doi: 10.17221/28/2016-VETMED

Levels of fatty acids in the whole body of hens and cocks of the Cobb 500 and Ross 308 hybrid combinations at the end of the fattening period

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ABSTRACT: In this study, we determined the levels of individual fatty acids in the whole chicken body, as well as dry matter, nitrogenic substances and fat in Cobb 500 and Ross 308 chickens after 40 days of fattening. The highest level of all fatty acids (FA), regardless of the hybrid combination and sex of the chickens, was determined for oleic/elaidic acid, followed by palmitic, linoleic/linolelaidic, palmitoleic and stearic acids. In Cobb 500 cocks, higher values ($P \leq 0.05$; $P \leq 0.01$) were found for all saturated fatty acids (SaFA) compared to hens. With the exception of γ-linoleic acid, the levels of n-6 FA measured in cocks were higher ($P \leq 0.01$) than in hens and n-3 FA showed higher levels of eicosatrienoic ($P \leq 0.05$) and docosapentaenoic acids ($P \leq 0.01$). Ross 308 hens had higher levels of most SaFA, with differences for palmitic ($P \leq 0.01$), myristic, heptadecanoic and stearic acids ($P \leq 0.05$). Regarding monounsaturated fatty acids (MUFA), hens contained higher levels of myristoleic ($P \leq 0.05$) and oleic/elaidic acids ($P \leq 0.01$). Cocks showed higher levels of n-6 FA except for linoleic/linolelaidic and γ-linolenic acids; higher levels were found for *cis*-8,11,14-eicosatrienoic, docosatetraenoic ($P \leq 0.05$) and arachidonic acids ($P \leq 0.01$). With the exception of α-linolenic acid, n-3 FA levels were higher in cocks, with differences in the levels of *cis*-5,8,11,14,17-eicosapentaenoic and docosapentaenoic acids ($P \leq 0.01$). The results suggest possible directions for future research focused on the use of broiler chicken hybrids with more favourable proportions of n-6 FA and n-3 FA in fat and meat.

Keywords: saturated fatty acids; monounsaturated fatty acids; polyunsaturated fatty acids; n-6; n-3

The levels of fatty acids in vegetable and animal fats are of nutritional, dietetic and health relevance for both humans and animals. This is due to the physiological functions of fats in living organisms and the roles of the individual fatty acids (FA) in dietology, prevention and therapy of diseases related to their deficiency or overdosing.

Sources of lipids in human nutrition include both vegetable oils and fats of animal origin. Lipids of animal origin may represent a relevant source of FA in human diets. Human diet experts recommend a low intake of saturated fatty acids (SaFA) and high intake of poly-unsaturated FA (Mataix et al. 2001), above all FA with long n-3 chains (Connor 2000; Larsson et al. 2004). The ideal ratio of FA n-6 : n-3 is 4 : 1, or lower (Simopoulos 1999).

At present, poultry meat constitutes a significant proportion of human diets. Therefore, monitoring the levels of individual FA in the bodies of broiler chickens is important. A large body of evidence shows that FA levels in the meat of animals bred for meat, including broiler chickens, depend to a considerable extent on their levels in the diet (Kralik et al. 2004; Azman et al. 2005; Rymer and Givens 2005; Ortiz et al. 2006; Aldai et al. 2008; Zelenka et al. 2008 and others).

Levels of FA in animal products (eggs, meat, milk) reflect both biosynthesis and FA composition of the digested lipids. This relationship is stronger in monogastric animals (pig, poultry, rabbit) than in ruminants, where the dietary fatty acids may be hydrogenated in the rumen (Kouba and Mourot 2011). FA composition in meat is affected by genetic factors, but more significantly by dietary factors (De Smet et al. 2004). Broiler chickens were tested for the effect of diet on FA composition in broiler tissues, for example in connection with administra-

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

doi: 10.17221/28/2016-VETMED

tion of sunflower seeds (Ortiz et al. 2006), soy oil, poultry fat, beef tallow (Azman et al. 2004; Azman et al. 2005), fish oil (Kralik et al. 2004), linseed (Ozpinar et al. 2003) as well as white lupine seeds, in diets enriched with fats of animal or vegetable origin (Mieczkowska and Smulikowska 2005).

