Fattening performance, carcass and meat quality of slow and fast growing broiler strains under intensive and extensive feeding conditions

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For extensive chicken meat production (conventional and organic) slow growing broiler breeds are prescribed. Normally, diets with lower nutrient content are used in extensive production, although diets with higher nutrient content may result in better fattening performance. The objectives of the present study have been to compare different slow and fast growing broiler breeds under extensive and intensive feeding conditions for carcass and meat quality. Breeds Isa S 457 (brown feathered), Isa J 957 (white), Hubbard JV (white) and Ross 308 (white) were included in the survey. Experimental diets were either low in nutrients (LD, according to Isa S 457) or high (HD, according to Ross 308). Experimental design: 4 breeds x 2 diets = 8 treatments x 4 repetitions = 32 pens x 60 birds = 1,920 unsexed day-old broilers. Birds were slaughtered on days 32, 37, 56, 63, 70 and 84 of life and carcass (slaughter yield, abdominal fat, proportion of valuable parts) and meat (ultimate pH, colour, grilling losses, texture, dry matter, ash, protein) quality criteria were determined. Results of day 84: Ross cocks fed on HD were 1.77 times heavier (5,941 g) than Isa S 457 cocks (3,350 g) fed on LD. Feeding birds with HD resulted in 8-14 % and 2-8 % higher life weights on day 84 in cocks and hens, respectively. Carcass yield was 4 % higher in cocks and hens of breeds Ross and Hubbard than in breeds Isa J 957 and S 457. Differences between HD and LD amounted to 1-2 %. Breast meat was more yellow (b* value) in females than in males, whereas no differences were observed between breeds. Breast meat yield was higher in fast growing breeds (Ross 26.9 %) than in slow growing ones (S 457 18.1 %) and for HD than for LD feeding. The highest grilling losses were determined for breed Ross 308 and Hubbard JV (25-30 %) and the lowest ones for Isa J 957 and S 457 (19-24 %). In contrast to earlier investigations texture values were higher in fast growing than in slow growing birds.

Keywords: broiler, slow growing, carcass quality, meat quality

Introduction

In extensive and ecological broiler production slow growing broiler breeds are prescribed. Slow growing broiler strains are offered by companies Hubbard-Isa and Sasso, whereas fast growing broiler breeds are mainly of companies Hubbard, Ross or Cobb. For nutrition breeders recommend diets with nutritive levels adjusted to the respective growth potential of their breed. Havenstein et al. (2003a) conducted some experiments on feeding today's fast growing broiler strains and broiler strains of the 1950ies with actually composed diets and diets of the 1950ies. The authors concluded that the change in performance was mainly caused by breeding programs (85-90 %), whereas improvements in nutrition contributed only 10-15 %. Today's slow growing broiler breeds show comparable performance to old broiler strains but differ significantly in their genetic background. Therefore, the question arises, whether slow growing broiler breeds react differently to diets with different nutritive levels in comparison to fast growing breeds. A first study on this topic was published recently by Bellof et al. (2005), but there was no fast growing breed included in the experiment.

It is well known that slow growing broilers differ in carcass and meat quality features from fast growing breeds (f.e. Berri, 2000; Culioli et al., 1990; Grashorn and Clostermann, 2002; Havenstein et al. 2003b; Ristic, 1992). In different studies it was shown, that slow growing broilers have lower carcass yield and breast meat yield. In breast meat cooking losses are lower, but texture values are higher and sensory attributes are superior. But, these comparisons are mainly made with broiler breeds fed according to the respective recommendations of breeders.

The objective of the present study was, therefore, to compare different slow and fast growing broiler breeds under extensive and intensive feeding conditions for carcass and meat quality.

Material and methods

Slow growing breeds Isa S 457 (brown feathered), Isa J 957 (white) and fast growing breeds Hubbard JV (white), Ross 308 (white) were included in the survey. All-mash experimental diets, mainly composed of wheat, extracted soybeans and corn were either low in nutrients (LD, according to Isa S 457) or high (HD, according to Ross 308) as shown in *Table 1*. Feed and water was provided ad libitum, rearing conditions were according to commercial practice.

