Zb. Bioteh. Fak. Univ. Ljubl., Kmet. Zooteh., 80(avgust 2002)1, 71–80.

http://www.bfro.uni-lj.si/zoo/publikacije/zbornik

Original scientific article
Izvirni znanstveni prispevek

THE FATTY ACID COMPOSITION OF BROILERS FROM FREE RANGE REARING *

Tomaž POLAK [a)], Antonija HOLCMAN [b)], Vekoslava STIBILJ [c)] and Božidar ŽLENDER [d)]

[a)] Univ. of Ljubljana, Biotechnical Fac., Dept. of Food Science and Technology, Jamnikarjeva 101, SI-1111 Ljubljana, Slovenia.
[b)] Univ. of Ljubljana, Biotechnical Fac., Zootechnical Dept., Groblje 3, SI-1230 Domžale, Slovenia, Ass.Prof., Ph.D., M.Sc.
[c)] Institute Jozef Stefan, Dept. of Environmental Sciences, Jamova 39, SI-1000 Ljubljana, Slovenia, Ass.Prof., Ph.D., M.Sc.
[d)] same address as [a)], Assoc. Prof., Ph.D.

Received April 15, 2002, accepted July 19, 2002.
Delo je prispelo 15. aprila 2002, sprejeto 19. julija 2002.

ABSTRACT

The study aimed to investigate the effect of rearing method on the fatty acid composition of broiler meat. The subjects were chickens of two genotypes (Ross 208 and Prelux-bro). Experiment went on for 56 days, chickens were kept in a standard deep litter house and fed the same diet. After 28 days chickens were divided into two groups of 50 birds, the first grup had a 12-hours daily access to a grassy surface (free range), the second remaining indoors. At the end of experiment, 8 broilers per group (total of 32) were randomly chosen for fatty acid composition analysis. After slaughter, breasts and legs with skin were excised, homogenised and freeze-stored. Analyses of fatty acid composition was preformed by gas-liquid chromatography (*in situ* transesterification). The results were processed with statistical computer program SAS. From the perspective of human nutrition, free range broilers gave meat with better fatty acid composition (increased content of ω-3 and ω-6 fatty acids) compared to indoor raised chickens. Fatty acid composition was more favourable for breast then leg, and for Prelux-bro than Ross 208 genotype.

Key words: poultry / broiler chickens / rearing / meat / fatty acids / genotype / anatomical parts

MAŠČOBNOKISLINSKA SESTAVA MESA PIŠČANCEV IZ PROSTE REJE †

IZVLEČEK

Namen naše raziskave je bil ugotoviti vpliv načina reje na maščobnokislinsko sestavo mesa pitovnih piščancev. V poskus sta bila vključena 2 genotipa piščancev (50 ross 208 in 50 prelux-bro). Prvih 28 dni so bili vsi piščanci v pitališču s talno rejo na nastilju, nato je polovica piščancev imela 12 ur dnevno dostop na travne površine (prosta reja). Na koncu poskusa smo naključno izbrali 8 piščancev iz vsake skupine (skupaj 32) za določitev maščobnokislinske sestave. Po zakolu smo odvzeli mišičnino prsi in beder skupaj s pripadajočo kožo in vzorce homogenizirali ter jih zmrznili do analiz. Analize maščobnokislinske sestave so bile opravljene z *in situ* transesterifikacijo in plinsko-tekočinsko kromatografijo. Rezultate smo statistično obdelali z računalniškim programom SAS. S prehranskega stališča imajo piščanci v prosti reji boljšo maščobnokislinsko sestavo (povečana vsebnost ω-3 in ω-6), kot tisti v zaprti reji.

* The article is part of a graduation thesis (justification July 9, 1999), supervisor assoc.prof. Božidar Žlender, Ph.D., co-advisor ass.prof. Vekoslava Stibilj, Ph.D.
† Prispevek je del diplomske naloge (zagovor 09. julija 1999), mentor izr.prof. dr. Božidar Žlender, somentorica doc. dr. Vekoslava Stibilj.

Maščobnokislinska sestava prsi je boljša od beder, in genotip prelux-bro je ugodnejši kot ross 208.

Ključne besede: perutnina / pitovni piščanci / reja / meso / maščobne kisline / genotip / anatomski deli

INTRODUCTION

The World Health Organization (WHO, 1990) recommends that a daily consumption of fat in nutrition should amount up to 30% of all daily energy, out of which only 10% should pertain to saturated fatty acids (SFA). In addition to provision of energy, some fatty acids are essential because they are necessary for vital functions but cannot be synthesized by the human body; these are the ω-6 and ω-3 families (Harwood, 1995). A daily consumption of 3–7% of poli-unsaturated fatty acids (PUFA) is also advisable, since the linoleic (18:2, ω-6) and α-linolenic (18:3, ω-3) acids are essential fatty acids (EFA). The consumption of larger quantities of PUFA (above 7%) is not recommended, since the free radicals of PUFA can increase the risk of cancer.

