doi: 10.17221/7976-CJAS

Comparison of the content of crude protein and amino acids in the whole bodies of cocks and hens of Ross 308 and Cobb 500 hybrids at the end of fattening

E. Straková[1], P. Suchý[2], P. Navrátil[1], T. Karel[3], I. Herzig[1]

[1]Department of Animal Nutrition, Faculty of Veterinary Hygiene and Ecology, University of Veterinary and Pharmaceutical Sciences Brno, Brno, Czech Republic
[2]Department of Animal Husbandry and Animal Hygiene, Faculty of Veterinary Hygiene and Ecology, University of Veterinary and Pharmaceutical Sciences Brno, Brno, Czech Republic
[3]Department of Statistics and Probability, Faculty of Informatics and Statistics, University of Economics Prague, Prague, Czech Republic

ABSTRACT: Dry matter (DM), crude protein (CP), and the content of individual amino acids (AA) were determined in the bodies of Ross 308 and Cobb 500 hybrids including feathers after 40 days of fattening. Percentages for the content of individual AA were then calculated from the total sums of AA. The level of CP, irrespective of sex, was 453.16 ± 5.916 g/kg of DM for the Ross and 470.94 ± 5.404 g/kg of DM for the Cobb hybrid ($P \leq 0.05$). For both hybrids, the content of CP was significantly ($P \leq 0.01$) higher for cocks as opposed to hens. The AA levels in DM, irrespective of sex, were higher in the Cobb hybrid except for Glu; it was significantly higher for Asp, Ser, Ala, Lys ($P \leq 0.01$), and Thr and Arg ($P \leq 0.05$). The values for the majority of AA were higher for cocks than for hens in both hybrids. For the majority of essential AA, significant ($P \leq 0.01$; $P \leq 0.05$) differences were recorded between sexes. For non-essential AA except for Ser and Ala, significantly ($P \leq 0.01$; $P \leq 0.05$) higher values were found in cocks. Of the total sums of AA in DM of Ross broilers, the largest presence (here and after in %) was that of Glu (14.92), followed by Leu (8.80), Asp (8.73), Gly (8.71), Arg (7.21), Val (6.33), and Pro (6.09). The lowest contents were those of Met (2.41) and His (3.28). For the Cobb hybrid, the AA were Glu (13.90), Asp (9.12), Gly (8.48), Leu (8.43), Arg (7.48), Lys (6.44), and Pro (6.09). The AA lowest contents were those of Met (2.30) and His (3.16).

Keywords: broiler chickens; chemical analysis; essential amino acids; nonessential amino acids; AA spectrum

List of abbreviations: DM = dry matter, CP = crude protein, AA = amino acids, EAA = essential amino acids, NEAA = nonessential amino acids, Lys = lysine, Thr = threonine, Try = tryptophan, His = histidine, Phe = phenylalanine, Leu = leucine, Ile = isoleucine, Met = methionine, Cys = cysteine, Val = valine, Arg = arginine, Asp = aspartate, Ser = serine, Glu = glutamate, Pro = proline, Gly = glycine, Ala = alanine, Val = valine, Tyr = tyrosine

INTRODUCTION

Knowledge of the amino acids (AA) content in the whole body and feathers of broiler chickens contributes to better understanding of their requirements (Stilborn et al. 1997), which are derived from the presence of AA in the bodies of broiler chickens (Saunders et al. 1977). An optimal content of AA in the diet is particularly important for animal growth. Extensive literature data exists and is available regarding the requirements for crude protein (CP) and AA in the ration for broiler chickens (e.g. National Research Council 1994; Dozier et al. 2008). The content of AA in

Supported by the Ministry of Education, Youth and Sports of the Czech Republic (Project No. MSM 6215712402).

doi: 10.17221/7976-CJAS

the body is relatively constant; nonetheless, partial differences are mentioned, e.g. between the sexes and ages of chickens. However, we did not find any comparison of the content of AA in the bodies of broiler chickens among different hybrids in the literature.

As is stated by Baker (1997), the requirements for AA are influenced by a series of factors such as the level of protein, the level of energy, and the presence of protease inhibitors, environmental factors such as crowding, space at the feeder, temperature, changes in health, genetic factors such as sex and propensity for the leanness or fat content of the meat.

