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Influence of genotype and feeding on chemical composition of organic chicken meat

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ABSTRACT - The aim of this study was to evaluate the effects of different genotypes and of feeding on meat chemical composition, including fatty acid profile, of chickens reared under organic conditions. Two meat–type fast-growing (FG) and medium-growing (MG), and one egg-type slow-growing (SG) strains were assigned to 2 different diets differing for the protein source: soybean (SB) and faba bean (FB) in partial substitution of soybean. Genotype markedly affected the meat chemical composition. SG breast and thigh meat showed lower content of lipids (P<0.01) than FG. The highest proportions of polyunsaturated fatty acids (PUFA) n-6 and n-3 and the lowest proportion of monounsaturated (MUFA) (P<0.01), as well as the lowest ratio of PUFA n6/n3 (P<0.01) were found in SG breast and thigh meat. MG showed always intermediate values. As for feeding, FB treatment produced only a slight increment of protein in breast and a decrease of fat and ash in thigh meat. Total PUFA and PUFA n-6 resulted lower in both thigh and breast meat of FB groups compared to SB (P<0.01).

Key words: Organic chicken, Genotype, Faba bean, Meat quality, Fatty acid composition.

Introduction - Poultry meat quality attributes may be affected by several factors such as genotype, rearing condition and feeding that impact on muscle metabolism as well as on chemical composition. Although the organic system regulation 1804/99 (Council Regulation, 1999) suggests the use of indigenous breeds, that have a slow-growing profile, however the same fast-growing broiler genotypes used in conventional rearing system are also mostly utilized. In several experiments carried out to compare fast-, medium- and slow-growing broiler chicken genotypes reared under organic conditions, important differences both in productivity and meat quality attributes were observed (Fanatico *et al*., 2005; Berri *et al*., 2005; Quentin *et al*., 2003; Castellini *et al*., 2002). Poultry diets are based on corn-soybean ingredients and the concern for GMO contamination in organic feeds has led to investigate the potential introduction of protein sources alternative to soybean. Farrell *et al.* (1999), in three different experiments, attempted to establish recommended inclusion rates of different cultivars of grain legumes (peas, faba beans, sweet lupins, chick peas) in broilers diets. Faba beans gave better growth rate and feed efficiency compared with other grains, at the maximum inclusion level of 200 g/kg. The objective of this study was to evaluate the effects of both genotype (slow-growing egg-type strain, medium- and fast-growing meat type strains) and of the partial substitution of soybean with faba bean on meat chemical composition, including fatty acid profile, of chickens reared under organic conditions.

Material and methods - A total of 720 1-d-old male chicks, equally divided into 3 experimental groups represented by two meat–type fast-growing (FG) Cobb 700 and medium-growing (MG) Naked Neck Kabir, and one egg-type slow-growing (SG) Brown Classic Lohman strains were housed in three indoor pens at a density of 20 birds/m^2 in the same environmental controlled poultry house till 21 d of age. All the birds were fed *ad libitum* the same starter diet (ME 3,100 kcal/kg; CP 20.2%) formulated according to the EC Regulation by using organic raw materials. Afterwards birds of each genotype were split in 2 groups and transferred in 6 different poultry houses with outdoor pens covered with grass. One half received a grower diet based on corn and soybean (SB) (ME 3,091 kcal/kg; CP 17.3%) and the other half received a diet containing faba bean (FB) in substitution of 40% soybean (ME 3,011 kcal/kg; CP 17.2%). FG and MG birds were raised for 81 d, the minimum age required by the regulation 1804 (Council Regulation EC, 1999), and SG for 96d according to the achievement of the market live weight typical for these birds. Feeds and representative samples of grass cut from outdoor pens were submitted to proximate and fatty acid analysis. Moisture, CP, ash (AOAC, 1990), fat (Folch, 1957) and fatty acid composition (Christopherson and Glass, 1969) were individually determined on breast (*P. minor*) and thigh (*B. femoris*) collected from 15 carcasses per group. Data were submitted to two-way ANOVA considering as main effects genotype (G) and diet (D) and means were separated by Student Newman Keuls test (GLM, SAS, 1990).

Results and conclusions – Genotype deeply affected the chemical composition of breast meat. SG and MG showed 30% lower content of lipid than FG birds (P<0.01), whereas SG had the highest content of protein and the lowest of ash (P<0.01, Table 1). Similar results were obtained by Lonergan *et al.* (2003) who compared fast growing broilers with inbred lines and crosses. Fanatico *et al.* (2005), studying slow-, medium- and fast-growing genotypes raised outdoor and slaughtered at similar live weights, found no significant differences among genotypes as for dry matter, fat and ash even if slow-growing birds were numerically lower in fat. In thigh meat the differences in fat content resulted more relevant than in breast with SG birds showing half of the content than FG. The partial substitution of soybean with faba bean produced only slight increment of protein in breast and a decrease of fat and ash in thigh meat.

