcass yield (p=0.002) than the CP concept. Breast yield for strain B was significantly better than for strain A, and also significantly better in the concept PI than in the concept CP. There was no interaction between the two sources of variation (protein concept *x* strain).

Table 3 - Mean percentages (%) of carcass yield (CY), breast yield (BY) and abdominal fat (AF) in males.

	CY	BY	AF
Protein Concept			
Crude protein	73.5 b	26.3 b	2.3
Ideal Protein	75.4 a	28.2 a	2.0
Strain*			
Strain A	74.2	26.6 b	2.1
Strain B	74.8	27.8 a	2.2
Probability			
Protein Concept	0.002	0.0006	0.116
Strain	0.326	0.018	0.696
Interaction	0.674	0.304	0.041
CV%	2.70	4.25	16.9

Means followed by different letters in the columns are different by Test F. *A= Hybro G; B= Hybro PG.

Similarly, Rosa *et al* (1995) reported no significant differences for breast and carcass data of birds fed according to the recommendations from Han & Baker (1994) compared to birds fed with the recommended levels of TAA and CP from NRC (1994).

Although the concept CP resulted in slightly higher percentage of abdominal pad, there were no significant differences between the two evaluated protein concepts.

The percentage of abdominal fat was not significantly different between the two strains. The results do not agree with results described by Vieira & Moran (1998) that reported differences of up to 20% in the abdominal fat among four different bird strains.

Moisture, Crude Fat and Crude Carcass Protein

There were no interactions between protein concept and strains for moisture, crude fat or crude carcass protein (Table 4).

There was a trend of higher MOI in the carcasses of birds from the IP concept and from strain B, although there were no significant differences between the two concepts or between the two strains.

Crude fat (CF) was higher in the carcasses from birds fed diets based on concept CP (p=0.053) compared to birds fed diets based on the concept IP. These results are in part similar to the results reported by Scheuermann & Mazzuco (1996), who tested essential amino acids levels (AAE) that were 100, 110 and 120% higher than NRC recommendations (1994) and observed that increasing AAE levels had no effect on CCP, but decreased carcass CF and increased breast yield.

The higher CF levels in the carcasses of birds fed the diets based on the CP concept may be explained by the higher feed intake shown by these birds.

Table 4 - Mean carcass percentages (%) of moisture (MOI), crude fat (CF) and carcass crude protein (CCP) in males

	MOI	CF	CCP
Protein Concept			
Crude protein	62.6	15.1a	16.8
Ideal protein	63.4	14.2b	16.9
Strain*			
Strain A	62.3	15.6a	16.7
Strain B	63.7	13.7b	17.0
Probability			
Protein concept	0.305	0.053	0.612
Strain	0.110	0.001	0.152
Interaction	0.257	0.127	0.269
CV%	2.12	4.76	2.59

Means followed by different letters in the columns are different by Test F. *A= Hybro G; B= Hybro PG.

lthough the diets IP and CP were isocaloric, the lipid contents were higher in the latter (3.64 *x* 4.45%, respectively). According to Fialho & Kessler (2001), high-energy diets for swine and poultry are energetically more efficient only at higher levels of feed intake. In other words, efficiency will be increased only when the animals deposit high amounts of body fat using the dietary fat. An unbalance of the essential amino acids might also explain this finding, since an excess of amino acid would be converted to fat.

Strain B, that showed higher MOI, had also lower CF (p=0.053) than strain A.

There were no differences for CCP between strains or between protein concepts.

Amino acid levels

The results of the evaluated amino acids (Met, Met+Cys, Lys, Thr) are shown in Table 5.

A significant interaction between protein concept and strains was seen for Met. Although there were no significant differences between strains within each protein concept, the IP concept was superior to the CP concept (p=0.023) within strain A.

There was a significant interaction (p=0.040) between concepts and strains for Lys. Strains A and B were not different within concept IP. Nevertheless, strain A fed according to the concept IP had higher Lys levels than both strains fed according to the concept CP.