For the creation of body protein in poultry, some 22 AA are essential. Some of these can be synthesized by the birds, and these involve nonessential amino acids (NEAA); on the other hand, essential amino acids (EAA) cannot be synthesized in necessary quantities (Applegate and Angel 2008). Of the EAA, the AA lysine (Lys) and threonine (Thr) cannot be produced by the animal at all, since it has no transaminases required for their production. Other indispensible AA also include those that are essential for the organism and which may indeed be synthesized within the body, but not in sufficient quantity. These are tryptophan (Try), histidine (His), phenylalanine (Phe), leucine (Leu), isoleucine (Ile), methionine (Met), valine (Val), and arginine (Arg). The possibilities for their synthesis are more theoretical rather than practical, since the feed does not contain the appropriate keto acids necessary for their production. Feed for broiler chickens should therefore meet their complete requirements for all EAA (Zelenka et al. 2007).

Literature data concerning the content of AA in the body and feathers of chickens varies and is sporadic (Stilborn et al. 1997, 2010). The genetic potential of broiler chickens has risen significantly, and greater performance has led to changes in requirements for AA (Selehifar et al. 2012). Thus the aim of this study was to verify the content of CP, EAA, and NEAA in the whole body including feathers in Ross 308 and Cobb 500 hybrid chickens, and compare the possible differences with respect to the sex of the birds.

MATERIAL AND METHODS

Animals. The experiment was conducted using 160-day-old, sexed broiler chickens of the hybrids Ross 308 and Cobb 500, thereby creating four experimental groups consisting of 40 hens and 40 cocks for each hybrid.

Environment. The experiment was conducted at an accredited experimental animal facility (stable) at the Department of Animal Nutrition at the University of Veterinary and Pharmaceutical Sciences Brno. The chickens were reared separately, according to the sex of hybrid, in four enclosures with deep-litter loose housing. Throughout the fattening, stocking density met the requirements for optimal area load, namely that of 17 individuals per m^2. The lighting regime was set at 23 h of light and 1 h of dark. Microclimatic conditions, including ventilation, were controlled automatically. The temperature of the straw beds at the start of the experiment was 34°C; thereafter, it was reduced daily by 0.3–0.4°C and reached 18°C by the end of the experiment.

Feeding. Over the course of fattening, the chickens of both hybrids received identical complete compound feeds – on days 1–9 the compound BR_1, 10–30 the compound BR_2, 31–40 the compound BR_3. The content of nitrogen-containing substances and AA in the complete compound

Table 1. Content of amino acids and nitrogen-containing substances (g/kg) in the dry matter of complete compound feeds (BR) administered during the fattening period

Amino acid	BR_1	BR_2	BR_3
Asp	23.8	21.2	18.4
Thr	8.0	9.3	7.8
Ser	10.6	11.3	9.5
Glu	48.0	43.0	39.3
Pro	14.6	15.8	15.2
Gly	11.3	9.6	8.6
Ala	10.4	9.7	8.6
Val	12.4	10.7	9.7
Met	2.7	2.9	2.5
Ile	10.6	9.2	8.9
Leu	18.8	16.3	14.1
Tyr	7.9	7.1	6.3
Phe	12.4	10.8	10.4
His	7.2	5.7	5.2
Lys	15.3	13.7	12.3
Arg	18.2	16.9	15.0
ΣAmino acids	232.2	213.2	191.8
Nitrogen-containing substances	247.9	224.4	205.3

doi: 10.17221/7976-CJAS

feeds is presented in Table 1. The feeding and drinking area complied with the recommendations for the technology of rearing Ross 308 and Cobb 500 hybrids. Intake of feed and access to potable water was *ad libitum*. The health of the animals was continuously monitored. At the end of fattening on day 40, 20 cocks and 20 hens of the Ross hybrid were selected at random, with the same numbers of chickens of both sexes selected from the Cobb hybrid. After 24 h of fasting, the selected chickens were killed and their whole bodies, including feathers, were individually analyzed.

Laboratory methods. The complete compound feeds (BR_1, BR_2, and BR_3) were analyzed for their essential nutrient content according to AOAC methods (2003). The whole body of the chicken, including feathers, was homogenized in a cutting machine, and the homogenized material was weighed and dried. The DM of the homogenized material was determined by drying at 105°C and weighing. The nitrogen content was then determined using the Kjeldahl method on a Buchi analyzer (Centec automatika s.r.o., Prague, Czech Republic) and the CP contents were calculated by multiplying the nitrogen value by a coefficient of 6.25. The AA contents were determined following acid hydrolysis in 6 N HCl at 110°C for 24 h using the automatic amino acid analyzer AAA 400 (Ingos a.s., Prague, Czech Republic) based on the colour-forming reaction of AA with the oxidative agent ninhydrin. The AA analysis was used to determine the value for pure protein, expressed as the sum of AA (Asp, Thr, Ser, Glu, Pro, Gly, Ala, Val, Met, Ile, Leu, Tyr, Phe, His, Lys, and Arg).