Literature data concerning FA levels in the whole chicken body are scattered, and data for the currently bred and used broiler hybrids are completely missing. The genetic potential of broiler chickens has increased significantly in recent years and the higher yield has resulted in altered nutritional needs (Selehifar et al. 2012), and presumably also in altered proportions of bio-active substances in the body. Therefore, this study focused on levels of individual FA in the whole chicken body, including feathers, at the end of the fattening period in the Cobb 500 and Ross 308 hybrid combination and compared the observed differences with respect to gender.

MATERIAL AND METHODS

Animals. The trial was performed on 160 1-day-old sex-sorted broiler chickens of the Cobb 500 and Ross 308 hybrids. Four trial subgroups were formed, consisting of 40 hens and 40 cocks of each hybrid and sex.

Environment. The trial was performed in the accredited trial stable of the Institute for Animal Nutrition of the University of Veterinary and Pharmaceutical Sciences in Brno. The chickens were kept in four separate pens on deep bedding, separated by hybrid and sex. Animal density in the pens corresponded to the optimum surface loading throughout the fattening period, i.e. 17 chickens per 1 m^2. The lighting mode was set to 23 h of light and 1 h of darkness. Microclimatic conditions including ventilation were controlled automatically. The temperature of the bedding at trial commencement was 34 °C and was reduced daily by 0.3–0.4 °C, reaching 18 °C at the end of the trial.

Feeding. During the fattening period, the chickens of both hybrids received identical complex rations, the starter mix (BR1) on Days 1–9, the grower mix (BR2) on Days 10–30 and the finisher mix (BR3) on Days 31–40. Mixes BR2 and BR3 were identical, except that anticoccidial drugs were removed from the finisher mix. The composition and levels of basic nutrients, minerals, amino acids and fatty acids in the BR feed mix are presented in Tables 1–4. The diet was not fortified with fat. The feeding and drinking space corresponded to the requirements defined in the technological procedures for Cobb 500 and Ross 308 hybrids (Anonymous 2012; Anonymous 2014a; Anonymous 2014b). Feed intake and access to water were *ad libitum*. The health status of the chickens was monitored on an ongoing basis. At the end of the 40-day fattening period 10 cocks and 10 hens of the Cobb hybrid and the same numbers of the Ross hybrid were randomly selected. The selected chickens were slaughtered after 24 h of starvation, with free access to water, and their whole bodies, including feathers, were individually analysed.

Table 1. Ingredient composition of the feed mix

	(g/kg)
Wheat	586.45
Solvent extracted soybean meal	226.5
Corn	157.25
Calcium carbonate	10.7
Monocalcium phosphate	5.7
Sodium chloride	2.5
L-Threonine	1.0
Methionine hydroxy analogue	2.7
L-Lysine (fluid)	4.0
Actigen	0.2
Noack AC AL 2	1.0
Ag-BR/UNI P 0.2% (AG-12352)	2.0

Laboratory methods. Whole chicken bodies including feathers were homogenized in a K 120 F High Speed Cutter® (PSS Svidnik, Slovakia) which cuts, grinds and mixes the processed material in three steps. The homogenisation product was weighed, dried and the chicken whole-body dry matter was calculated. Before the chemical analysis,

Table 2. Levels of basic nutrients and minerals in grower (BR2) and finisher feed mixes (BR3) (g/kg)

	(g/kg)	
Dry matter	888.30	1000.00
N-substances	182.40	205.30
Fat	76.40	86.00
Fibre	21.30	24.00
NFE	561.90	632.60
Starch	421.10	474.10
Organic substance	842.00	947.90
Ash	46.30	52.10
Ca	8.50	9.60
P	5.10	5.70
Mg	1.90	2.10