The fatty acid composition of animal lipids in non-ruminants and in poultry can be essentially influenced by the quality of fats in the feed (Ajuyah *et al.*, 1991, Chanmugam *et al.,* 1992). Using the feed enriched with various nutritionally important fatty acids can substantially improve the nutritive value of animal fats and thus indirectly ensure a better supply of essential fatty acids for humans (Scaife *et al.*, 1994).

In general, consumers prefer ecological production of broilers e.g. free range rearing from viewpoint of better animal well-fare and since they believe that such meat has better flavour and texture. Some consumers are prepared to pay more for meat if animals are reared in more natural surroundings: sufficient natural light in stable, limited density. But free range rearing is interesting from the human nutritive viewpoint because broilers can eat grass, which is the source of PUFA and EFA (Lopez-Bote, 1998).

The purpose of this study was to evaluate the fatty acid composition of broiler meat from the perspective of healthy human nutrition. Tree factors were studied, the effect of rearing method, genotype and anatomical part.

MATERIAL AND METHODS

Chickens (50 per genotype) of Ross 208 and Prelux-bro genotypes (the latter being a Slovenian genotype) were included in the study. The feeding strategy was chosen to comply EU legislation (Commision regulation (EEC) No 1538/91) for "Extensive indoor" ("Barn reared") and "Free range" rearing. The experiment lasted 56 days. During the first 28 days all broilers were kept in a standard deep litter house and fed a bro-starter diet (E=12.98 MJ kg^{-1} and 23% crude proteins). Thereafter chickens were divided into two groups of 50 birds. The first group of broilers (free range) had a 12-hour daily access to a grassy surface (2 m^2 per bird), whereas the second remained indoors with no access to the grass. From the 28^{th} to the 56^{th} day they were given the bro-finisher (extensive rearing), with 70% of corn having the energy value E = 16.26 MJ kg^{-1} and containing 14% of raw proteins. At the end of experiment, 16 broilers (total 32) of each genotype were randomly chosen from free range and indoor group for fatty acid composition analysis.

Preparation of samples for analysis

The same day of slaughter the samples of breasts and legs muscles together with the skin were taken from the left side of the cooled up chicken carcases and frozen stored at the temperature –21 °C ± 1 °C. The frozen samples were cut into small pieces, dipped into liquid N_2 (T = –196 °C) and homogenized with a blender. During the homogenization the temperature of the samples did

not raise above the melting-point (T < –2 °C). Homogenized samples were packed into polyethylene bags, tightly closed and stored at –21 °C. Just before analysis of fatty acid composition, an aliquot of each samples was dipped into liquid N_2 (rapid freezing) and then slowly thawed in the nitrogen atmosphere at ≈ 0 °C. This step was repeated for three times with the intention to destroy the cellular membranes and to extract the lipids as thoroughly as possible.

Analysis of the fatty acid composition

The fatty acid (FA) composition of samples was determined by the method of gas-liquid chromatography (GLC). The method chosen was *in situ* transestherification (ISTE) (Park and Goins, 1994), as modified by Fidler & Stibilj (1996). Each sample was analyzed in duplicate.

The capillare gas-liquid chromatography

The content of fatty acid methyl esters (FAME) was determined with the GLC with the use of the gas chromatograph Hewlett Packard 5890, series I, with a flame ionization detector (FID), the capillare column HP-20M (Carbowax 20 M) (50 m × 0.32 mm × 0.3 μm) and the integrator Hewlett Packard 3392A.

The separation and detection was performed under the following conditions:

- Temperature programme = 140 °C; 7 °C/min to 215 °C (81.29 min.);
- Temperature of the injector = 250 °C;
- Temperature of the detector = 290 °C;
- Injector: split:splitless = 1:30, volume 1 μl;
- Carrier gas: Ar 2 ml/min;
- Make-up gas: N_2 30 ml/min;
- The gases of the detector: H_2 30 ml/min; synthetic air (21% O_2) 300 ml/min.

FAME was determined through the retention times of the FAME in standard mixture (NuCheck 85 Prep. Inc.) and standards Sigma (16:0 (antheiso), 17:0 (antheiso), 18:4 (ω-3), 19:0, 20:5 (ω-3), 22:4 (ω-6), 22:5 (ω-3), 23:0). The standard mixture Nu Check 85 Inc. was used to determine the response factor – Rf_i for each fatty acid separately. The weight proportion of a fatty acid in a sample was determined with the response factor and the factor of transformation of FAME into FA. For the determination of reliability and accuracy of the analytical method for the detection of fatty acids, the certified reference matrix – CRM 164 (Anhydrous Milk-Fat – BCR) was used and a good agreement was obtained with certified values.