All results stated in this study are, for the purpose of more accurate reproducibility, stated in the DM of whole-body chickens (g/kg of DM).

Statistical analysis. The results obtained were processed using the statistical program Unistat CZ (Version 5.6, 2005) for MS Excel, in which differences between mean values were evaluated by multiple comparison using the Tukey's HSD test, on 1% and 5% levels of significance.

RESULTS

Content of essential nutrients and gross energy. The content of essential nutrients and gross energy in complete compound feeds consumed in the course of the experiment corresponded

Table 2. Level of dry matter and crude protein (g/kg) in the whole bodies of Ross and Cobb hybrid broiler chickens at the end of fattening

	n	Dry matter		Crude protein	
		$\bar{x}$	SD	$\bar{x}$	SD
Broilers					
Ross	40	376.54	3.275	453.16^{a}	5.916
Cobb	40	378.21	2.473	470.94^{b}	5.404
Hens					
Ross	20	392.81	2.855	430.14^{a}	8.524
Cobb	20	388.19	2.788	452.04^{b}	6.039
Cocks					
Ross	20	359.19^{A}	2.054	477.34^{a}	3.000
Cobb	20	368.24^{B}	2.619	489.84^{b}	6.771
Ross hens and cocks					
	40	376.54	3.275	453.16	5.916
♀	20	392.80^{A}	2.855	430.14^{A}	8.553
♂	20	359.19^{B}	2.054	477.34^{B}	3.000
Cobb hens and cocks					
	40	378.21	2.473	470.94	5.404
♀	20	388.19^{A}	2.788	452.04^{A}	6.039
♂	20	368.24^{B}	2.619	489.84^{B}	6.771

^{A,B}statistical significance A : B ($P \leq 0.01$), ^{a,b}statistical significance a : b ($P \leq 0.05$)

doi: 10.17221/7976-CJAS

to the necessary nutrients recommended for the given hybrid Ross 308 (Ross 308 broiler nutrition specification; www.aviagen.com) and the hybrid Cobb 500 (Cobb 500. Technological guide to fattening broilers; www.xavergen.cz/download/cobb-500-technologicky-postup-pro-broilery.doc). The content of CP in BR_1 was 247.9, in BR_2 224.4, and in BR_3 205.3 g/kg of DM. The gross energy values were 19.0, 19.3, and 19.5 MJ/kg of DM.

Weight of Ross and Cobb hybrid broiler chickens. At the end of the fattening period (day 40) the average weight of the Ross hybrid broiler chickens was statistically significantly ($P \leq 0.05$) higher than of the Cobb hybrid (2.40 ± 0.029 kg compared to 2.31 ± 0.028 kg).

Levels of DM in the bodies of Ross and Cobb hybrid broiler chickens. The level of DM in the whole body of Ross hybrid broiler chickens was 376.54 ± 3.275, and in the Cobb hybrid it was 378.21 ± 2.473. For both hybrids the value for DM in hens was statistically significantly ($P \leq 0.01$) higher than for cocks (Table 2). For Ross hybrid cocks it was 91.4%, and for the Cobb hybrid 94.9% of the value determined for hens of the respective hybrid. For Ross hybrid hens the content of DM was 392.81 ± 2.855, and for Cobb hybrid hens 388.19 ± 2.788. For cocks, the content of DM was statistically more significant ($P \leq 0.01$) for the Cobb hybrid (368.24 ± 2.619) as opposed to the Ross (359.19 ± 2.054).

Levels of CP in the DM of the bodies of Ross and Cobb hybrid broiler chickens. At the end of fattening, on day 40 of chickens' age, levels of CP in the DM of the bodies of Ross hybrid broiler chickens were significantly ($P \leq 0.05$) lower compared to those of the Cobb hybrid (453.16 ± 5.916 compared to 470.94 ± 5.404 g/kg) (Table 2). Higher levels were recorded for hens (Cobb 452.04 ± 6.039 compared to Ross 430.14 ± 8.524 g/kg) as well as cocks (Cobb 489.84 ± 6.771 compared to Ross 477.34 ± 3.000 g/kg). For Ross hybrid hens this represents 95.2% and for Ross cocks 97.5% of the value ascertained for the Cobb hybrid. On day 40 of fattening, the differences between CP values in both hybrids were statistically significant ($P \leq 0.01$) for cocks and hens: Ross hybrid hens reached only 90.1% of the value for cocks, while Cobb hybrid hens achieved 92.3% of the value ascertained for cocks.