NFE = nitrogen-free extractives

doi: 10.17221/28/2016-VETMED

Table 3. Levels of amino-acids in grower (BR2) and finisher feed mixes (BR3)

Amino acid	(g/kg)	Amino acid	(g/kg)
Asp	16.3	Met	2.2
Thr	6.9	Ile	7.9
Ser	8.4	Leu	12.5
Glu	34.9	Tyr	5.6
Pro	13.5	Phe	9.2
Gly	7.6	His	4.6
Ala	7.6	Lys	10.9
Val	8.6	Arg	13.3

the dried sample was homogenised using the Ultra Centrifugal Mill ZM 200® (Retsch, Germany).

The dry matter proportion in the product of the homogenisation was specified by drying and weighing at 105 °C. Nitrogen levels were determined using the Kjeldahl method in a Buchi analyzer® (Centec automatika, Czech Republic) and nitrogenic substance levels (crude protein) were calculated by multiplication of the nitrogen values by the coefficient 6.25. Samples of the feed mixes and the homogenisation product were used for specification of the individual FA levels. The analyses were performed in a gas chromatograph GC 2010 made by Shimadzu. For more accurate reproducibility, all results are specified in the dry matter of the whole chicken body (g/kg of dry matter).

The complex feed mix was analysed to determine the level of basic nutrients (dry matter, N-substances, fat, starch, ash, calculation of NFE) and minerals (Ca, P, Mg) according to AOAC (2003).

Statistical analysis. The results were processed in Unistat CZ® statistical software, version 5.6 for Excel, where the mean values and their differences were evaluated by multiple comparisons with the help of the Tukey-HSD test, with significance levels of $P \leq 0.01$ and $P \leq 0.05$.

RESULTS

Basic nutrients and gross energy levels in feed mixes

The levels of basic nutrients and gross energy levels in the complex feed mixes fed during the trial corresponded to the recommended nutrient need for the given hybrids, Cobb 500 (Anonymous 2012) and Ross 308 (Anonymous 2014a). N-substance levels in BR2 and BR3 in the original dry matter

Table 4. Fatty acid levels in grower (BR2) and finisher feed mixes (BR3) (g/100 g of fat)

Fatty acid		Fatty acid	
Butyric C4:0	0.000	α-Linolenic C18:3n3	1.512
Caproic C6:0	0.015	Arachic C20:0	0.194
Caprylic C8:0	0.015	*Cis*-11-eicosenoic C20:1n9	0.520
Caprinic C10:0	0.071	*Cis*-11-14-eicosadienoic C20:2n6	0.189
Undecanoic C11:0	0.000	*Cis*-8,11,14-eicosatrienoic C20:3n6	0.076
Lauric C12:0	0.074	Heneicosanoic C21:0	0.000
Tridecanoic C13:0	0.007	Arachidonic C20:4n6	0.232
Myristic C14:0	1.289	*Cis*-11,14,17-eicosatrienoic C20:3n3	0.041
Myristoleic C14:1	0.152	*Cis*-5,8,11,14,17-eicosapentaenoic C20:5n3	0.031
Pentadecanoic C15:0	0.000	Negenic C22:0	0.068
Cis-10-pentadecanoic C15:1	0.000	Erucic C22:1n9	0.025
Palmitic C16:0	21.496	C22:2n6	0.000
Palmitoleic C16:1	2.175	C23:0	0.000
Heptadecanoic C17:0	0.486	C24:00:00	0.056
Cis-10-heptadecanoic C17:1	0.280	C22:6n3	0.035
Stearic C18:0	11.578	C24:1	0.023
Oleic/elaidic C18:1n9t + C18:1n9c	34.372	C22:4n6	0.000
Linoleic/linolelaidic C18:2n6c + C18:2n6t	16.387	C22:5n3	0.000
γ-Linolenic C18:3n6	0.102		

doi: 10.17221/28/2016-VETMED

were 182.40 g/kg. In BR2 and BR3 in the dry matter, they reached 205.3 g/kg of dry matter. The values of gross energy equalled 19.5 MJ/kg of dry matter.