Genotype dramatically affected the fatty acid composition of both breast and thigh (Table 2). SG breast meat exhibited the highest value of PUFA n-6 and n-3 and the lowest value of MUFA (P<0.01) as well as the lowest ratio of PUFA n-6/n-3. MG showed always intermediate values. The fatty acid composition of thigh meat confirms the observations made for breast meat but the differences among groups were less pronounced. MUFA content was statistically (P<0.01) lower in SG birds than both in FG and MG whereas

Table 1. Effect of chicken genotype and diet on the chemical composition of breast and thigh meat.

	Genotype (G)				Diet (D)			P-value		
	FG	MG	SG	SEM	SB	FB	SEM	G	D	G*D
n.	30	30	30		45	45				
Live weight (g)	5,184^A	2,659^B	1,782C	60.11	3,216	3,200	49.08	0.0001	0.8187	0.8737
Breast										
Moisture (%)	74.8^A	72.3^B	74.4^A	0.19	73.5^B	74.2^A	0.15	0.0001	0.0031	0.0015
Protein (%)	23.7^B	24.2^{AB}	24.6^A	0.19	23.9^b	24.4^a	0.16	0.0043	0.0287	0.2029
Lipid (%)	1.28^A	1.00^B	0.94^B	0.05	1.08	1.06	0.04	0.001	0.7518	0.7444
Ash (%)	1.20^B	1.37^A	1.16^B	0.02	1.25	1.24	0.02	0.001	0.7870	0.3508
Thigh										
Moisture (%)	74.4^B	76.2^A	76.7^A	0.26	75.8	75.9	0.21	0.0001	0.6251	0.1359
Protein (%)	20.1	20.0	20.4	0.18	20.0	20.3	0.14	0.3905	0.2704	0.0504
Lipid (%)	4.34^A	3.07^B	2.29C	0.19	3.48^a	2.99^b	0.15	0.0001	0.0305	0.0566
Ash (%)	1.01	0.98	1.02	0.02	1.04	0.97^B	0.01	0.1970	0.0008	0.1769

$^{a, b}$Means within a row followed by differing superscript letters differ significantly (P≤0.05).
^{A,B}Means within a row followed by differing superscript letters differ significantly (P≤0.01).

total PUFA, PUFA n-6 and PUFA n-3 were significantly higher (P<0.01). In addition MG and SG groups exhibited significantly higher amounts of saturated fatty acids (SFA) (P<0.01). The inclusion of faba bean in the diet decreased the proportion of total PUFA, particularly n-6 (P<0.01) in both groups.

Table 2. Effect of chicken genotype and diet on breast (*P. minor*) and thigh meat fatty acid composition (g/100 g fat).

Fatty acid[1]	Genotype (G)				Diet (D)			P-value		
	FG	MG	SG	SEM	SB	FB	SEM	G	D	G*D
n.	30	30	30		45	45				
Breast										
SFA	32.2	32.0	33.1	0.37	32.1	32.8	0.29	0.1101	0.0904	0.4273
MUFA	34.1^{A}	30.3^{B}	23.9^{C}	0.69	28.7	30.3	0.56	0.0001	0.0895	0.6810
PUFA	32.4^{C}	35.8^{B}	41.3^{A}	0.60	37.5^{A}	35.3^{B}	0.48	0.0001	0.0034	0.1768
Total n-6	28.1^{C}	30.1^{B}	33.6^{A}	0.46	31.4^{A}	29.7^{B}	0.37	0.0001	0.0045	0.0918
Total n-3	4.35^{C}	5.64^{B}	7.71^{A}	0.23	6.16^{a}	5.58^{b}	0.18	0.0001	0.0479	0.8334
n-6/n-3	6.64^{A}	5.47^{B}	4.44^{C}	0.21	5.34	5.74	0.17	0.0001	0.1459	0.4296
Thigh										
SFA	29.8^{B}	30.8^{A}	31.4^{A}	0.31	29.9^{B}	31.5^{A}	0.25	0.0001	0.0001	0.0001
MUFA	38.0^{A}	34.8^{B}	28.7^{C}	0.50	33.2^{b}	34.4^{a}	0.41	0.0001	0.0470	0.1688
PUFA	30.5^{C}	32.5^{B}	38.0^{A}	0.63	35.1^{A}	32.2^{B}	0.52	0.0001	0.0002	0.0088
Total n-6	27.7^{B}	29.1^{B}	33.9^{A}	0.58	31.6^{A}	28.9^{B}	0.47	0.0001	0.0001	0.0042
Total n-3	3.04^{C}	3.74^{B}	4.38^{A}	0.09	3.77	3.67	0.08	0.0001	0.3113	0.8960
n-6/n-3	9.16^{A}	7.82^{B}	7.79^{B}	0.15	8.48^{a}	8.03^{b}	0.13	0.0001	0.0148	0.0259

[a, b]Means within a row followed by differing superscript letters differ significantly (P≤0.05).
[A,C]Means within a row followed by differing superscript letters differ significantly (P≤0.01).

The results of this experiment indicate that chicken meat quality is strongly affected by genotype whereas feeding exerts a minor effect. The appropriate choice of genotype seems to play a very important role in the quality of organic chicken products.

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