Statistical analysis

Data were analyzed by the GLM procedure of the SAS/STAT (SAS User's Guide, 1990). For the evaluation of statistical characteristics the CONTRAST option was used and the ESTIMATE option for the evaluation of differences between the groups. The statistical analysis included all fatty acids containing 0.5% content of all fatty acids. Beside those acids the myristoleic (14:1, ω-5), 14-methyl hexadecanoic (16:0 antheiso), 15-metyl heptadecanoic (17:0 antheiso), γ-linolenic (18:3, ω-6), eicosapentaenoic (20:5, ω-3) acids were included, as well as the common SFA, the mono-unsaturated (MUFA), PUFA, eicosapentaenoic (EPA) + docosahexaenoic (DHA), the ω-3 and ω-6 fatty acids and some quotients (P/S, the atherogenic index – AI) (Ulbricht & Southgate, 1991), the ω-6/ω-3, the ω-6/ω-3 long-chain (LC) acids.

$$Y_{ijk} = \mu + R_i + G_j + P_k + e_{ijk}$$

Sort by genotype (G_j, j = Ross 208, Prelux-bro)

$$Y_{ijk} = \mu + R_i + P_k + e_{ik}$$

Sort by anatomical part (P_k k = breasts, legs)

$$Y_{ijk} = \mu + R_i + G_j + e_{ij}$$

The statistical model provided answers to the questions: how the system of rearing (R_i, i = free range, indoors), genotype (G_j, j = Ross 208, Prelux-bro) and anatomical part (P_k k = breasts, legs) influenced the fatty acid composition of broiler meat.

RESULTS AND DISCUSSION

The influences on fatty acid composition of chicken meat

Various factors influence fatty acid composition: rearing, genotype and anatomical part (Table 1). The method of rearing and thus a different kind of nutrition significantly influenced the contents of essential fatty acids; however, they did not influence the ratio of (ω-6/ω-3) and ω-6/ω-3 of the long chain (LC) fatty acids. The genotypes Ross 208 and Prelux-bro statistically significantly differed in the proportion of the SFA and PUFA, and also in the contents of ω-6 fatty acids. The genotypes significantly differed also in both essential fatty acids (the linoleic 18:2, ω-6 and α-linolenic 18:3, ω-3 acids) and in some of their derivates like the arachidonic (20:4, ω-6), eicosapentaenoic (20:5, ω-3) and docosahexaenoic (22:6, ω-3) acids.

The anatomic part (breasts, legs) influenced statistically highly significantly the contents of LC fatty acids like arachidonic (20:4, ω-6), eicosapentaenoic (20:5, ω-3), adrenic (22:4, ω-6) and docosahexaenoic (22:6, ω-3) acids.

The influence of rearing system on the fatty acid composition of meat

In the present study the meat of free range broilers contained a larger amount of 15-methyl heptadecanoic (17:0 antheiso), linoleic (18:2, ω-6), α-linolenic (18:3, ω-3) and γ-linolenic (18:3, ω-6) acids than conventionally fattened chickens (Table 2). As a consequence, a lower MUFA (oleic (18:1), palmitoleic (16:1)), a higher PUFA (ω-3 and ω-6) content and increased P/S index were found for meat of free range broilers.

As expected, the content of the derivates of the α-linolenic (18:3, ω-3) acid does not differ, since the increase of the consumed α-linolenic (18:3, ω-3) acid rather nonsignificantly influences the content of the EPA and DHA. In the meat of free range broilers the content of the docosatetraenoic (22:4, ω-6) fatty acid is surprisingly increased.

Increased quantity of essential fatty acids (ω-3 and ω-6) observed in meat of free range broilers can mainly be attributed to the increase in the α-linolenic (18:3, ω-3) and increase in the linoleic (18:2, ω-6) fatty acids, suggesting an increased intake of these fatty acids by an addition of grass in the diet. Namely, grass has relatively high content (over 65% of total fatty acids) of essential fatty acids, in particular ω-3 fatty acids (over 50% of total fatty acids) (Lopez-Bote *et. al.,* 1998). Similarly Lin *et. al.* (1989) found that broilers fed on linseed-oil, rich in the α-linolenic acid, contained a much higher content of this acid than broilers fed by an addition of coconut or olive oils. In the free range broilers the content of the adrenic (22:4, ω-6) fatty acid was surprisingly increased. This might be caused by the addition of some food of animal origin (earth-worms, snails) that was pecked up by chickens on the pasture, since the grass does not

contain this fatty acid. From the human nutrition perspective the free range broilers, fed an addition of grass, provide meat with a better fatty acid composition that indoor reared broilers, due to the beneficial effect on the quantity of essential fatty acids.