Table 1 Nutritive content of experimental diets (calculated values).

	Day of life		Crude protein (%)	Crude fat (%)	ME*	Fibre (%)	Ca (%)	P_t (%)	Methionin (%)	Lysine (%)
Starter	1-14	Low	21.0	3.07	12.0	3.07	0.94	0,93	0.40	1.08
		High	23.0	5.33	12.1	3.08	0.99	0.82	0.48	1.37
Grower	15-28	Low	19.2	4.27	12.2	3.10	0.72	0.68	0.36	0.99
		High	21.0	7.89	12.8	3.01	0.86	0.74	0.45	1.25
Finisher I	29-56	Low	18.6	4.53	12.2	3.07	0.78	0.69	0.35	0.93
		High	20.0	8.51	13.0	2.98	0.89	0.73	0.40	1.09
Finisher II	57-84	Low	18.0	4.63	12.3	3.06	0.77	0.68	0.33	0.87
		High	19.0	7.54	12.8	3.01	0.88	0.73	0.37	1.01

* AME_N (MJ/kg) = 0.01551*g/kg crude protein + 0.03431*g/kg crude fat + 0.01669*g/kg starch + 0.01301*g/kg sugar

The experimental design was as follows: 4 breeds x 2 diets = 8 treatments x 4 repetitions = 32 pens x 60 birds = 1,920 unsexed day-old broilers. On days 32, 37, 56, 63, 70 and 84 of life 12 cocks and 12 hens per treatment were slaughtered and carcass (slaughter yield, abdominal fat, proportion of valuable parts according to Marché, 2000) and meat (ultimate pH, colour, grilling losses, texture (Warner-Brazler shear tool), dry matter, ash, protein) quality criteria were determined. Data were analysed by three-factorial ANOVA (breed, diet, sex) with procedure GLM of statistic software JMP (SAS Institute, version 5.1). Differences between means were tested for significance by Student's t-test.

Results and discussion

Least Square Means of life weight at slaughter and carcass characteristics are presented in T*able 2* and LSQ-Means of meat quality traits are shown in *Table 3*. Carcass yield and abdominal fat are related to life weight and thigh and breast meat yield are related to cold carcass weight (without feet, neck and gut). Data are presented as interactions breed x diet x sex.

Ross cocks fed on HD were 1.77 times heavier (5,941 g) than Isa S 457 cocks (3,350 g) fed on LD. In the same way, Ross hens fed on HD were 1.65 times heavier than their Isa S 457 counterparts fed on LD. In general, feeding birds with HD resulted in 8-14 % and 2-8 % higher life weights on day 84 in cocks and hens, respectively. Carcass yield was 4 % higher in cocks and hens of breeds Ross and Hubbard than in breeds Isa J 957 and S 457. Differences between HD and LD amounted only to 1-2 %. Proportion of abdominal fat was significantly higher in females than in males with minor differences between breeds and dietary treatments. Only small differences were observed for proportions of thighs (with skin and bone related to cold carcass weight) between breeds and dietary

treatments. But, yield of thighs was lower in hens than in cocks. Distinct significant differences were recorded for proportion of breast meat for breeds, dietary treatments and sex. Breast meat yield was higher in fast growing broilers, in HD groups and in hens. The difference between Isa S 457 cocks and Ross 308 cocks amounted to 8 percentage points for both diets, whereas, in females differences were 10 percentage points. Breast meat yield of Isa J 957 and Hubbard JV cocks and hens laid between breeds Isa S 457 and Ross 308.

Table 2 LSQ-Means of life weight, carcass yield and proportions of abdominal fat, thighs and breast meat on day 84 of age.

