The meat quality of layer males from free range in comparison with fast growing chickens

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ABSTRACT: In chick hatcheries, males of laying hybrids are considered to be "waste" and the majority of these males are killed just after hatching. On the other hand, the interest of consumers in products from alternative systems (organic, free-range) is increasing. The idea was to evaluate the meat quality of these males when they have access to free range because there is not such a study available. The aim of this study was to compare the physical and sensory quality of the meat of layer males with fast-growing broilers at the same age when they had both access to free range and when they were fed to 49 and 90 days of age. Slow-growing ISABROWN (IB) layer males and fast-growing Ross 308 (RS) chickens were kept in free-range conditions to evaluate carcass and meat quality at 49 days and 90 days of age. Live weight, carcass yield, breast meat yield and the proportion of abdominal fat were significantly higher ($P < 0.001$) in RS at both ages. The proportions of fat in the breast meat were significantly lower ($P < 0.01$) in IB at both ages. The value of pH 24 h was significantly higher in IB and the meat was darker ($P < 0.001$) in these chickens. The overall acceptability was significantly better ($P < 0.01$) in IB at 90 days of age. The laying males are acceptable for an alternative system of poultry meat production from the aspect of meat quality. The quality was comparable or even higher in comparison with fast-growing chickens.

Keywords: breast meat colour; fat; overall acceptability

The interest of consumers in products from alternative systems (organic, free-range) is increasing mainly because these systems can be environmentally friendly, sustaining animals in good health with high welfare standards and resulting in higher quality products (Sundrum, 2001) and more flavoursome products (Sauveur, 1997). But some assessors prefer breast fillets from a standard system to free-range or organic system (Brown et al., 2008). The free-range production of chicken meat is regulated in the EU (Directive EWG 1538/91) and organic livestock farming is defined by basic guidelines (EEC – the regulation for organic agriculture /EEC/ No. 1804/1999). Among others in organic production, the minimum age at slaughter shall be 81 days. In France, chickens reared under carefully specified conditions may be accorded the Label Rouge or Label Fermier quality marks. There are strict rules in the Label Rouge systems; among others, slow-growing genotype and age at slaughter not less than 84 days (King, 1984). Fast-growing commercial hybrids are not suitable for these production systems, because they are slaughtered between 5 and 7 weeks and at 81 (84) days of age they are too heavy. However, in the United States organic and other specialty poultry produc-

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tion mostly utilizes the same fast-growing broiler genotype as in conventional production systems (Fanatico et al., 2005a).

The antagonistic relationship between meat and egg production led to the separation of the meat and egg-type strains of fowl. Consequently, the day-old male layer chickens have been used in the pet food industry as a high quality animal protein source for predators, reptiles, falcons, hawks and zoo animals. Moreover, in hatcheries the male chickens of layer breeds have to be killed due to their poor fattening performance and consequently high fattening costs. In addition, consumers do not normally accept this type of bird as meat chicken.

The superiority and genetic improvement of meat-type chickens in terms of growth is well documented (Hardy et al., 1975; Zelenka et al., 2001; Damme and Ristic, 2003; Gerken et al., 2003; Havestein et al., 2003a; Lonergan et al., 2003); however, there are only a few studies concerning the carcass composition and meat quality of commercial layer males in comparison with broilers at the same age of birds (Gerken et al., 2003). Lewis et al. (1997) and Fanatico et al. (2005) evaluated the effect of genotypes on the carcass quality, but they compared fast and slower growing broilers, but no layer males. Levis et al. (1997) compared the carcass quality of slower and faster growing birds at the same live weight (different age) and Fanatico et al. (2005b) compared the carcass quality of slower and faster growing birds at the same carcass weight (different age and different live weight). Grashorn and Clostermann (2002) conducted a very extensive study concerning the performance and slaughter characteristics of broiler breeds for extensive production, but they also used slow-growing chickens without free range. Zelenka et al. (2001) compared the retention of protein and fat in the meat of fast and slow-growing chickens, but they kept the chickens in cages.