Levels of AA (g/kg) in the dry matter of the bodies of Ross and Cobb hybrid broiler chickens. Of the EAA, Lys, Met, Thr, Leu, Ile, Val, Tyr, and

Table 3. Levels of amino acids (g/kg) in the whole bodies of Ross (n = 40 and 20) and Cobb (n = 40 and 20) hybrid broiler chickens at the end of fattening

Amino acid (g/kg)	n = 40				n = 20			
	Ross (x ± SD)	Cobb (x ± SD)	Ross (%)	Cobb (%)	Ross (x ± SD)	Cobb (x ± SD)	Ross (%)	Cobb (%)
Asp	33.50^A ± 3.722	37.42^B ± 3.356	8.73	9.12	33.28 ± 3.834	36.29 ± 3.543	9.00	9.04
Thr	18.02^a ± 1.961	19.38^b ± 1.680	4.69	4.72	17.13^a ± 1.425	18.86^b ± 1.839	4.64	4.70
Ser	19.08^A ± 2.142	21.13^B ± 2.49	4.97	5.15	18.42 ± 2.204	20.69 ± 3.069	4.98	5.16
Glu	57.26 ± 7.632	57.02 ± 5.672	14.92	13.90	51.59^a ± 5.593	58.33^b ± 5.594	13.96	14.53
Pro	23.36 ± 2.835	24.98 ± 2.74	6.09	6.09	22.18^a ± 3.074	25.24^b ± 2.467	6.00	6.29
Gly	33.43 ± 7.87	34.78 ± 11.19	8.71	8.48	34.51 ± 11.072	38.08 ± 15.337	9.34	9.49
Ala	17.95^A ± 4.88	24.58^B ± 6.517	4.68	5.99	17.97 ± 1.852	20.33 ± 6.610	4.86	5.07
Val	24.31 ± 2.874	24.55 ± 1.563	6.33	5.98	22.32 ± 2.588	24.19 ± 1.595	6.04	6.03
Met	9.25 ± 1.742	9.42 ± 0.907	2.41	2.30	8.32 ± 0.944	9.06 ± 0.791	2.25	2.26
Ile	20.32 ± 2.092	20.34 ± 1.868	5.29	4.96	18.77 ± 1.674	19.99 ± 0.860	5.08	4.98
Leu	33.78 ± 3.369	34.60 ± 2.225	8.80	8.43	31.32 ± 2.735	33.08 ± 1.373	8.48	8.24
Tyr	13.09 ± 1.761	14.13 ± 2.434	3.41	3.44	13.28 ± 1.789	13.82 ± 2.617	3.59	3.44
Phe	17.37 ± 2.202	17.91 ± 1.444	4.52	4.36	15.97^a ± 1.577	17.36^b ± 0.992	4.32	4.32
His	12.61 ± 1.455	12.98 ± 1.243	3.28	3.16	11.78 ± 1.357	12.13 ± 0.683	3.19	3.02
Lys	22.83^A ± 3.70	26.44^B ± 3.625	5.95	6.44	24.00 ± 4.015	24.81 ± 3.435	6.49	6.18
Arg	27.67^a ± 4.032	30.69^b ± 4.062	7.21	7.48	28.75 ± 3.771	29.11 ± 4.761	7.78	7.25

^{A,B}statistical significance A:B ($P \leq 0.01$); ^{a,b}statistical significance a:b ($P \leq 0.05$)

Trp and Cys are destroyed during the acid hydrolysis

doi: 10.17221/7976-CJAS

Phe were analyzed, and of the semiessential AA, Arg, and His. Of the NEAA, Asp, Ser, Glu, Pro, Gly, and Ala were analyzed. The levels of AA in the DM of whole bodies, including feathers, of Ross and Cobb hybrid broiler chickens at the end of fattening were always, with the exception of Glu, higher for the Cobb (Table 3). Statistically higher were Lys ($P \leq 0.01$), Thr, and Arg ($P \leq 0.05$) of the EAA, and Asp, Ser, and Ala ($P \leq 0.01$) of the NEAA.

The levels of all AA in the dry matter of whole bodies, including feathers, were at the end of fattening always higher for Cobb hybrid hens as opposed to Ross hybrid hens. Statistically significant ($P \leq 0.05$) were the differences for AA Thr, Glu, Pro, and Phe (Table 3). For cocks the situation was less straight-forward (Table 5). With the exception of AA Glu, Gly, Val, Met, Ile, Leu, and Phe, the values of AA were higher for Cobb hybrid cocks; statistically significant differences were recorded for Asp, Glu, Lys, and Arg ($P \leq 0.01$), and additionally for Ser and Ala ($P \leq 0.05$).