Table 1. Influences on the fatty acid composition of the chicken meat
Preglednica 1. Vplivi na maščobno kislinsko sestavo piščančjega mesa

Fatty acid Maščobna kis.		Source of variability (P-value) Viri variabilnosti (p-vrednost) (n = 64)		
		System of rearing Način reje	Genotype Provenienca	Part Del
Myristic	14:0	0.0809	0.1583	0.0646
Myristoleic	14:1, ω-5	0.4766	**0.0493**	**0.0220**
14-metyl hexadecanoic	16:0 antheiso	0.7053	0.4811	**0.0001**
Palmitic	16:0	0.1663	**0.0001**	0.3945
Palmitoleic	16:1, ω-7	**0.0239**	0.3107	0.0778
15-metyl heptadecanoic	17:0 antheiso	**0.0001**	**0.0001**	0.3198
Stearic	18:0	0.4033	0.0446	0.8727
Oleic	18:1, ω-9	**0.0184**	0.9216	0.4263
Linoleic	18:2, ω-6	**0.0001**	**0.0001**	0.6203
γ-linolenic	18:3, ω-6	**0.0003**	0.0808	**0.0314**
α-linolenic	18:3, ω-3	**0.0001**	**0.0017**	0.5140
Arachidonic	20:4, ω-6	0.1674	**0.0439**	**0.0001**
EPA	20:5, ω-3	0.0828	**0.0113**	**0.0001**
Adrenic	22:4, ω-6	**0.0035**	**0.0281**	**0.0003**
DHA	22:6, ω-3	0.6106	0.4104	**0.0001**
Saturated fatty acids	SFA	0.9134	**0.0001**	**0.0001**
Mono unsaturated fatty acids	MUFA	**0.0005**	0.6111	0.2973
Poli unsaturated fatty acids	PUFA	**0.0009**	**0.0001**	0.0445
	ω-3 FA	**0.0015**	0.0616	**0.0015**
	ω-6 FA	**0.0010**	**0.0001**	**0.0646**
	P/S	**0.0115**	**0.0001**	**0.0018**
	AI	0.9161	**0.0001**	**0.0001**
	ω-6/ω-3	0.1752	0.1915	**0.0029**
	ω-6/ω-3 LC	0.3202	0.4815	**0.0097**
	EPA + DHA	0.4451	0.7064	**0.0261**

P ≤ 0.001 = highly statistically significant, P ≤ 0.01 and P ≤ 0.05 = statistically significant

$$P/S = \frac{PUFA}{SFA}$$

$$AI = \frac{lauric\ a. + 4 * myristic\ a. + palmitic\ a. + transFA}{PUFA + MUFA}$$

Lopez-Ferrer *et. al.* (1997) established that the planned nutrition could bring a great difference in the fatty acid composition of lipids in broilers. With such controlled nutrition a higher content of desired fatty acids both in legs and breasts can be achieved.

Still, we have found no report in literature on the influence of the free range rearing on the fatty acid composition of broilers.

Table 2. The influence of rearing system on the fatty acid composition (wt.% of FA of all FAs) of broilers meat

Preglednica 2. Vpliv načina reje na maščobnokislinsko sestavo (ut.% maščobne kisline od vseh maščobnih kislin) mesa brojlerjev

Fatty acid # Maščobna kis.	Rearing system / Način reje		
	Free range / Prosta reja (n = 32)	Indoors / Zaprta reja (n = 32)	Sig.
	LSM SEM	LSM SEM	
14:0	0.69 ± 0.01	0.65 ± 0.01	NS
14:1, ω–5	0.22 ± 0.01	0.22 ± 0.01	NS
16:0 antheiso	0.29 ± 0.01	0.29 ± 0.01	NS
16:0	24.22 ± 0.15	24.50 ± 0.14	NS
16:1, ω–7	7.10 ± 0.10	7.43 ± 0.10	*
17:0 antheiso	0.21 ± 0.00	0.18 ± 0.03	***
18:0	5.80 ± 0.06	5.73 ± 0.06	NS
18:1, ω–9	40.29 ± 0.20	40.97 ± 0.20	*
18:2, ω–6	17.25 ± 0.15	16.36 ± 0.15	***
18:3, ω–6	0.17 ± 0.00	0.15 ± 0.00	***
18:3, ω–3	0.85 ± 0.01	0.77 ± 0.01	***
20:4, ω–6	0.89 ± 0.02	0.84 ± 0.02	NS
20:5, ω–3	0.06 ± 0.00	0.06 ± 0.00	NS
22:4, ω–6	0.22 ± 0.01	0.19 ± 0.01	**
22:6, ω–3	0.17 ± 0.01	0.16 ± 0.01	NS
SFA	31.57 ± 0.16	31.54 ± 0.16	NS
MUFA	48.03 ± 0.22	49.12 ± 0.21	***
PUFA	20.27 ± 0.22	19.21 ± 0.22	***
ω-3 FA	1.30 ± 0.02	1.21 ± 0.02	**
ω-6 FA	18.96 ± 0.20	18.01 ± 0.20	***
P/S	0.64 ± 0.01	0.61 ± 0.01	*
AI	0.42 ± 0.01	0.42 ± 0.00	NS
ω-6/ω-3	14.73 ± 0.15	15.01 ± 0.15	NS
ω-6/ω-3 LC	4.98 ± 0.28	4.59 ± 0.28	NS
EPA+DHA	0.23 ± 0.01	0.22 ± 0.01	NS