The percentages of Met+Cys and Thr were significantly different between the two protein concepts. Birds fed diets formulated according to the concept IP had higher Met+Cys and Thr levels when compared to CP concept. Besides, Thr levels were higher in strain B when compared to strain A. Since the increased amino acid levels add value to the carcass, this may be an advantage and even justify diet formulation based on the IP concept.

Table 5 - Mean amino acid levels of the carcass defatted samples in males.

	Met %	Met+Cys %	Lys %	Thr %
Protein Concept				
Crude protein (CP)	1.81 b	2.56 b	5.32 b	2.87 b
Ideal Protein (IP)	1.87 a	2.75 a	5.70 a	3.03 a
Strain*				
Strain A	1.84	2.65	5.51	2.87 b
Strain B	1.83	2.65	5.52	3.03 a
Interaction				
CP/ Strain A	1.80 b	2.55	5.23 c	2.75
CP/ Strain B	1.83 ab	2.56	5.42 bc	3.00
IP/ Strain A	1.89 a	2.76	5.79 a	2.99
IP/ Strain B	1.84 ab	2.74	5.61 ab	3.06
Probability				
Protein concept	0.008	0.007	0.0009	0.015
Strain	0.538	1.000	0.965	0.012
Interaction	0.023	0.811	0.040	0.124
CV%	1.46	3.53	2.31	2.90

Means followed by different letters in the columns are different by Tukey's Test. *A= Hybro G; B= Hybro PG.

Trial II- females

The performance results for females (Table 6) were similar to the results seen in Trial I, evidencing better response in the birds fed according to the concept IP. Feed intake results are in accordance with Cahaner *et al.* (1995) who reported that the response to diet protein levels is variable among different strains, depending on the growth rate and the protein deposition rate. Therefore, speed of growth affects the bird response and demands different percentages of amino acids in diets, since birds with faster growth seem to have lower degradation rate of the body protein than birds with slower growth. Therefore, a temporarily deficient amino acid has decreased physiologic supply for protein synthesis and might influence the efficiency of dietary protein utilization.

Carcass Yield, Breast Yield and Abdominal Fat

There was a significant interaction (p=0.024) for breast yield (Table 7). Strain A fed according to concept CP had significantly lower BY, whereas such reduction was not seen in strain B. Smith *et al.* (1998) also reported that the response to protein levels is different among strains when breast yield is considered.

The analysis of the independent effects showed no significant difference in AF between the two concepts, although concept CP had slightly superior results. There was also no difference between strains for abdominal fat. Conversely, Vieira & Moran (1998) reported that AF differed up to 20% among four different strains.

Table 6 - Feed intake (FI), weight gain (WG) and feed conversion (FC) of female broilers in the period from 1 to 42 days of age.

	FI	WG	FC
Protein concept			
Crude protein (CP)	4,037	2,033b	1.958b
Ideal protein (IP)	4,072	2,103a	1.914a
Strain*			
A	3,943b	2,014b	1.936
B	4,166a	2,122a	1.936
Interaction			
CP/ Strain A	3,906	1,974	1.950
CP/ Strain B	4,168	2,092	1.966
IP/ Strain A	3,980	2,054	1.922
IP/ Strain B	4,164	2,152	1.907
Probability			
Protein Concept	0.535	0.002	0.008
Strain	0.000	0.000	0.964
Interaction	0.489	0.619	0.295
CV %	3.33	2.35	1.86

Means followed by different letters in the columns are different by Tukey's test. *A= Hybro G; B= Hybro PG.

Table 7 - Mean percentage (%) of carcass yield (CY), breast yield (BY) and abdominal fat pad (AF) in females.

