Effect of Genotype, Gender, and Feed Restriction on Slaughter Results and Meat Quality of Broiler Chickens

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Summary

Slaughter results and meat quality were evaluated in 768 broilers according to genotype (standard breast yield vs. high breast yield), gender, and feeding systems (*ad libitum* vs. feed restriction from 13 to 21 d of age). Standard-yield chickens had higher carcass weights (2358 g vs. 2319 g; P < 0.001) and hind legs proportion (31.1% vs. 30.6%; P < 0.01), and lower dressing out percentage (73.6% vs. 74.0%; P < 0.01) compared to high-yield birds, besides lower meat L* index (45.3 vs. 46.2; P < 0.05), higher final pH (5.89 vs. 5.85; P < 0.05) and thawing losses (10.5% vs. 9.43%; P < 0.05). Males showed higher carcass weight (+24%), dressing percentage (+0.7%), and hind leg yield (+4%) (P < 0.001) than females. Restricted birds had lower carcass weight (–2%; P < 0.001) and dressing percentage (-0.3%) (P < 0.05) than those always fed *ad libitum*. As what concerns meat quality, gender and feeding system affected only meat final pH, lower in *ad libitum* group than in restricted one and in females than males. In conclusions, slaughter results and carcass traits changed especially with genotype and gender, coherently with slaughter weight whereas meat quality was mostly affected by genotype.

Key words

broiler chickens, meat quality, gender, genotype, feeding system

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Introduction

Poultry production uses fast-growing genotypes, which assure profitable performance and constant carcass traits and meat quality (Petracci et al. 2014). However, selection for growth rates has brought about changes in meat quality until the occurrence of severe myopathies, which in turn could affect the rheological and nutritional traits of poultry meat, besides its potential for processing (Petracci et al. 2014; Kuttappan et al., 2016). Moreover, genetic selection has increased susceptibility of broiler chickens to health and welfare problems (e.g. sudden death syndrome, leg abnormality). Feed restriction may control growth and health, but it may affect carcass and meat quality (Sahraei, 2012; Butzen et al., 2013). Accordingly, the present study aimed at evaluating slaughter results and meat quality of broiler chickens differing for genotype (standard vs. high breast yield), gender, and feeding systems (*ad libitum* vs. feed restriction).

Materials and methods

A total of 768 chickens were housed at the poultry house of the University of Padova in 32 pens (2.2 m^2) (28 chicks per pen), randomly allocated to 8 experimental groups, *i.e.* 2 genotypes x 2 genders x 2 feeding systems (*ad libitum vs.* restricted), and controlled until slaughtering (46 d of age). Half pens were always fed *ad libitum*, the remaining half was restricted from 13 to 21 d of age. The restricted birds received the 80% of the quantity consumed by the birds fed *ad libitum* on the previous day. Trocino et al. (2015) give further details on housing and *in vivo* recordings.

All birds were slaughtered in a commercial slaughterhouse, after about 7 h of feed withdrawal and 4 h of drinking withdrawal. Eviscerated carcasses without feathers, head, neck, abdominal fat, and feet were individually weighed after 2 h of refrigeration at 2°C to measure slaughter dressing percentage. A total of 128 carcasses (4 per pen) were selected on the basis of the slaughter live weight to be representative within a pen and stored at 2°C before carcass and meat quality analyses. Forty-eight hours after slaughter, carcasses were dissected into main cuts (breast, wings, thighs, and drumstick); meat and bones were separated from drumstick; *Pectoralis major* muscles were separated from the breasts (World's Poultry Science Association, 1984; Petracci and Baéza, 2011). On the ventral side of *P. major*, pH was measured with a pH meter (Basic 20, Crison Instruments Sa, Carpi, Italy) and a specific electrode (cat. 5232, Crison Instruments Sa); L*a*b* color indexes were measured using a Minolta CM-508 C spectrophotometer (Minolta Corp., Ramsey, NJ, USA) (Petracci and Baéza, 2011). Thereafter, one meat portion (8 cm × 4 cm × 3 cm) was cut off from the cranial side of *P. major*, parallel to muscle fibers directions, and stocked under vacuum in plastic bags at -18°C until measuring thawing and cooking losses (Petracci and Baéza, 2011). After thawing, the meat portion was cooked in a plastic bag in water bath for 45 min, until an internal temperature of 80°C. After a 40-min cooling, a meat portion (4 cm × 2 cm × 1 cm) was separated and used to measure the maximum shear force using a LS5 dynamometer (Lloyd Instruments Ltd, Bognor Regis, UK) and Allo-Kramer (10 blades) probe (load cell: 500 kg; distance between the blades: 5 mm; thickness: 2 mm; cutting speed: 250 mm/min) (Mudalal et al., 2014).