*** = P ≤ 0.001 highly statisticaly significant
** = P ≤ 0.01 statisticaly significant
* = P ≤ 0.05 statisticaly significant
NS = P > 0.05 statisticaly not significant

LSM = least squares mean
SEM = standard error of the mean
# = names of fatty acids are in Table 1

The influence of rearing system on the fatty acid composition of two broiler genotypes

The influence of free range rearing was much more pronounced in the genotype Ross 208 (Table 3) than in the Prelux-bro. Meat of free range Ross 208 had from human nutrition perspective better fatty acid composition than of the indoor reared birds because of the higher content of PUFA (linoleic (18:2, ω-6), γ-linolenic (18:3, ω-6), α-linolenic (18:3, ω-3), 15-methyl heptadecanoic (17:0 antheiso), arachidonic (20:4, ω-6) and adrenic (22:4, ω-6)) acids, higher content of ω-3 and ω-6 FA, higher P/S index (0.63 vs.0.56) and lower AI.

Table 3. The influence of rearing system on the fatty acid composition (wt.% of FA of all FAs) of chicken meat of two genotypes

Preglednica 3. Vpliv načina reje na maščobnokislinsko sestavo (ut.% maščobne kisline od vseh maščobnih kislin) mesa piščancev dveh provenienc

	ROSS 208			PRELUX-BRO		
Fatty acid # Maščob. kis.	Free range Prosta reja (n = 16)	Indoors Zaprta reja (n = 16)	Sig.	Free range Prosta reja (n = 16)	Indoors Zaprta reja (n = 16)	Sig.
	LSM SEM	LSM SEM		LSM SEM	LSM SEM	
14:0	0.68 ± 0.02	0.69 ± 0.02	NS	0.69 ± 0.02	0.62 ± 0.02	**
14:1, ω–5	0.21 ± 0.01	0.24 ± 0.01	**	0.22 ± 0.01	0.20 ± 0.01	NS
16:0 antheiso	0.29 ± 0.01	0.28 ± 0.01	NS	0.29 ± 0.01	0.29 ± 0.01	NS
16:0	24.39 ± 0.18	25.48 ± 0.17	***	24.05 ± 0.21	23.53 ± 0.21	NS
16:1, ω–7	7.00 ± 0.12	7.68 ± 0.12	***	7.21 ± 0.16	7.18 ± 0.16	NS
17:0 antheiso	0.199 ± 0.00	0.18 ± 0.00	***	0.21 ± 0.00	0.19 ± 0.00	***
18:0	5.92 ± 0.09	5.80 ± 0.09	NS	5.69 ± 0.09	5.66 ± 0.09	NS
18:1, ω–9	40.35 ± 0.29	40.94 ± 0.28	NS	40.23 ± 0.28	41.00 ± 0.28	NS
18:2, ω–6	17.02 ± 0.25	15.29 ± 0.24	***	17.48 ± 0.18	17.43 ± 0.18	NS
18:3, ω–6	0.17 ± 0.00	0.15 ± 0.00	***	0.16 ± 0.00	0.15 ± 0.00	NS
18:3, ω–3	0.84 ± 0.02	0.73 ± 0.02	***	0.86 ± 0.01	0.81 ± 0.01	*
20:4, ω–6	0.89 ± 0.03	0.77 ± 0.03	**	0.88 ± 0.04	0.91 ± 0.04	NS
20:5, ω–3	0.06 ± 0.00	0.06 ± 0.00	NS	0.06 ± 0.00	0.05 ± 0.00	NS
22:4, ω–6	0.22 ± 0.01	0.16 ± 0.01	**	0.22 ± 0.01	0.21 ± 0.01	NS
22:6, ω–3	0.17 ± 0.01	0.15 ± 0.01	NS	0.17 ± 0.01	0.17 ± 0.01	NS
SFA	31.82 ± 0.23	32.46 ± 0.22	*	31.31 ± 0.23	30.62 ± 0.23	*
MUFA	47.94 ± 0.28	49.37 ± 0.27	***	48.13 ± 0.32	48.86 ± 0.32	NS
PUFA	20.10 ± 0.35	18.04 ± 0.34	***	20.43 ± 0.24	20.39 ± 0.24	NS
ω-3 FA	1.30 ± 0.03	1.15 ± 0.03	**	1.30 ± 0.02	1.26 ± 0.02	NS
ω-6 FA	18.80 ± 0.32	16.89 ± 0.31	***	19.13 ± 0.23	19.12 ± 0.23	NS
P/S	0.63 ± 0.01	0.56 ± 0.01	***	0.65 ± 0.01	0.67 ± 0.01	NS
AI	0.42 ± 0.01	0.43 ± 0.01	*	0.41 ± 0.01	0.40 ± 0.01	*
ω-6/ω-3	14.65 ± 0.25	14.81 ± 0.24	NS	14.80 ± 0.17	15.22 ± 0.17	NS
ω-6/ω-3 LC	5.27 ± 0.56	4.58 ± 0.54	NS	4.70 ± 0.13	4.59 ± 0.13	NS
EPA+DHA	0.23 ± 0.01	0.21 ± 0.01	NS	0.22 ± 0.01	0.23 ± 0.01	NS