Diet	Breed	Life weight (g)	Carcass yield (%)	Abdominal fat (%)	Thighs (%)	Breast meat (%)
			Cocks			
LD	Isa S 457	3,350	67.9	1.93	32.3	17.0
	Isa J 957	3,810	70.9	1.72	31.6	21.4
	Hubbard JV	4,845	71.4	1.67	32.3	21.9
	Ross 308	5,370	72.8	1.69	31.1	25.0
HD	Isa S 457	3,647	69.2	1.79	31.3	17.9
	Isa J 957	4,413	70.5	1.95	31.8	21.0
	Hubbard JV	5,607	73.2	1.78	31.8	24.3
	Ross 308	5,941	73.0	1.66	30.7	26.5
			Hens			
LD	Isa S 457	2,695	67.4	2.14	30.3	19.1
	Isa J 957	3,150	69.9	2.85	29.1	21.9
	Hubbard JV	4,207	72.2	2.41	29.5	24.8
	Ross 308	4,331	73.6	2.21	27.9	28.6
HD	Isa S 457	2,925	67.9	2.92	29.8	18.4
	Isa J 957	3,352	71.7	2.81	28.8	23.6
	Hubbard JV	4,287	72.8	3.15	28.9	25.3
	Ross 308	4,453	74.0	2.92	28.1	27.5
Significance						
Breed		***	***	n.s.	**	***
Diet		***	**	**	n.s.	n.s.
Sex		***	n.s.	***	***	***
Breed x Diet x Sex		n.s.	n.s.	n.s.	n.s.	n.s.

n.s. – not significant, * - P<0.05, ** - P<0.01, *** - P<0.001

Breast meat was more light (L* value) and more yellow (b* value) in females than in males, whereas, only minor differences were observed between breeds. Breast meat of hens tended to be redder then breast meat of cocks. In general, colour differences in breast meat were more pronounced between sexes than between breeds or diets. The highest grilling losses were determined for breed Ross 308 and Hubbard JV (25-30 %) and the lowest ones for Isa S 457 and J 957 (19-24 %). No obvious differences occurred between diets and sexes. Texture values of breast meat of hens were higher in fast growing breeds than in slow growing breeds, whereas, for cocks no clear differences could be observed. Dietary treatments obviously did not affect texture of breast meat.

Comparing carcass and meat quality characteristics of breeds at the relevant slaughter age reveals for cocks that birds of the slow growing breeds are twice as heavy on day 84 of age as their fast growing counterparts on day 32 of age (*Table 4*). There is a distinct difference between diets. Slow growing broilers fed on diet LD reached 86 (Isa J 957) and 92 (Isa S 457) % of life weight of slow growing broilers fed on diet HD, whereas, fast growing broilers fed on LD diet reached only 75 % of life weight of broilers fed on HD diet. Carcass yield of slow growing broilers and of fast growing broilers amounted to 68 to 71 % and to 64 to 66 %, respectively. Proportion of abdominal fat pad was in general higher in slow than in fast growing broilers due to the differences in age. The highest breast meat yield was observed in the Ross breed and the lowest one in Isa S 457, with breeds Isa J 957 and Hubbard JV between the two others. Differences between dietary treatments were minor. Grilling losses did not show clear differences, neither between dietary treatments nor between sexes. Texture values of breast meat were higher in fast growing than in slow growing cocks. The highest values were observed for breed Hubbard JV. Differences between breeds Isa S 457 and Isa J 957 were minor.

Table 3 LSQ-Means of L*, a*, b* values, grilling losses and texture of breast meat on day 84 of age.