Differences between levels of AA in relation to the sex of Ross and Cobb hybrids are given in Table 5. The level of AA in cocks is higher for both hybrids. In the Ross hybrid, statistically significant differences were found for AA Glu, Val, Ile, Leu, Phe, and His ($P \leq 0.01$), as well as for Thr and Met ($P \leq 0.05$), and in the Cobb hybrid for AA Ala, Leu, and His ($P \leq 0.01$), and for Lys ($P \leq 0.05$).

Percentages for the content of AA in the protein of the bodies of Ross and Cobb hybrid chickens. Based on the results of the amino acid analysis of the chicken bodies, percentages were calculated for the contents of individual AA in the body protein of the DM of hens and cocks' bodies of both hybrids. Body protein was taken as the sum of AA.

Of the total sum of AA, the highest content in the DM of the bodies of Ross broilers showed (in %) Glu (14.92), followed by Leu (8.80), Asp (8.73), Gly (8.71), Arg (7.21), Val (6.33), and Pro (6.09), while the lowest contents were for Met (2.41) and His (3.28). For the Cobb hybrid, the AA with the highest percentages (%) were Glu (13.90), Asp (9.12), Gly (8.48), Leu (8.43), Arg (7.48), Lys (6.44), and Pro (6.09), while the lowest contents were for Met (2.30) and His (3.16) (Table 3).

Of the EAA, the highest content in body protein (ΣAA) of the DM of the bodies of Ross hybrid hens (Table 3) exhibited (in %) Leu (8.48), followed by Lys (6.49), Val (6.04), Ile (5.08), Thr (4.64), Phe

Table 4. Levels of amino acids (g/kg) in the whole bodies of Ross (n = 20) and Cobb (n = 20) hybrid broiler cocks at the end of fattening

Amino acid (g/kg)	Ross ($\bar{x}$ ± SD)	Cobb ($\bar{x}$ ± SD)	Ross (%)	Cobb (%)
Asp	33.73^{A} ± 3.799	38.55^{B} ± 2.894	8.79	9.54
Thr	18.92 ± 2.076	19.92 ± 1.397	4.93	4.93
Ser	19.75^{a} ± 1.959	21.58^{b} ± 1.798	5.15	5.34
Glu	62.93^{A} ± 4.501	55.72^{B} ± 5.730	16.40	13.79
Pro	24.54 ± 2.102	24.72 ± 3.101	6.40	6.12
Gly	32.34 ± 2.357	31.48 ± 2.235	8.43	7.79
Ala	17.94^{a} ± 7.006	28.83^{b} ± 2.414	4.68	7.14
Val	26.30^{a} ± 1.383	24.91^{b} ± 1.526	6.85	6.17
Met	10.18 ± 1.893	9.78 ± 0.910	2.65	2.42
Ile	21.86 ± 1.064	20.68 ± 2.523	5.70	5.12
Leu	21.86 ± 1.064	20.68 ± 2.523	5.70	5.12
Tyr	12.89 ± 1.807	14.45 ± 2.331	3.36	3.58
Phe	18.76 ± 1.850	18.46 ± 1.656	4.89	4.57
His	13.43 ± 1.055	13.84 ± 1.080	3.50	3.43
Lys	21.66^{A} ± 3.119	28.07^{B} ± 3.165	5.64	6.95
Arg	26.59^{A} ± 4.185	32.27^{B} ± 2.572	6.93	7.99

^{A,B}statistical significance A:B ($P \leq 0.01$); ^{a,b}statistical significance a : b ($P \leq 0.05$)

Trp and Cys are destroyed during the acid hydrolysis

doi: 10.17221/7976-CJAS

Table 5. Levels of amino acids (g/kg) in the whole bodies of Ross and Cobb hybrid broiler cocks (n = 20) and hens (n = 20) at the end of fattening