FA levels in feed mixes

The highest FA levels in the feed mixes (BR2 and BR3) fed between Day 10 and Day 40 of the fattening period were determined for oleic/elaidic, palmitic, linoleic/linolelaidic, stearic, palmitoleic, α-linolenic and myristic acids. The other FA levels were below 1 g/100 g of fat.

Weight of Cobb and Ross hybrid broiler chickens

At the end of the fattening period (Day 40), the mean weight of the Ross hybrid broiler chickens was higher ($P \leq 0.05$) than the weight of the Cobb hybrid animals (2.40 ± 0.029 kg vs 2.31 ± 0.028 kg). The amount of fat in the whole body of broiler chickens in both hybrids was higher in hens (Ross 179.50 g/kg, Cobb 178.51 g/kg) than in cocks (Ross 150.52 g/kg, Cobb 155.85 g/kg). In the dry matter, the amount of fat in Ross hens was 456.26 g/kg, in Cobb hens 459.31 g/kg, in Ross cocks 418.74 g/kg and in Cobb cocks 422.50 g/kg.

Dry matter levels in Cobb and Ross hybrid broiler chicken bodies

The mean dry matter level in the whole body of broiler chickens was 376.54 ± 3.275 g/kg for the Ross hybrid, and 378.21 ± 2.473 g/kg for the Cobb hybrid. In both hybrids, the dry matter level values were higher in hens than in cocks ($P \leq 0.01$).

Nitrogenic substance levels in dry matter of Cobb and Ross hybrid broiler chicken bodies

At the end of the fattening period, when the chickens were 40 days old, the levels of N-substances in the dry matter of the broiler chicken bodies, taking both sexes together, were 470.94 ± 5.404 g/kg of dry matter in the Cobb hybrid and 453.16 ± 5.916 g/kg of dry matter in the Ross hybrid. The difference was significant ($P \leq 0.05$). Higher levels were measured both in hens (Cobb 452.04 ± 6.039 g/kg vs Ross 430.14 ± 8.524 g/kg) and in cocks (Cobb 489.84 ± 6.771 g/kg vs Ross 477.34 ± 3.00 g/kg).

FA levels in dry matter of Cobb and Ross hybrid broiler chicken bodies

The highest level of FA (g/100 g of fat), regardless of the hybrid and the sex, was measured for oleic/elaidic acid (Cobb hens 38.95, Cobb cocks 39.59, Ross hens 41.18, Ross cocks 37.22). The second highest level was measured for palmitic acid (20.63, 21.93, respectively, in the Cobb hybrid, and 22.67, 20.21, respectively, in Ross). The third rank was occupied by linoleic/linolelaidic acid (8.69 and 9.81, respectively, for Cobb, and 9.58 and 9.45, respectively, for Ross). The next rank was represented by palmitoleic acid (5.63 and 5.99, respectively, for Cobb, and 6.22 and 5.51, respectively, for Ross) and stearic acid (5.18 and 5.67, respectively, for Cobb, and 5.73 and 5.26, respectively, for Ross). The levels of other FA were below 1 g/100 g of fat (Table 5).

In Cobb 500 hybrids (Table 5), the levels of all measured FA were higher in cocks than in hens. Differences in the values of all measured SaFA were significant ($P \leq 0.05$; $P \leq 0.01$), with the exception of caprylic acid. On the other hand, in the case of MUFA, no differences were found. For FA n-3, higher levels were measured for eicosatrienoic acid ($P \leq 0.05$) and docosapentaenoic acid ($P \leq 0.01$) and levels of all FA n-6 with the exception of γ-linolenic acid were higher ($P \leq 0.01$).