*** = P ≤ 0.001 highly statisticaly significant
** = P ≤ 0.01 statisticaly significant
* = P ≤ 0.05 statisticaly significant
NS = P > 0.05 statisticaly not significant

LSM = least squares mean
SEM = standard error of the mean
# = names of fatty acids are in Table 1

The Prelux-bro genotype, however, was less influenced by the free range rearing. Compared to the indoor broilers the ratio of the α-linolenic (18:3, ω-3) acid was increased (which is favourable), but at the same time the content of the SFA (miristic (14:0) and the 15-methyl heptadecanoic (17:0 antheiso) acids) was also increased, causing a higher IA. From human nutrition perspective the fatty acid composition of meat from the Prelux-bro broilers was more favourable compared with Ross 208, irrespective of rearing method.

The influence of rearing on the fatty acid composition of breasts and legs

Rearing method influenced significantly the FA composition of breasts, except of SFA and ω-6/ω-3 LC index (Table 4). Breasts of free range broilers showed higher ratio of PUFA and lower ω-6/ω-3 LC index, more ω-3 and ω-6 FA, more EPA + DHA, higher P/S index (0.69 vs. 0.61) and lower AI what indicate favorable FA composition compared with indoor rearing.

Table 4. The influence of rearing system on the fatty acid composition (wt.% of FA of all FAs) of breasts and legs

Preglednica 4. Vpliv načina reje na maščobno kislinsko sestvo (ut.% maščobne kisline od vseh maščobnih kislin) prs in beder

	BREAST / PRSI			LEG / BEDRA		
Fatty acid # Maščob. kis.	Free range Prosta reja (n = 16)	Indoors Zaprta reja (n = 16)	Sig.	Free range Prosta reja (n = 16)	Indoors Zaprta reja (n = 16)	Sig.
	LSM SEM	LSM SEM		LSM SEM	LSM SEM	
14:0	0.70 ± 0.02	0.60 ± 0.02	***	0.67 ± 0.02	0.70 ± 0.02	NS
14:1, ω–5	0.22 ± 0.01	0.20 ± 0.01	*	0.21 ± 0.01	0.24 ± 0.01	**
16:0 antheiso	0.37 ± 0.01	0.38 ± 0.01	NS	0.21 ± 0.01	0.19 ± 0.01	*
16:0	24.36 ± 0.17	24.21 ± 0.16	NS	24.08 ± 0.22	24.80 ± 0.22	*
16:1, ω–7	7.18 ± 0.15	7.12 ± 0.15	NS	7.03 ± 0.13	7.74 ± 0.13	***
17:0 antheiso	0.21 ± 0.00	0.18 ± 0.00	***	0.20 ± 0.00	0.19 ± 0.00	*
18:0	5.67 ± 0.09	5.84 ± 0.10	NS	5.94 ± 0.08	5.61 ± 0.08	**
18:1, ω–9	39.84 ± 0.25	41.18 ± 0.25	***	40.74 ± 0.30	40.77 ± 0.30	NS
18:2, ω–6	17.36 ± 0.23	16.37 ± 0.22	**	17.15 ± 0.22	16.36 ± 0.22	*
18:3, ω–6	0.17 ± 0.00	0.16 ± 0.00	**	0.16 ± 0.00	0.15 ± 0.00	*
18:3, ω–3	0.85 ± 0.01	0.76 ± 0.02	***	0.85 ± 0.01	0.78 ± 0.01	***
20:4, ω–6	0.98 ± 0.04	0.96 ± 0.04	NS	0.80 ± 0.03	0.73 ± 0.03	NS
20:5, ω–3	0.07 ± 0.00	0.07 ± 0.00	NS	0.05 ± 0.00	0.05 ± 0.00	NS
22:4, ω–6	0.23 ± 0.01	0.21 ± 0.01	NS	0.21 ± 0.01	0.16 ± 0.01	***
22:6, ω–3	0.20 ± 0.01	0.20 ± 0.01	NS	0.13 ± 0.01	0.13 ± 0.01	NS
SFA	30.77 ± 0.24	31.40 ± 0.24	NS	32.36 ± 0.20	31.68 ± 0.20	*
MUFA	47.98 ± 0.28	49.47 ± 0.28	***	48.08 ± 0.31	48.77 ± 0.30	NS
PUFA	21.11 ± 0.26	19.00 ± 0.25	***	19.43 ± 0.31	19.43 ± 0.31	NS
ω-3 FA	1.41 ± 0.03	1.18 ± 0.03	***	1.19 ± 0.02	1.23 ± 0.02	NS
ω-6 FA	19.69 ± 0.23	17.82 ± 0.23	***	18.24 ± 0.29	18.20 ± 0.29	NS
P/S	0.69 ± 0.01	0.61 ± 0.01	***	0.60 ± 0.01	0.62 ± 0.01	NS
AI	0.39 ± 0.01	0.41 ± 0.01	**	0.44 ± 0.01	0.42 ± 0.01	**
ω-6/ω-3	14.05 ± 0.19	15.13 ± 0.18	***	15.40 ± 0.18	14.90 ± 0.18	NS
ω-6/ω-3 LC	4.17 ± 0.14	4.51 ± 0.14	NS	5.80 ± 0.52	4.66 ± 0.52	NS
EPA+DHA	0.26 ± 0.01	0.21 ± 0.01	**	0.20 ± 0.01	0.22 ± 0.01	NS