Statistical analysis

Individual data of slaughter results, carcass traits, and meat quality were analyzed by ANOVA with the following model:

$$Y_{ijklm} = \mu + F_i + G_j + S_k + (FG)_{ij} + (FS)_{ik} + (GS)_{jk} + (FGS)_{ijk} + P_{ijkl} + e_{ijklm}$$

where μ is the overall mean; F*i* is the effect of the feeding system; G*j* is the effect of genotype; S*k* is the effect of gender (sex); (FG)*ij* is the effect of interaction between the feeding system and the genotype; (FS)*ik* is the effect of interaction between the feeding system and the gender; (GS)*jk* is the effect of interaction between the genotype and the gender; (FGS)*ijk* is the effect of interaction between the feeding system, the genotype and the gender; P*ijkl* is the random effect of the pen; e*ijklm* is the experimental error. Three levels of significance for P value were considered in this study P<0.001, P<0.05 and P<0.10.

Results and discussion

Both genotypes tested in our trial fully expressed their growth potential. Nevertheless, at slaughter, the chickens of the standard genotype were heavier (P < 0.001) and had higher carcass weights (P < 0.001), but lower dressing out percentage (P < 0.01) compared to high-yield chickens (Table 1). Similarly, Petracci et al. (2013) observed that standard-yield chickens reached earlier the slaughter weight (4.2 kg) compared to high-yield chickens (53 d vs. 55 d of age). In our conditions, breast yield did not vary with the genotype. Differently, Petracci et al. (2013) found a lower breast rate in standard chickens compared to high-yield chickens at the same slaughter weight (4.2 kg). Moreover, in our trial, the heavier carcasses of the standard genotype showed a higher development of thighs compared to the high-breast-yield genotype (P < 0.01). The effect of genotype on meat quality was expressed in terms of lower L* index (P < 0.05), higher final pH (P < 0.05) and thawing losses (P < 0.05) of *P. major* in standard-yield chickens compared to high-yield ones (Table 2). The higher final meat pH explains the lower breast lightness index of standard-yield chickens compared to high-yield ones, due to the negative correlation between the two traits (Debut et al., 2003). Indeed, meat quality is expected to largely vary among genotypes with large genetic differences and different growth rates (Berri et al., 2005; Sirri et al., 2011), but even two genotypes belonging to the same commercial brand may show some differences. In fact, Petracci et al. (2013) found lower meat pH and lower drip losses in standard chickens compared to high-yield chickens.

As expected, males showed higher final live weight, carcass weight and dressing percentage compared to females (P < 0.001) (Table 1). Males also showed a higher yield in both thighs and drumsticks, which resulted in a higher yield in hind legs (P < 0.001) (Table 1), as reported also by Abdullah et al. (2010). Meat quality did not differ to an appreciable extent according to gender: pH of *P. major* was lower in females than in males (-0.7%; P < 0.01) (Table 2), as previously found by other authors (López et al., 2011; Brewer et al., 2012; Schneider et al., 2012). Lightness and red indexes and water holding capacity were similar; whereas we measured a higher yellow index in females than in males (+6%; P < 0.05) (Table 2), as previously reported by Schneider et al. (2012).