Amino acid (g/kg)	Ross				Cobb			
	♀ ($\bar{x}$ ± SD)	♂ ($\bar{x}$ ± SD)	♀ (%)	♂ (%)	♀ ($\bar{x}$ ± SD)	♂ ($\bar{x}$ ± SD)	♀ (%)	♂ (%)
Asp	33.28 ± 3.834	33.73 ± 3.799	9.33	8.64	36.29 ± 3.543	38.55 ± 2.894	9.04	9.19
Thr	17.13^{a} ± 1.425	18.92^{b} ± 2.076	4.80	4.85	18.86 ± 1.839	19.92 ± 1.397	4.70	4.75
Ser	18.42 ± 2.204	19.75 ± 1.959	5.16	5.06	20.69 ± 3.069	21.58 ± 1.798	5.16	5.15
Glu	51.59^{A} ± 5.593	62.93^{B} ± 4.501	14.46	16.13	58.33 ± 5.594	55.72 ± 5.730	14.53	13.29
Pro	22.18 ± 3.074	24.54 ± 2.102	6.22	6.29	25.24 ± 2.467	24.72 ± 3.101	6.29	5.89
Gly	34.51 ± 11.072	32.34 ± 2.357	9.67	8.29	38.08 ± 15.337	31.48 ± 2.235	9.49	7.51
Ala	17.97 ± 1.852	17.94 ± 7.006	5.04	4.60	20.33^{A} ± 6.610	28.83^{B} ± 2.414	5.07	6.87
Val	22.32^{A} ± 2.588	26.30^{B} ± 1.383	6.26	6.74	24.19 ± 1.595	24.91 ± 1.526	6.03	5.94
Met	8.32^{a} ± 0.994	10.18^{b} ± 1.893	2.33	2.61	9.06 ± 0.791	9.78 ± 0.910	2.26	2.33
Ile	18.77^{A} ± 1.674	21.86^{B} ± 1.064	5.26	5.60	19.99 ± 0.860	20.68 ± 2.523	4.98	4.93
Leu	31.33^{A} ± 2.735	36.24^{B} ± 1.757	8.78	9.29	33.08^{A} ± 1.373	36.11^{B} ± 1.865	8.24	8.61
Tyr	13.28 ± 1.789	12.89 ± 1.807	3.72	3.30	13.82 ± 2.617	14.45 ± 2.331	3.44	3.45
Phe	15.97^{A} ± 1.577	18.77^{B} ± 1.850	4.48	4.81	17.36 ± 0.992	18.46 ± 1.656	4.32	4.40
His	11.78^{A} ± 1.357	13.43^{B} ± 1.055	3.30	3.44	12.13^{A} ± 0.683	13.84^{B} ± 1.080	3.02	3.30
Lys	24.00 ± 4.015	21.66 ± 3.119	6.73	5.55	24.81^{a} ± 3.435	28.07^{b} ± 3.165	6.18	6.69
Arg	28.75 ± 3.771	26.59 ± 4.185	4.48	4.81	29.11 ± 4.761	32.27 ± 2.572	7.25	7.69

^{A,B}statistical significance A:B ($P \leq 0.01$); ^{a,b}statistical significance a:b ($P \leq 0.05$)
Trp and Cys are destroyed during the acid hydrolysis

(4.32), Tyr (3.59), and Met (2.25). For Cobb hybrid hens, the percentages (%) were Leu (8.24), followed by Lys (6.18), Val (6.03), Ile (4.98), Thr (4.70), Phe (4.32), Tyr (3.44), and Met (2.26).

The highest content of EAA in the body protein (ΣAA) of the DM of the bodies of Ross hybrid cocks (Table 4) showed (in %) Leu 5.70 and Ile (5.70), followed by Val (6.85), Lys (5.64), Thr (4.93), Phe (4.89), Tyr (3.36), and Met (2.65). For Cobb hybrid cocks, the percentages (%) were Lys (6.95), followed by Val (6.17), Leu (5.12), Ile (5.12), Thr (4.93), Phe (4.57), Tyr (3.58), and Met (2.42).

When comparing percentages for the contents of AA in the body protein of the DM of bodies between cocks and hens of the Ross and Cobb hybrids, no substantial differences were recorded and the calculated values are given in Table 5.

DISCUSSION

Lots of information can be found in the literature concerning both the requirements for AA and their possible supplementation in the diet (Aletor et al. 2000; Mukhtar et al. 2007; Zelenka et al. 2007) as well as the content of AA in the muscle tissue of broiler chickens (Suchy et al. 2002; Strakova et al. 2006; Meluzzi et al. 2009; Bogosavijevic-Boskovic et al. 2010, a.o.); in contrast, data concerning the content of AA in the whole bodies of chickens, including feathers, at the end of fattening, are only sporadic (Stilborn et al. 1997, 2010). What is primarily lacking in current practice is, however, any monitoring of the broiler hybrids. Over the course of recent years the genetic potential of broiler chickens has significantly increased, and greater performance has led to changes in requirements for AA (Selehifar et al. 2012). As argued by Emmans (1989), the question of AA requirement can be resolved by analyzing the AA contents in the protein of the body and feathers.