The aim of this study was to evaluate the meat quality of laying males when they have access to the free range and to compare the physical and sensory quality of meat with fast-growing broilers at the

Table 1. Diet formulations and calculated analyses

Ingredient (%)	Starter	Grower	Finisher
Wheat	20.2	40.4	40.3
Maize	30.0	30.0	20.0
Wheat bran	–	–	10.0
Wheat flour	10.0	–	10.0
Palm oil	2.5	–	–
Soybean meal	34.5	26.0	16.4
Calcium carbonate	1.0	1.5	1.3
Methionine 40	0.3	0.2	0.2
Lysine 40	–	–	0.2
NaCl	0.3	0.4	0.2
Dicalcium phosphate	0.7	1.0	0.9
Aminovitan	0.5	0.5	0.5
Calculated analysis			
AME_N (MJ/kg)	11.1	11.7	11.3
Crude protein (N × 6.25, g/kg)	228.6	186.9	165.5
Methionine (g/kg)	5.1	4.2	3.9
Lysine (g/kg)	11.9	9.2	8.0
Calcium (g/kg)	8.6	9.2	8.1
Phosphorus (g/kg)	2.4	5.6	6.1

same age when they were fed to 49 and 90 days of age. On the basis of the results the suitability of laying males for an alternative system with regard to meat quality should be concluded.

MATERIAL AND METHODS

Animals and diets

Fifty 1-day-old Ross 308 (RS) and fifty 1-day-old ISABROWN males (IB) were housed in the same building in two separated pens (6 birds/m^2). The floor was covered with wood shavings. All birds were given an initial 23 h photoperiod, then a 16L:8D lighting schedule from 8 days of age was provided. Temperature was maintained at 30°C at the beginning of the experimental period, and gradually decreased to 20°C by the fourth week of age. From 4 weeks of age, the birds were subjected to the ambient temperature. Outdoor access to a grass paddock (6 m^2/bird) was provided after 14 days of age during daylight hours. The birds were confined to indoor pens at night. The birds had free access to feed and water at all times (both outside and inside). All birds received the same diets (Table 1) *ad libitum* (1–14 days: starter; 15–44 grower; 45 slaughter; finisher). Diet formulations and calculated analyses are given in Table 1. All birds were individually weighed at weekly intervals.

Physical and chemical analysis

At 49 and 90 days of age 10 birds from each group were slaughtered. The birds were killed by manual exsanguinations. The plucked carcasses were eviscerated and chilled for 24 h at 5°C before dissection. Boneless thighs and drumsticks with skin, breast meat and abdominal fat were weighed. The right sides of breast meat were individually wrapped in tinfoil and put to a –24°C freezer before sensory evaluation. The left sides of breast meat were evaluated for colour, pH, drip loss and chemical analysis. Breast meat (4–5 g) of IB in 49 days and 10–12 g of other samples (RS 49 days, IB and RS 90 days) were carefully weighed, then put in a refrigerator (5°C) for 24 h and then dried with filter paper and precisely weighed again. Drip loss was expressed as a percentage of the initial muscle weight.

The pH values were measured with a digital pH meter PORTAMESS 911 Ph KNICK (Knick Elektronische Messgeräte, Berlin) 1 cm from the sternum in the middle part of the muscle and at a depth of 1 cm at 0.5, 1.0, 1.5, 2.0 and 24 h intervals. The colour parameters (L^*, a^*, b^*) were measured on raw muscles and on the skin of thigh using a spectrophotometer (CM-2600d, Konica Minolta, Osaka). In this method, higher L^* values are light, higher a^* values are red, and higher b^* values are yellow. Colour measurements were taken on the cross-section of the breast muscle. Chemical analyses of the breast meat were done as follows: Moisture was determined by drying at 105°C for 6 h and total lipids were analysed by extraction with petroleum ether (Soxtec method).