Table 1. Slaughter results and carcass traits (LS means) in broiler chickens slaughtered at 46 d

	Breast yield (B)		Gender (G)		Feeding system (F)		Prob.						RSD
	Standard	High	Females	Males	*Ad libitum*	Restricted	B	G	F	F×B	F×G	B×G	
Chickens (n)	364	364	363	365	362	366							
Final live weight (g)	3,207	3,130	2,845	3,492	3,194	3,142	<0.001	<0.001	<0.01	0.13	0.24	<0.01	234
Cold carcasses (g)	2,358	2,319	2,086	2,581	2,357	2,310	<0.001	<0.001	<0.001	0.23	0.18	<0.01	165
Dressing out percentage (%)	73.6	74.0	73.5	74.0	73.9	73.7	<0.01	<0.001	0.02	0.36	0.57	0.02	1.41
Dissected carcasses (n)	64	64	64	64	64	64							
Breast yield (% CC)	39.9	40.1	40.3	39.7	40.6	39.5	0.68	0.34	0.06	0.23	0.31	0.24	3.27
Thighs (%CC)	18.3	17.7	17.6	18.4	17.7	18.3	<0.01	<0.01	0.02	0.73	0.14	0.71	1.27
Drumsticks (% CC)	12.7	12.8	12.6	13.0	12.9	12.7	0.53	<0.01	0.22	0.56	0.09	0.26	0.91
Hind legs (% CC)	31.1	30.6	30.3	31.5	30.7	31.1	0.10	<0.001	0.25	0.96	0.81	0.36	1.67
Wings (% CC)	9.7	9.5	9.5	9.7	9.6	9.6	0.11	0.07	0.80	0.06	0.50	0.91	0.77

Table 2. Rheological traits (LS means) of *Pectoralis major* muscle in chickens slaughtered at 46 d of age

	Breast yield (B)		Gender (G)		Feeding system (F)		Prob.						RSD
	Standard	High	Females	Males	*Ad libitum*	Restricted	B	G	F	F×B	F×G	B×G	
Carcasses (n)	64	64	64	64	64	64							
pH	5.89	5.85	5.85	5.89	5.85	5.89	0.04	<0.01	<0.01	0.07	0.02	0.61	0.09
L*	45.3	46.2	45.6	45.9	46.1	45.4	0.02	0.43	0.10	0.63	0.36	0.06	2.18
a*	-0.70	-0.84	-0.79	-0.76	-0.78	-0.77	0.13	0.69	0.92	0.86	0.60	0.84	0.52
b*	14.0	13.6	14.2	13.4	14.0	13.6	0.16	0.02	0.30	0.27	0.75	0.05	1.83
Thawing losses (%)	10.5	9.43	10.3	9.64	10.3	9.66	0.04	0.20	0.24	0.07	0.35	0.17	2.86
Cooking losses (%)	22.7	23.7	22.7	23.8	23.0	23.4	0.15	0.09	0.51	0.58	0.24	0.55	3.49
Shear force (kg/g)	3.03	2.98	2.80	3.21	2.98	3.02	0.83	0.08	0.86	0.42	0.44	0.45	1.28

The feeding system affected growth rate of chickens during the trial. Restricted birds showed compensatory growth during re-feeding (Trocino et al., 2015), but the re-alimentation period was not so long to permit a full recovery of the final live weight, that was lower in restricted birds than in those always fed *ad libitum* (Table 1). The former birds also showed lower dressing percentage ($P < 0.05$), breast yield ($P < 0.10$), and thighs yield ($P < 0.05$) than the latter ones (Table 1), as reported by other authors (Zhan et al., 2007; Butzen et al., 2013). As what concerns meat quality, the feeding system only affected final pH, lower in the *P. major* of the chickens fed *ad libitum* compared to those submitted to feed restriction (Table 2). We could hypothesize that chickens fed *ad libitum* stored more glycogen than restricted ones and, therefore, more lactic acid was available in meat after 24 h (Alnahhas et al., 2014). Among other authors, Butzen et al. (2013) did not detect any significant effect of early feed restriction on thawing and cooking losses or shear force, like in our study; also Ponte et al. (2008) did not find significant effects on final meat pH of chickens even when restricted until slaughter.

In conclusions, slaughter results and carcass traits changed with genotype, gender, and feeding systems, coherently with differences in slaughter weight, whereas meat quality was mostly affected by genotype.

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