In Ross 308 hybrids (Table 6), FA levels were mostly higher in hens. This was true for most SaFA, for palmitic acid ($P \leq 0.01$), as well as for myristic, heptadecanoic and stearic acids ($P \leq 0.05$). The levels of the following SaFA were higher in cocks: caproic, arachidic and negenic acids. The values of all MUFA were higher in hens, with differences in myristoleic FA ($P \leq 0.05$) and oleic/elaidic acid ($P \leq 0.01$) levels. The levels of FA n-6, with the exception of linoleic/linolelaidic and γ-linolenic acids, were higher in cocks. Differences ($P \leq 0.05$) were found in *cis*-8,11,14-eicosatrienoic, docosatetraenoic and arachidonic acids ($P \leq 0.01$). With the exception of α-linolenic acid, FA n-3 levels were higher in cocks, significantly so ($P \leq 0.01$) in the case of *cis*-5,8,11,14,17-eicosapentaenoic and docosapentaenoic acids.

Comparison of hens of the Cobb 500 and Ross 308 hybrids (Table 6) revealed generally lower lev-

doi: 10.17221/28/2016-VETMED

Table 5. Fatty acid (FA) levels in hens and cocks of the Cobb 500 and Ross 308 hybrid (g/100 g of fat)

Fatty acid (FA)	Cobb 500		Ross 308	
	hens (n = 10) $\bar{x}$ ± SD	cocks	hens (n = 10) $\bar{x}$ ± SD	cocks
Saturated FA				
Caproic C6:0	0.0038^{a} ± 0.0008	0.0049^{b}	0.0037 ± 0.0008	0.040
Caprylic C8:0	0.0057 ± 0.0009	0.0058	0.0060 ± 0.0009	0.0054
Caprinic C10:0	0.0278^{A} ± 0.0028	0.0373^{B}	0.0398 ± 0.0179	0.0304
Lauric C12:0	0.0360^{A} ± 0.0024	0.0424^{B}	0.0366 ± 0.0032	0.0365
Myristic C14:0	0.6699^{A} ± 0.0424	0.7526^{B}	0.7322^{a} ± 0.0334	0.7002^{b}
Palmitic C16:0	20.63^{a} ± 1.2140	21.93^{b}	22.67^{A} ± 1.3390	20.21^{B}
Heptadecanoic C17:0	0.1795^{a} ± 0.0155	0.1946^{b}	0.1928^{a} ± 0.0151	0.1771^{b}
Stearic C18:0	5.180^{a} ± 0.4614	5.671^{b}	5.7319^{a} ± 0.4515	5.2627^{b}
Arachic C20:0	0.0723^{a} ± 0.0065	0.0808^{b}	0.0668 ± 0.0072	0.0735
Behenic C22:0	0.0126^{a} ± 0.0022	0.0152^{b}	0.0132 ± 0.0020	0.0133
			0.01153 ± 0.0164	0.0
			0.0213 ± 0.0205	0.0026
Monounsaturated FA				
Myristoleic C14:1	0.1839 ± 0.0251	0.1993	0.2116^{a} ± 0.0244	0.1906^{b}
Palmitoleic C16:1	5.628 ± 0.6985	5.989	6.2171 ± 0.7409	5.5107
Cis-10-heptadecanoic C17:1	0.1443 ± 0.0149	0.1557	0.1564 ± 0.0140	0.1475
Oleic/elaidic C18:1n9t + C18:1n9c	38.95 ± 1.6250	39.59	41.18^{A} ± 2.9480	37.22^{B}
Cis-11-eicosenoic C20:1n9	0.3348 ± 0.0152	0.3483	0.3355 ± 0.0226	0.3159
Erucic C22:1n9	0.0126 ± 0.0025	0.0142	0.0129 ± 0.0017	0.0123
FA n-6				
Linoleic/linolelaidic C18:2n6c + C18:2n6t	8.6873^{A} ± 0.5740	9.8073^{B}	9.578 ± 0.6439	9.449
γ-Linolenic C18:3n6	0.1086 ± 0.0131	0.1092	0.1158 ± 0.0137	0.1120
Cis-11,14- eicosadienoic C20:2n6	0.0801^{A} ± 0.0047	0.0933^{B}	0.0870 ± 0.0056	0.0909
Cis-8,11,14-eicosatrienoic C20:3n6	0.0561^{A} ± 0.0046	0.0712^{B}	0.0595^{a} ± 0.0068	0.0666^{b}
Arachidonic C20:4n6	0.2508^{A} ± 0.0235	0.3303^{B}	0.2479^{A} ± 0.0290	0.3027^{B}
Docosatetraenoic C22:4n6	0.0451^{A} ± 0.0052	0.0604^{B}	0.0480^{a} ± 0.0068	0.0584^{b}
FA n-3				
α-Linolenic C18:3n3	0.6917 ± 0.0492	0.7729	0.7881 ± 0.0512	0.7570
Cis-11,14,17-eicosatrienoic C20:3n3	0.0132^{a} ± 0.0020	0.0157^{b}	0.0157 ± 0.0018	0.0165
Cis-5,8,11,14,17-eicosapentaenoic C20:5n3	0.0326 ± 0.0052	0.0372	0.0320^{A} ± 0.0034	0.0385^{B}
Cis-4,7,10,13,16,19-docosahexaenoic C22:6n3	0.0326 ± 0.0053	0.0422	0.0297 ± 0.0162	0.0364
Docosapentaenoic C20:5n3	0.0471^{A} ± 0.0078	0.0596^{B}	0.0320^{A} ± 0.0034	0.0385^{B}