Sensory assay

Ten chickens from each genotype in both age categories were assessed by five highly trained panellists under controlled conditions of a sensory study in a sensory laboratory. Birds with average weights were chosen for the evaluation. Only the cooked breast meat was subjected to the sensory evaluation due to the lack of homogeneity of thigh muscles. The breast samples were cooked in foil in their own juice at 190°C for 1.5 h. Panellists described the colour, flavour, texture, juiciness, taste and overall acceptability. Each attribute was scored on an unstructured linescale 100 mm long. The extreme points of the linescales were as follows: colour 0-dark, 100-light, flavour 0-typical, very pleasant, 100-untypical, off-flavour, texture 0-soft, 100-tough, juiciness 0-very juicy, 100-dry, taste 0-unpleasant, aftertaste, 100-pleasant, without aftertaste, overall acceptability 0-pleasant, 100-unpleasant.

Statistical analyses

Data on live weight and sensory assays were analysed by t-test and the chemical and physical characteristics were analysed by the nonparametric Mann-Whitney U-Test using the software package Unistat 5.1 (Unistat Ltd., England).

RESULTS AND DISCUSSION

The live weight of IB and RS at week intervals is given in Figure 1. It is clear that due to selective

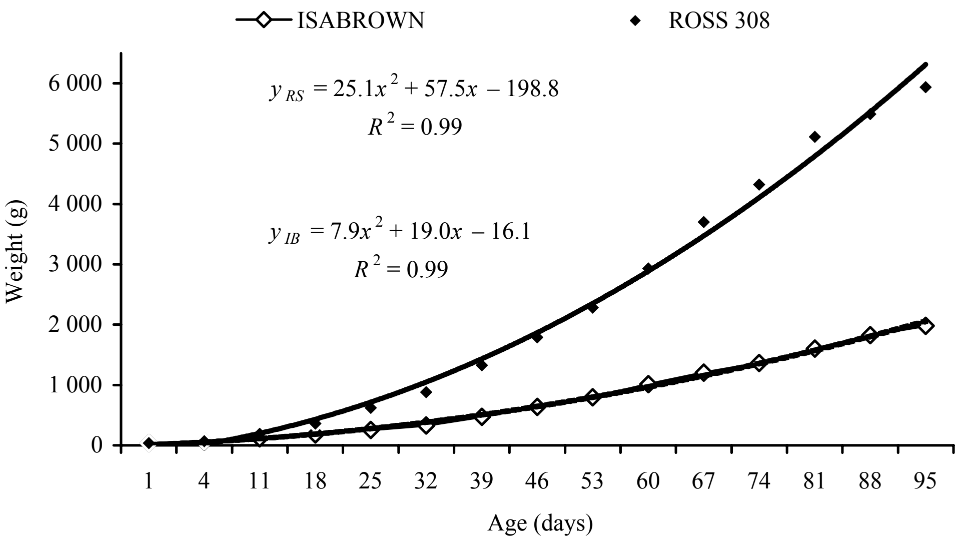

Figure 1. The live weight of the different genotypes (g)

breeding decisions the live weight of RS was significantly higher ($P < 0.001$) than in IB, as it was already reported many times (Hardy et al., 1975; Gerken et al., 2003; Damme and Ristic, 2003; Lonergan et al., 2003). Mortality till 90 days of age was 9.1% in IB and 8.0% in RS. The feed conversion ratio till 90 days of age was 3.1 kg/kg in RS and 3.8 kg/kg in IB.