*** = P ≤ 0.001 highly statisticaly significant
** = P ≤ 0.01 statisticaly significant
* = P ≤ 0.05 statisticaly significant
NS = P > 0.05 statisticaly not significant

LSM = least squares mean
SEM = standard error of the mean
# = names of fatty acids are in Table 1

In our experiment the rearing method didn't influence the FA composition of the legs, except of the higher SFA and AI of free range samples. This results are unexpected and we couldn't explain them.

Miller *et al.* (1969) and Ajuyah *et al.* (1991) stated that in general the content of the EPA and DHA was substantially higher in the chicken breasts, which is in agreement with our findings. Ajuyah *et al.* (1991) also stated that the chicken legs contained more essential fatty acids than the breasts – this, however, does not agree with our results. According to our findings the content of essential fatty acids does not differ in various anatomical parts of chicken.

Ahn *et al.* (1995) found that the addition of α-linolenic (18:3, ω-3) acid to the feed mixture for broilers increased the content of ω-3 fatty acids in breasts and legs. This statement is in accordance with our findings for breast muscle.

CONCLUSIONS

The free range rearing of broilers influences the fatty acid composition of the meat with skin, bringing substantial increase of ω-3 and ω-6 fatty acids (α-linolenic (18:3, ω-3) and linoleic (18:2, ω-6) acids) compared to indoor raised chicken.

Fatty acid composition was more favourable for breast then leg, and for Prelux-bro than Ross 208 genotype.

POVZETEK

Maščobnokislinska sestava živil ima velik pomen za človekovo zdravje; nekatere maščobne kisline (nasičene) so lahko v večjih količinah zdravju škodljive, druge (večkrat nenasičene) pa koristne ali celo nujne (ω-3 in ω-6), ker jih človeško telo ne more sintetizirati samo. Človek mora dnevno dobiti predvsem esencialne maščobne kisline s hrano, iz katerih lahko sintetizira svoje lastne maščobne kisline. V prehrani živali uporaba krme, ki je bogata s prehransko pomembnimi maščobnimi kislinami, posredno zagotavlja boljšo prehrano ljudi. Namen te naloge je bil ugotoviti, kako način reje vpliva na maščobnokislinsko sestavo maščob mesa pitovnih piščancev.

V poskus sta bila vključena dva genotipa (ross 208 in prelux-bro) pitovnih piščancev (50 na genotip). Piščance smo pitali 56 dni. Prvih 28 dni so bili vsi piščanci v pitališču s talno rejo na nastilju, nato je polovica piščancev imela čez dan dostop na travnate površine. Vsi piščanci so bili krmljeni z enakim krmilom (bro finišer – ekstenzivna reja). Piščance smo razdelili v 4 skupine glede na genotip in rejo. Ob tehtanju na 56. dan smo naključno izbrali po 8 piščancev iz vsake skupine. Izbranim piščancem smo za analizo odvzeli mišičnino prsi in beder s pripadajočo kožo. Takoj po zakolu smo vzorce zamrznili, homogenizirali in skladiščili pri 253 K. Pred pripravo metilnih estrov maščobnih kislin po postopku *in situ* transesterifikacije smo vzorce še dodatno obdelali s tekočim dušikom. Tako pripravljene metilne estre maščobnih kislin smo ločili na GC in določili s FID detektorjem.

Piščanci iz proste reje so imeli večji delež esencialnih maščobnih kislin, kar je ugodno s stališča humane prehrane. Ugotovili smo, da se genotipa razlikujeta v maščobnokislinski sestavi. Genotip prelux-bro ima s prehranskega stališča nekoliko boljšo maščobnokislinsko sestavo. Tudi prsi imajo ugodnejše razmerje maščobnih kislin kot bedra.

Najprimernejši piščanci za prosto rejo so pitovni piščanci genotipa ross 208, medtem ko so za ekstenzivno zaprto rejo primernejši piščanci genotipa prelux-bro.

Vsebnost α-linolenske kisline, ki naj bi kazala vpliv načina reje, je v prosti reji ocenjena na 0,85 ut.% in v ekstenzivni zaprti reji na 0,77 ut.%.