Diet	Breed	L*	a*	b*	Grilling loss (%)	Texture (N)
			Cocks			
LD	Isa S 457	56.4	-0.23	4.05	19.5	26.9
	Isa J 957	54.3	-0.03	4.33	22.3	26.1
	Hubbard JV	54.4	0.27	4.51	25.2	25.4
	Ross 308	54.9	0.50	4.24	26.9	31.3
HD	Isa S 457	54.0	-0.30	2.95	20.9	30.9
	Isa J 957	54.0	-0.39	3.86	21.9	27.6
	Hubbard JV	56.0	-0.15	4.60	28.7	29.5
	Ross 308	54.8	-0.52	4.68	29.5	30.5
			Hens			
LD	Isa S 457	58.5	-0.16	7.08	21.3	26.3
	Isa J 957	59.0	-0.40	6.60	23.5	24.6
	Hubbard JV	56.3	0.89	7.40	26.2	26.9
	Ross 308	56.8	1.16	7.03	30.1	27.5
HD	Isa S 457	58.4	0.28	5.35	22.2	26.5
	Isa J 957	58.1	-0.48	6.94	23.7	25.1
	Hubbard JV	58.7	-0.44	7.32	26.5	27.7
	Ross 308	56.9	0.74	7.44	29.3	30.0
Significance						
Breed		n.s.	*	n.s.	***	*
Diet		n.s.	*	n.s.	*	n.s.
Sex		***	n.s.	***	*	n.s.
Breed x Diet x Sex		n.s.	n.s.	n.s.	n.s.	n.s.

n.s. – not significant, * - P<0.05, ** - P<0.01, *** - P<0.001

Table 4 Some carcass and meat quality characteristics of cocks slaughtered at the normal slaughter age of the respective breed.

Diet	Breed	Age at slaughter (d)	Life weight (g)	Slaughter yield (%)	Abdominal fat (%)	Breast meat (%)	Grilling loss (%)	Texture (N)
LD	Isa S 457	84	3,350	67.9	1.93	17.0	19.5	26.9
	Isa J 957	84	3,810	70.9	1.72	21.4	22.3	26.1
	Hubbard JV	32	1,477	63.9	1.15	19.0	20.1	42.0
	Ross 308	32	1,574	63.5	1.27	22.2	20.9	37.4
HD	Isa S 457	84	3,647	69.2	1.79	17.9	20.9	30.9
	Isa J 957	84	4,413	70.5	1.95	21.0	21.9	27.6
	Hubbard JV	32	1,959	64.9	1.31	21.2	20.2	56.6
	Ross 308	32	2,067	65.7	1.22	24.8	19.5	29.1

The different growth potential of slow and fast growing broiler breeds and of cocks and hens within breeds was clearly demonstrated. Live weight of fast growing breeds was 1.6 to 1.8 times higher on day 84 of life than for slow growing ones. Carcass yield and breast meat yield was in general higher in fast growing breeds due to the higher capacity to built up muscle tissue. In accordance with Havenstein et al. (2003a, 2003b) life weight, carcass yield and breast meat yield was mainly depending on genetics, whereas the effects of nutrition were minor. Achieved life weights were lower and results of carcass quality of the tested breeds were better than reported earlier (Grashorn and Clostermann, 2002).

Meat quality characteristics were mainly influenced by genetic effects (breeds and sex). Interestingly, breast meat of hens was brighter and more yellow than breast meat of cocks. This may be caused by the higher fat content of tissues in hens. Yellowness was less than in a previous study (Grashorn and Clostermann, 2002), probably, caused by differences in the content of corn in diets. The higher grilling loss in breast meat of fast growing breeds is due to the reduced water holding capacity of the bigger meat parts. In contrast to previous investigations (Culioli et al., 1990; Grashorn and

Clostermann, 2002) texture values of breast meat were higher in fast growing broilers. This was quite pronounced in young broilers (see *Table 4*) and has to be studied in more detail. But in general, it has to be expected that breast meat of slow growing broilers shows lower grilling losses and higher texture values. Nutrition had no significant impact on these meat quality criteria.

The results clearly show that nutritive density of diets mainly affects growth and feed consumption (data not presented), but has only a minor effect on carcass and meat quality. Therefore, feeding slow growing broilers with diets with a higher nutritive density may affect fattening performance in a positive way without negative impact on most carcass and meat quality characteristics, whereas, feeding fast growing broilers with a low nutritive diet will depress growth significantly. Fatness in hens will be reduced, but other carcass and meat quality characteristics will not be influenced.

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