Stilborn et al. (2010) state that the content of proteins in the bodies of broiler chickens (without feathers) is significantly influenced by age and sex. Over the period from 0 to 42 days of age, both a decline in the value for protein in relation to chicken age, and lower values for hens were recorded. The greater reduction in the level of CP for hens in comparison with cocks reflects their earlier maturation, similarly the greater deposition of fat (Stilborn et al. 2010). The values we give for

doi: 10.17221/7976-CJAS

CP levels fully accord with the data in the aforementioned literature.

Content of AA in the DM of the bodies of Ross and Cobb hybrid broiler chickens. Sklan and Noy (2004) monitored the AA composition of the bodies of broilers (without feathers) from day 0 until day 42, and found that after the 14^{th} day of age the composition changed very little. When comparing levels of individual EAA in the DM of bodies in terms of the sex of fattened chickens, values determined at the end of the experimental period (the 35^{th} and 40^{th} day), with the exception of Lys and Tyr, were higher for cocks and statistically significant differences were demonstrated for the majority of EAA. This finding is in complete agreement with the results of this study, in which the levels of most AA were higher for cocks in both hybrids. For the Ross hybrid, the differences demonstrated for AA Glu, Val, Ile, Leu, Phe, His, Thr, and Met were statistically significant, while in the Cobb hybrid the same applied for AA Ala, Leu, His, and Lys.

Stilborn et al. (2010) likewise recorded that in addition to a chicken's age, its sex was a second factor influencing the values of AA – both EAA and NEAA. Differences between the sexes were observed in the later part of the fattening period, and reflect different maturation times. It can be concluded that in this respect too we are seeing the genetic potential of modern hybrids.

The trends described for EAA can also be generally applied to NEAA, and we also match the data of Stilborn et al. (2010). Partial minor differences can be explained by the fact that in our study whole-body chickens including feathers were analyzed, whereas Stilborn et al. (2010) analyzed chicken bodies without feathers. In another study of Stilborn et al. (1997), dealing with the influence of age on the contents of AA in the feathers of broiler chickens, it was documented that age also plays a significant role in the contents of AA in feathers, in particular on days 14–42 of age. Kreuzer et al. (1988) also confirmed that levels of AA in birds change with age, especially in the early growth stage (weeks 0–2). The AA Pro, Lys, His, and Cys were especially influenced by changes in plumage, connective tissues, and muscles in proportions of the body. In contrast, Nitsan et al. (1981), who studied the composition of AA in the carcass, skin, and feathers of goslings from hatching until day 42 of age, did not find that age had any influence. They stated that proteins in gosling plumage are characterized by higher levels of Cys, Ser, Pro, Val, and Tyr compared to the carcass and skin. Similarly, Pellet and Kaba (1972) stated that for quickly or relatively quickly growing animals, the AA composition is relatively constant.

Stilborn et al. (1997) stated that age has a greater role in the content of individual as well as total EAA than either the hybrid or sex of a broiler chicken. Total NEAA as a percentage of total EAA increases with the age of broilers and points to changes in the composition of feathers during that period. Our results, however, do not fully concur with this assertion.

Changes in the percentage content of AA in the DM of protein in the chicken bodies. Of the total sum of AA in the DM of Ross broilers bodies, the largest content showed Glu, followed by Leu, Asp, Gly, Arg, Val, and Pro. Met and His had the lowest content. With a few minor exceptions, a similar pattern emerged for the Cobb hybrid. Comparisons between the sexes for the Ross hybrid did not reveal any large differences, and the same applied for the Cobb hybrid. The percentage content of EAA and NEAA for both hybrids did not show any major differences.

In body proteins there are 22 AA, and all of them are essential for the organism. Poultry needs CP in quantities which ensure a sufficient amount of all EAA, as well as enough semi-essential and NEAA, or enough of the substances required to produce them. There has been a long-term trend to try not to increase, and even to decrease, the content of CP in feed mixtures, even though animals with a modern genetic pool grow more intensively and thus store more CP from feed (Hussein et al. 2001). When using industrially manufactured AA, provided the content of individual EAA has been successfully balanced, a mixture can contain less CP. Such a mixture is generally cheaper and yet the performance of the animal is not reduced. Thus less excessive AA are metabolized in the body, the content of CP in the faeces falls, and environmental damage is thereby curtailed.

REFERENCES

Aletor V.A., Hamid I.I., Niess E., Pfeffer E. (2000): Low-protein amino acid supplemented diets in broiler chickens: effects on performance, carcass characteristics, whole-body composition and efficiencies of nutrient utilisa-

doi: 10.17221/7976-CJAS

tion. Journal of the Science of Food and Agriculture, 80, 547–554.