^{a,b}the mean values with same superscripts in the same parameter differ significantly ($P \leq 0.05$)

^{A,B}the mean values with same superscripts in the same parameter differ significantly ($P \leq 0.01$)

SD = standard deviation

els of all measure substances in the Cobb 500. The differences were significant in a number of cases. In the case of SaFA, this concerned myristic, palmitic ($P \leq 0.01$) and stearic ($P \leq 0.05$) acids, while in the case of MUFA the difference was significant for myristoleic acid ($P \leq 0.05$). The values of FA n-6 were higher ($P \leq 0.01$) in Ross hybrid hens in the case of linoleic/linolaidic and *cis*-11,14-eicosadienoic acids and the values of FA n-3 showed the same difference in the case of α-linolenic acid ($P \leq 0.01$).

Comparison of values measured in Cobb 500 and Ross 308 hybrid cocks (Table 6) showed generally higher levels in the Cobb 500 hybrid cocks. Levels of γ-linolenic, *cis*-11,14,17-eicosatrienoic, *cis*-5,8,11,14,17-eicosapentaenoic and docosatetraenoic acids represented exceptions to this trend and were

doi: 10.17221/28/2016-VETMED

Table 6. Fatty acid (FA) levels in hens and cocks of the Cobb 500 and Ross 308 hybrids (g/100 g of fat)