The carcass characteristics and meat quality are shown in Table 2. As expected, carcass weight and carcass yield percentages were also significantly higher ($P < 0.001$) in RS. Regardless of the age, breast yield was significantly higher ($P < 0.001$) in fast-growing RS than in slow-growing IB, as a lot of authors have shown (Lewis et al., 1997; Gerken et al., 2003; Fanatico et al., 2005b). This is the result of intensive selective breeding for this characteristic in broilers. The breasts are considered the most valuable part of the broiler carcass. The heritability of breast weight of the carcass was estimated at 0.5 (Ricard and Rouvier, 1967 in Crawford, 1993). The heavier weight of RS resulted in all their components being heavier than those of IB. But there were no significant differences between the genotypes in the percentage of leg muscle plus skin (thigh and drumstick). Gerken et al. (2003) found that the proportion of the less valuable parts and the percentage of leg tended to be higher in egg-type males than in broilers. Fanatico et al. (2005) observed a significant effect of the genotype (fast vs. slow) on the percentage of both breast and leg meat to the total weight of the carcass. In their experiment with slow-growing chickens, the percentage of breast meat was lower, but the percentage of leg meat was higher in comparison with fast-growing broilers. The quality of carcasses with the same weight of slow and fast growing broilers was compared by Lewis et al. (1997). They did not note a significant difference in the breast, thigh, or total meat production.

At both ages, the amount of abdominal fat was significantly lower ($P < 0.001$) in IB than in RS. The unusually higher feed conversion ratio in RS (3.1 kg/kg) was probably due to higher fat deposition in these birds. The same effect of genotypes was reported by Lewis et al. (1997). On the basis of his scientific works, Crawford (1993) concluded that although only a few authors presented correlations higher than 0.5, these findings indicated that the selection of birds to increase body weight would also give rise to an increase in abdominal fatness. The fat content of the carcass increased over time (Perreault and Leeson, 1992), but Havenstein et al. (2003) reported that the proportion of abdominal fat was higher in Ross 308 at 43 days of age (1.40%) than in Athens-Canadian Randombred Control at 85 days of age (1.21%). On the other hand, Grashorn and Clostermann (2002) found a partly higher proportion of abdominal fat in slow-growing breeds than in the breed Ross 308.

The chemical characteristics of breast meat (Table 2) showed almost the same values of dry matter at 49 days but significantly higher ($P < 0.001$) in IB at 90 days. Holcman et al. (2002) reported also a higher content of dry matter in the breast meat of slower-growing broilers than in Ross 208. Fanatico et al. (2005) showed significantly higher dry matter in fast-growing hybrids but they compared birds

Table 2. Slaughter traits, chemical and physical characteristics and sensory quality of breast meat

Carcass quality		Age (days)	ISABROWN	ROSS 308	Significance
			mean ± SE		
Live weight (g)		49	721.4 ± 12.0[a]	2 243.0 ± 100.3[b]	***
		90	1 769.0 ± 15.9[a]	5 408.0 ± 254.7[b]	***
Carcass weight (g)		49	437.0 ± 9.5[a]	1 533.4 ± 50.4[b]	***
		90	1 119.9 ± 14.9[a]	3 998.6 ± 138.4[b]	***
Carcass yield (%)		49	60.6 ± 1.1[a]	68.8 ± 1.3[b]	**
		90	63.3 ± 0.6[a]	74.4 ± 1.3[b]	***
Breast yield (%)		49	14.2 ± 0.4[a]	20.9 ± 0.6[b]	***
		90	15.6 ± 0.3[a]	27.2 ± 0.7[b]	***
Leg muscle + skin yield (%)		49	24.1 ± 0.8	25.4 ± 0.6	NS
		90	25.4 ± 0.5	26.6 ± 0.7	NS
Abdominal fat (%)		49	0.1 ± 0.1[a]	2.0 ± 0.1[b]	***
		90	0.7 ± 0.1[a]	2.7 ± 0.3[b]	***
Dry matter – breast (%)		49	25.1 ± 0.06	25.0 ± 0.52	NS
		90	26.6 ± 0.06[a]	25.7 ± 0.12[b]	***
Fat – breast (%)		49	0.49 ± 0.08[a]	2.06 ± 0.46[b]	**
		90	0.68 ± 0.11[a]	1.22 ± 0.11[b]	**
Drip loss – breast (%)		49	3.1 ± 0.3	3.4 ± 0.3	NS
		90	1.5 ± 0.2[a]	0.7 ± 0.07[b]	***
pH 30 min		49	6.12 ± 0.068	6.15 ± 0.055	NS
		90	6.16 ± 0.051	6.28 ± 0.052	NS
pH 24 h		49	5.77 ± 0.024[a]	5.66 ± 0.019[b]	**
		90	5.73 ± 0.024[a]	5.63 ± 0.023[b]	**
Skin colour 24 h	L^*	49	70.6 ± 1.19	71.6 ± 1.56	NS
		90	68.2 ± 1.02	70.1 ± 0.58	NS
	a^*	49	6.6 ± 0.94	5.9 ± 0.66	NS
		90	7.0 ± 0.69	8.8 ± 0.61	NS
	b^*	49	27.5 ± 2.29[a]	20.6 ± 0.92[b]	*
		90	31.6 ± 1.29[a]	26.7 ± 0.28[b]	**
Breast colour 24 h	L^*	49	55.2 ± 0.78[a]	59.2 ± 0.99[b]	*
		90	50.8 ± 0.47[a]	54.7 ± 0.73[b]	***
	a^*	49	3.0 ± 0.5[a]	1.3 ± 0.18[b]	*
		90	–0.34 ± 0.30	0.13 ± 0.23	NS
	b^*	49	19.3 ± 0.65[a]	14.5 ± 0.46[b]	**
		90	13.6 ± 0.53[a]	9.6 ± 0.66[b]	**