AOAC (2003): Official Methods of Analysis. 17th Ed. Association of Official Analytical Chemists, Gaithersburg, USA.

Applegate T.J., Angel R. (2008): Protein and amino acid requirements for poultry [serial online], 6: 1–8. Available from www.extension.purdue.edu/extmedia (accessed Nov 1, 2014).

Baker D.H. (1997): Ideal amino acid profiles for swine and poultry and their application in feed formulation. Biokyowa Technical Review, 9, 1–24.

Bogosavijevic-Boskovic S., Pavlovski Z., Petrovic M.D., Doskovic V., Rakonjac S. (2010): Broiler meat quality: proteins and lipids of muscle tissue. African Journal of Biotechnology, 9, 9177–9182.

Dozier W.A., Kidd M.T., Corzo A. (2008): Amino acid responses of broilers. Journal of Applied Poultry Research, 17, 157–167.

Emmans G.C. (1989): Computer simulation in poultry nutrition. In: Proc. 3rd European Symposium on Poultry Nutrition. Peebles, UK, 91–104.

Hussein A.S., Cantor A.H., Pescatore A.J. (2001): Effect of low protein diets with amino acid supplementation on broiler growth. The Journal of Applied Poultry Research, 10, 354–362.

Kreuzer M., Kirchgessner M., Steinhart H. (1988): Effect of the level of energy and protein supply, respectively of age on the amino acid composition of broiler chicks. Archiv Geflügelkunde, 52, 133–141.

Meluzzi A., Sirri F., Castellini C., Roncarati A., Melotti P., Franchini A. (2009): Influence of genotype and feeding on chemical composition of organic chicken meat. Italian Journal of Animal Science, 8, 766–768.

Mukhtar A.M., Mekkawi A., El Tigani M. (2007): The effect of feeding increasing levels of synthetic lysine and methionine in broiler chicks. Research Journal of Animal Veterinary Science, 2, 18–20.

National Research Council (1994): Nutrient Requirements of Poultry. 9th Ed. The National Academies Press, Washington, USA.

Nitsan Z., Dvorin A., Nir I. (1981): Composition and amino acid content of carcass, skin, and feathers of the growing gosling. British Poultry Science, 22, 79–84.

Pellett P.L., Kaba H. (1972): Carcass amino acids of the rat under condition of determination of net protein utilization. Journal of Nutrition, 102, 61–68.

Saunders A.J., Wessels J.P.H., Gous R.M. (1977): Carcass amino acid composition and utilization of dietary amino acids by chickens. South African Journal of Animal Science, 7, 111–115.

Selehifar E., Shivazad M., Foroudi F., Chamani M., Kashani R.B. (2012): Reevaluation of digestible amino acid requirements of male and female broilers based on different ideal amino acids rations in starter period. Livestock Science, 147, 154–158.

Sklan D., Noy Y. (2004): Direct determination of optimal amino acid intake for maintenance and growth in broilers. Poultry Science, 84, 412–418.

Stilborn H.L., Moran E.T., Gous R.M., Harrison M.D. (1997): Effect of age on feather amino acid content in two broiler strain-crosses and sexes. The Journal of Applied Poultry Research, 6, 205–209.

Stilborn H.L., Moran E.T., Gous R.M., Harrison M.D. (2010): Influence of age on carcass (feather-free) amino acid for two broiler strain-crosses and sexes. The Journal of Applied Poultry Research, 19, 13–23.

Strakova E., Suchy P., Vitula F., Vecerek V. (2006): Differences in the amino acid composition of muscles from pheasant and broiler chickens. Archiv für Tierzucht, 49, 508–514.

Suchy P., Jelinek P., Strakova E., Hucl J. (2002): Chemical composition of muscles of hybrid broiler chickens during prolonged feeding. Czech Journal of Animal Science, 47, 511–518.

Zelenka J., Heger J., Zeman L. (2007): Recommended nutrient content in poultry diets and nutritive value of feeds for poultry. Mendel University of Agriculture and Forestry, Brno, Czech Republic. (in Czech)

Received: 2014–05–06
Accepted after corrections: 2014–07–11

Corresponding Author

Prof. Ing. Eva Straková, Ph.D., University of Veterinary and Pharmaceutical Sciences Brno, Faculty of Veterinary Hygiene and Ecology, Department of Animal Nutrition, Palackého 1-3, 612 42 Brno, Czech Republic
Phone: +420 541 562 672, e-mail: strakovae@vfu.cz