Fatty acid (FA)	Hens		Cocks	
	Cobb 500 (n = 10) $\bar{x}$ ± SD	Ross 308	Cobb 500 (n = 10) $\bar{x}$ ± SD	Ross 308
Saturated FA				
Caproic C6:0	0.0038 ± 0.0037	0.0008	0.0049 ± 0.040	0.0012
Caprylic C8:0	0.0057 ± 0.0060	0.0009	0.0058 ± 0.0054	0.0007
Caprinic C10:0	0.0278 ± 0.0398	0.0179	0.0373 ± 0.0304	0.0098
Lauric C12:0	0.0360 ± 0.0366	0.0032	0.0424B ± 0.0365^{A}	0.0046
Myristic C14:0	0.6699^{B} ± 0.7322^{A}	0.0334	0.7526^{B} ± 0.7002^{A}	0.0347
Palmitic C16:0	20.63^{B} ± 22.67^{A}	1.3390	21.9335^{B} ± 20.2091^{A}	0.9475
Heptadecanoic C17:0	0.1795 ± 0.1928^{a}	0.0151	0.1946^{B} ± 0.1771^{A}	0.0103
Stearic C18:0	5.180^{b} ± 5.732^{a}	0.4515	5.6714^{b} ± 5.2627^{a}	0.3051
Arachic C20:0	0.0126 ± 0.0668	0.0072	0.0808 ± 0.0735	0.0137
Behenic C22:0	0.0126 ± 0.0132	0.0020	0.0152 ± 0.0133	0.0019
C23:0	0.0 ± 0.01153	0.0164	0.0 ± 0.0	0.0000
C24:0	0.0 ± 0.0213	0.0205	0.0026 ± 0.0026	0.0082
Monounsaturated FA				
Myristoleic C14:1	0.1839^{b} ± 0.2116^{a}	0.0244	0.1993 ± 0.1906	0.0188
Palmitoleic C16:1	5.628 ± 6.217	0.7409	5.9892^{b} ± 5.5107^{a}	0.5280
Cis-10-heptadecanoic C17:1	0.1443 ± 0.1564	0.0140	0.1557 ± 0.1475	0.0128
Oleic/elaidic C18:1n9t + C18:1n9c	38.95 ± 41.18	2.9480	39.5887 ± 37.2218	2.5328
Cis-11-eicosenoic C20:1n9	0.3348 ± 0.3355	0.0226	0.3483 ± 0.3159	0.0439
Erucic C22:1n9	0.0126 ± 0.0129	0.0017	0.0142^{b} ± 0.0123^{a}	0.0016
FA n-6				
Linoleic/linolelaidic C18:2n6c + C18:2n6t	8.687^{B} ± 9.578^{A}	0.6439	9.8073 ± 9.4486	0.8132
γ-Linolenic C18:3n6	0.1086 ± 0.1158	0.0137	0.1092 ± 0.1120	0.0176
Cis-11,14-eicosadienoic C20:2n6	0.0801^{B} ± 0.0870^{A}	0.0056	0.0933 ± 0.0909	0.0127
Cis-8,11,14-eicosatrienoic C20:3n6	0.0561 ± 0.0595	0.0068	0.0712 ± 0.0666^{b}	0.0080
Arachidonic C20:4n6	0.2508 ± 0.2479	0.0290	0.3303 ± 0.3027^{B}	0.0396
Docosatetraenoic C22:4n6	0.0451 ± 0.0480^{a}	0.0068	0.0604 ± 0.0584^{b}	0.0102
FA n-3				
α-Linolenic C18:3n3	0.6917^{B} ± 0.7881^{A}	0.0512	0.7729 ± 0.7570	0.0684
Cis-11,14,17-eicosatrienoic C20:3n3	0.0132 ± 0.0157	0.0018	0.0157 ± 0.0165	0.0026
Cis-5,8,11,14,17-eicosapentaenoic C20:5n3	0.0326 ± 0.0320	0.0034	0.0372 ± 0.0385	0.0055
Cis-4,7,10,13,16,19-docosahexaenoic C22:6n3	0.0326 ± 0.0297	0.0162	0.0422 ± 0.0364	0.0077
Docosapentaenoic C20:5n3	0.0471 ± 0.0320	0.0034	0.0596 ± 0.0599	0.0093

^{a,b}the mean values with same superscripts in the same parameter differ significantly ($P \leq 0.05$)

^{A,B}the mean values with same superscripts in the same parameter differ significantly ($P \leq 0.01$)

SD = standard deviation

lower in the Cobb 500 hybrid cocks. Differences between the Cobb and Ross hybrids were recorded in the case of lauric, myristic and heptadecanoic acids ($P \leq 0.01$) and in the case of stearic, palmitoleic and erucic acids ($P \leq 0.05$). Differences were also measured in the case of eicosatrienoic, decoratetraenoic ($P \leq 0.05$) and arachidonic ($P \leq 0.01$) acids.