	CY	BY	AF
Protein concept			
Crude protein (CP)	75.5	27.2 b	3.0
Ideal protein (IP)	75.7	30.1 a	2.7
Strain*			
Strain A	75.2	28.6	2.8
Strain B	76.1	28.7	3.0
Interaction			
CP/ Strain A	74.7	26.4 c	2.9
CP/ Strain B	76.3	28.1 bc	3.1
IP/ Strain A	75.6	30.9 a	2.7
IP/ Strain B	75.8	29.2 ab	2.9
Probability			
Protein concept	0.850	0.0007	0.412
Strain	0.230	0.958	0.344
Interaction	0.334	0.024	0.926
CV%	3.32	5.99	21.4

Means followed by different letters in the columns are different by Tukey's Test. *A= Hybro G; B= Hybro PG.

Although AF was not statistically compared between trials, results were higher in females than in males, corroborating findings from Smith *et al.* (1998) and Vieira & Moran (1998). These authors stated that females produce carcasses with higher AF than males. The higher AF proportion in females may be due to the presence of adipocytes larger than in males.

Moisture, Crude Fat and Crude Carcass Protein

Results in Table 8 show a significant interaction (p=0.047) for the variable MOI. There were no differences between the two strains within concept IP, but strain A had lower carcass moisture than strain B when both were fed according to the concept CP. Strain A had also higher levels of carcass crude fat, although these were not significantly different.

Table 8 - Mean carcass percentages (%) of moisture (MOI), crude fat (CF) and carcass crude protein (CCR) in females.

	MOI	CF	CCR
Protein Concept			
Crude protein (CP)	61.7 b	15.6	16.4
Ideal protein (IP)	62.8 a	14.7	16.0
Strain*			
Strain A	61.6 b	15.7	16.4
Strain B	62.9 a	14.6	16.1
Interaction			
CP/ Strain A	60.5 b	16.9	16.8
CP/ Strain B	62.9 a	14.4	16.1
IP/ Strain A	62.7 a	14.5	16.0
IP/ Strain B	63.0 a	14.9	16.1
Probability			
Protein concept	0.041	0.190	0.324
Strain	0.025	0.128	0.447
Interaction	0.047	0.052	0.289
CV%	1.33	7.17	4.21

Means followed by different letters in the column are different by Tukey's Test. *A= Hybro G; B= Hybro PG.

The analysis of the independent effects for the variables CF and CCP showed no significant differences between the protein concepts, although there was a higher trend for CF in the CP concept. The results are in accordance with findings from Summers *et al.* (1992), who reported that birds fed levels of Met and Lys 20% lower than recommended by NRC (1994) had greater percentage of carcass fat than birds fed higher levels of these amino acids from 3 to 6 weeks.

Amino acid levels

Table 9 shows the results of the carcass amino acid levels. Also in this trial, only the amino acids Met, Met+Cys, Lys and Thr were analyzed, since these amino acids were added to the diet.

There was no interaction between the factors for the evaluated variables. The analysis of the independent effects showed no differences between protein concepts for theses variables. However, Met+Cys levels were higher (p=0.052) in strain B compared to strain A.

CONCLUSIONS

- Males and females fed with diets formulated according to the concept IP show higher carcass and breast yields than birds fed according to CP.

Table 9 - Mean amino acid levels results of the carcass defatted samples of females.

	Met %	Met+Cys %	Lys %	Thr %
Protein concept				
Crude protein	1.80	2.59	5.49	2.86
Ideal protein	1.84	2.69	5.48	2.96
Strain*				
Strain A	1.83	2.57 b	5.46	2.91
Strain B	1.82	2.72 a	5.51	2.92
Probability				
Protein concept	0.279	0.183	0.959	0.348
Strain	0.687	0.052	0.555	0.925
Interaction	0.403	0.459	0.491	0.348
CV%	3.40	4.49	2.99	6.16

Means followed by different letters in the columns are different by Test F.*A= Hybro G; B= Hybro PG.

• Males from different strains show differences in the crude fat percentage, suggesting that different formulations are needed within the same protein concept depending on the bird strain.

• The concept IP improves carcass quality in males, evidenced by the increased concentration of the studied amino acids in the carcass composition. This is due to the greater protein percentage in male carcasses compared to females.

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