ACKNOWLEDGEMENT

The investigation was sponsored by the Ministry of Education, Science and Sport of Republic Slovenia and the Ministry of Agriculture, Forestry and Food of Republic Slovenia.

REFERENCES

Ahn, D.U./ Wolfe, F.H./ Sim, J.S. Dietary α-Linolenic Acid and Mixed Tocopherols, and Packaging Influences on Lipid Stability in Broiler Chicken Breast and Leg Muscle. Journal of Food Science, 60(1995)5, 1013–1018.

Ajuyah, A.O./ Lee, K.H./ Hardin, R.T./ Sim, J.S. Changes in the Yield and in the Fatty Acid Composition of Whole Carcass and Selected Meat Portions of Broiler Chicken Fed Full-Fat Oil Seed. Poultry Science, 70(1991)11, 2304–2314.

Certification of the Fatty Acid Profile and Mass Fraction of Butiric Acid (n-butanoic acid) Cholesterol and Tree Individual Sterols of an Anhidrous Milk Fat Reference Material with Values for Information on Triglycerides, Minor Fatty Acids, Added Vanilin and 'Total' Sterol Mass Fraction. CRM 164, BCR Information, Reference Material. Gell, European Commission, Joint Research Center, Institute for Reference Materials and Measurements (IRMM), 1993, 78–86.

Chanmugam, P./ Boudreau, M./ Boutte, T./ Park, R.S./ Hebert, J./ Berrio, L./ Hwang, D.H. Incorporation of Different Types of n-3 Fatty Acids Tissue Lipids of Poultry. Poultry Science. 71(1992)3, 516–521.

Commission regulation (EEC) No. 1538/91. Official Journal of European Communities, No L 173, 06.07.1990, 11–22.

Fidler, N./ Stibilj, V. Suitability of different methods for fat extraction and determination of the fatty acid composition of milk. In: 1st Slovenian Congress on Food and Nutrition. Proceedings. Bled, 1996-04-21/25. Ljubljana, Association of Food and Nutrition Specialists of Slovenia, 1996, 914–920.

Harwood, F.W. Lipid Methabolism. In: The Lipid Handbook (Eds.: Gustone, F.D./ Harwood, F.W./ Padley, F.B.). New York, Chapman & Hall, 1995, 605–632.

Komprda, T./ Zelenka, J./ Tieffova, P./ Stohandkova, M./ Foltyn, J. Effect of growth intensity on cholesterol and fatty acids content in broiler chicken tissues. Archiv fur Geflugelkunde, 63(1999)1, 36–43.

Lin, C.F./ Gray, J.I./ Asghar, A./ Buckley, D.J./ Booren, A.M./ Flegal, C.J. Effects of Dietary Oils and α-Tocopherol Supplementation on Lipid Composition and Stability of Broiler Meat. Journal of Food Science, 54(1989)6, 1457–1460.

Lopez-Bote, C.J./ Sanz Arias, R./ Rey, A.I./ Castano, A./ Isabel, B./ Thos, J. Effect of Free-range Feeding on n-3 Fatty Acid and α-Tokopherol Content and Oxidative Stability of Eggs. Animal Feed Science and Technology, 72(1998), 33–40.

Lopez-Ferrer, S./ Baucells, M.D./ Barroeta, A.C./ Blanch, A./ Grashorn, M.A. ω-3 Enrichment of Chicken Meat: Use of Fish, Rapeseed and Linseed oils. In: Poultry Meat Quality, Proceedings of the XIII European Symposium on the Quality of Poultry Meat, Poznań, 1997-09-21/29. Poznań, World Poultry Science Association Polish Branch, Agricultural University, 1997, 45–51.

Miller, D./ Leong, K.C./ Smith, P. Effect of Feeding and Withdrawal of Medhaden Oil on the ω3 and ω6 Fatty Acids Content of Broiler Tissue. Journal of Food Science, 34(1969)3, 136–141.

Park, P.W./ Goins, R.E. *In Situ* Preparation of Fatty Acid Methyl Esters for Analysis of Fatty Acid Composition in Foods. Journal of Food Science, 59(1994)6, 1262–1266.

SAS/STAT. User's guide. 4th ed., Cary, SAS Institute Inc., 1990, 891–1230.

Scaife, J.R./ Moyo, J./ Galbraith, H./ Michine, W./ Campbell, V. Effect of Diferent Dietary Supplemental Fats and Oils on the Tissue Fatty Acid Composition and Growth of Female Broilers. British Poultry Science. 35(1994)1, 107–118.

Ulbricht, T.L./ Southgate, D.A.T. Coronary hearth disease: seven dietary factors. The Lancet, 338(1991)8773, 985–992.

WHO. Diet, Nutrition, and the Prevention of Chronic Diseases. Report of a WHO Study Group. Geneva, World Health Organization, 1990, 100–111.