DISCUSSION

Unsaturated fatty acid 18:3 n-3 (linolenic acid) and 18:2 n-6 (linoleic acid) are classified as essential, meaning that the organism is unable to generate them and therefore they must be provided in the feed (Tvrznicka et al. 2011). These substances exert

doi: 10.17221/28/2016-VETMED

significant effects on many aspects of organismal health. They favourably affect prognosis in cardiovascular diseases, are highly beneficial for the brain and quality of vision, and, in addition, strengthen immunity and help to cure eczema, acne and psoriasis.

Generally speaking, the human diet is FA n-3 deficient, which can contribute to degenerative diseases such as cardiovascular diseases, diabetes, arthritis, cancer and mental disorders (Bhalerao et al. 2014).

It has been demonstrated in animal experiments that deficiency in essential fatty acids causes growth retardation and increased transepidermal loss with the consequence of increased permeability of the skin and infertility in males and females. Experiments have shown an increased consumption of feed in animals with a negative nitrogen balance and a decrease in ATP production (Tvrznicka et al. 2011).

Poultry meat, with its low FA n-3 levels and higher FA n-6 levels, is an important component of the human diet (Bhalerao et al. 2014). This ratio can also be observed in our results. In the case of the Cobb hybrid, the sum of FA n-6 was 9.23 in hens, and 10.47 in cocks, while in the case of the Ross hybrid, the same values were 10.14 and 10.10, respectively. The values of FA n-3 were significantly lower. In the case of the Cobb hybrid, the sum of FA n-3 was 0.817 in hens, and 0.928 in cocks, while in the case of the Ross hybrid, the same values were 0.898 and 0.887, respectively. The recommended ratio of FA n-6 : n-3 of 4 : 1, or lower (Simopoulos 1999) was far from being reached, ranging in the case of both hybrids around 11 : 1.

A large number of studies have discussed the possibility of modulating fatty acid composition in the body and muscle fat of poultry through diet (Kralik et al. 2004; Azman et al. 2005; Rymer and Givens 2005; Ortiz et al. 2006; Aldai et al. 2008; Zelenka et al. 2008 and others). It is therefore foreseeable that chicken meat might become an effective source of n-3 FA for the human diet, similarly to n-3 (omega-3) eggs (Van Elswyk 1997).

There are several problems associated with the commercial production of omega-3 chicken meat related to the source of fatty acids in the feed, cost of production, consumer acceptability and stability of the chicken meat that need to be tackled (Bhalerao et al. 2014).

Literary data concerning FA levels in the whole chicken body are scattered. One of the few exceptions is the work by Jakesova et al. (2014), in which FA levels in the whole body of pheasants was studied. Studies on the broiler hybrids used here have been completely missing.

In recent years, the genetic potential of broiler chickens has increased significantly, with higher yield leading to changes in nutritional needs as well as body composition (Anonymous 2012). Information about the levels of fatty acids in the whole body of broiler chickens at the time of slaughter with regard to sex and the currently used modern hybrids is largely missing. For example (Poureslami et al. 2010a) reported that sex has only a marginal effect on n-3 and n-6 PUFA metabolism and no effect on metabolism of SaFA and MUFA (Poureslami et al. 2010b). In marked contrast to these earlier data, the results of our trial document the existence of effects of sex on FA levels. In the case of the Cobb 500 hybrid the levels of all SaFA were higher ($P \leq 0.05$; $P \leq 0.01$) in cocks than in hens, and the same was true for FA n-6 and from the FA n-3 for α-linolenic and docosapentaenoic acids.

In addition to elucidating sex differences, our trial has also revealed that there are significant differences between the Cobb 500 and Ross 308 hybrids. Generally lower levels of the measured substances were found for Cobb 500 hens compared to Ross 308 hybrids. Comparisons of values measured in cocks of the Cobb 500 and Ross 308 hybrids showed generally higher levels of FA in cocks of the Cobb 500 hybrid.

These results suggest possible directions for future research focused on the development of broiler chicken hybrids "with a more favourable proportion of n-6 FA and n-3 FA" in fat and meat. When considering the levels of particular FA the gender of the chickens should also be taken into account.

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Received: 2016–02–10
Accepted after corrections: 2016–06–03

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