Table 2 to be continued

Carcass quality	Age (days)	ISABROWN	ROSS 308	Significance
		mean ± SE		
Sensory characteristics of breast meat				
Colour	49	36.6 ± 1.90[a]	51.2 ± 2.22[b]	***
	90	51.7 ± 2.91[a]	67.4 ± 2.00[b]	***
Flavour	49	49.2 ± 2.52	54.3 ± 2.66	NS
	90	32.5 ± 3.12	38.8 ± 3.21	NS
Texture	49	57.8 ± 3.21[a]	43.9 ± 3.26[b]	**
	90	47.9 ± 3.67	56.2 ± 3.56	NS
Juiciness	49	66.0 ± 3.37	60.2 ± 2.85	NS
	90	67.9 ± 2.83	69.3 ± 3.45	NS
Taste	49	52.0 ± 3.13	50.8 ± 2.79	NS
	90	37.5 ± 2.88[a]	51.0 ± 3.21[b]	**
Overall acceptability	49	56.3 ± 3.25	53.3 ± 2.84	NS
	90	47.1 ± 2.52[a]	58.9 ± 2.55[b]	**

*,**,***indicates significance levels at 0.05, 0.01 and 0.001, respectively

of the same weight but at different ages. However, age (maturity) significantly affects the content of dry matter in breast meat. At both ages, the content of fat was significantly higher ($P < 0.01$) in RS, which corresponds with the findings of Castellini et al. (2002). According to Lonergan et al. (2003), the breast meat of modern fast-growing broilers also contained a higher percentage of lipids and a lower percentage of proteins compared with the slow-growing strains. Havenstein et al. (1994) suggested that the selection of birds based on their body weight concomitantly promoted fat accretion. On the other hand, Zelenka et al. (2001) did not observe any increase in breast fat content in fast-growing broilers depending on their age, but they found a significant increase in breast fat content in slow-growing chickens ($P < 0.01$) depending on their age.

There was no significant difference between samples regarding drip losses at 49 days. But at 90 days the drip loss was significantly higher ($P < 0.001$) in IB as Debut et al. (2003) and Fanatico et al. (2005b) also reported. Regardless of the age, the genotype had no significant effect on pH 0.5 h, pH 1 h, pH 1.5 h and pH 2 h. But pH 24 h was significantly higher ($P < 0.01$) in IB for both ages. Castellini et al. (2002) and Alvarado et al. (2005) also reported higher pH in slow-growing chickens. But Debut et al. (2003) and Lonergan et al. (2003) did not find a significant effect of genotype on pH, these authors did not observe a significant difference between slow and fast growing chickens in L^*, a^*, b^*, either. As Fletcher (1999) showed, the correlations between the colour values and pH were all highly significant. But in this experiment the meat colour as an indicator of meat quality was also affected by genotype. The L* values of the breast were significantly higher at both ages in RS (49 days $P < 0.05$; 90 days $P < 0.001$). The same effect of genotype on L^* was reported by Debut et al. (2003). Grashorn and Clostermann (2002) observed the significantly lowest L^* in broilers with the significantly lowest live weight, but only at 84 days of age (not at 70 days). The IB had higher redness (a^*) at 49 days ($P < 0.05$) but at 90 days the difference was not significant. Debut et al. (2003) did not observe a significant difference between slow and fast growing lines in a^* values, either. Significantly higher ($P < 0.01$) b^* values were found at both ages in IB, which confirmed the effect of genotype on this characteristic (Debut et al., 2003; Lonergan et al., 2003; Fanantico et al., 2005). The colour difference was apparent not only by instrumental means but was also visible and confirmed by sensory evaluation. The b^* values of skin were also significantly higher in IB (49 days $P < 0.05$; 90 days $P < 0.01$). The yellowness of the IB birds may be related to the increased foraging of plant material (unpublished data).

The results of sensory quality are also shown in Table 2. At both ages of 49 days and 90 days, breast meat was significantly darker ($P < 0.001$) in IB. Improving the breast weight through selection can potentially result in the production of lighter-coloured breast meat (Le Bihan-Duval et al., 1999). The breast meat of IB was tougher ($P < 0.01$) at 49 days, but at 90 days there was no significant difference in the texture of breast meat between RS and IB. Farmer et al. (1997) reported significantly less tough ($P < 0.01$) breast meat from ISA 657 than Ross. The two genotypes delivered no significant difference in flavour, which agrees with Farmer et al. (1997). The intensity of flavour increased with age in both genotypes, which was reviewed by Ramasway and Richards in 1982. There were no significant differences between genotypes in juiciness at both ages, which agrees with Farmer et al. (1997). But these authors observed increased juiciness in breast meat when the birds were older, which was not confirmed by this study. On the other hand, Delpech et al. (1983 in Farmer et al., 1997) found no difference in juiciness between birds at 7, 9, and 11 weeks of age, for either ISA birds or a fast-growing strain. The overall acceptability was significantly better ($P < 0.01$) in IB at 90 days of age, but at 49 days there was no difference between genotypes. Castellini et al. (2003) also showed an overall preference for slow-growing birds in comparison with fast-growing ones.

Some authors (Farmer et al., 1997; Berri et al., 2005; Fanatico et al., 2005) drew a different conclusion concerning the effect of genotypes on meat quality, but they compared slow and fast-growing chicken at different ages but at the same weight. Increasing the age of slaughter affects the meat quality (Perreault and Leeson, 1992; Farmer et al., 1997; Horsted et al., 2005). Alvarado et al. (2005) also reported some similar results (pH, L^*, b^*), but they compared different genotypes bred in different conditions (diets, age at slaughter). In addition to genotypes, both the diet and the age also have an effect on sensory attributes, mainly on texture and appearance (Farmer et al., 1997).

In organic, free-range or Label Rouge systems there is no advantage in improved growth rate, since birds cannot be slaughtered before a specified age and the body weight of fast-growing hybrids at these ages exceeded the requirements of the market. ISABROWN males seem to offer utility for an alternative system of poultry meat production. Of course, the rate of growth is lower in comparison with slow-growing chickens and the meat yield would also be lower, but the meat quality of ISABROWN males is higher mainly due to the fat content. Colour, taste and overall acceptability seem to be influenced by genotype to the greatest extent, while the ISABROWN males demonstrate superior attributes. Concerning the meat quality, this study shows that the fattening of males from egg-type hybrids could provide an alternative product for free-range systems. The quality of meat was comparable or even higher in comparison with fast-growing chickens.

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