Comparison of meat quality and sensory attributes of conventional and organic broilers

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Introduction

In recent years demand for organic food (including organic chicken meat) has increased, as consumers' interest in organic poultry production and in quality attributes of meat is still growing. Despite this rising demand production of organic chicken meat increased only slightly and knowledge on the main factors contributing to the observed differences in quality is still limited.

Some studies revealed that in comparison to conventionally reared birds, meat obtained from organic production system is characterized by more yellow colour of meat, lower ultimate pH, better water holding capacity, less cooking losses and higher shear values (Castellini *et al*., 2002; Enfält *et al*., 1997).

Meat of slow-growing birds raised with access to free-range is believed to have an improved texture and flavour and consumer preferred it to meat of conventionally reared broilers (Touraille *et al*., 1981; Castellini *et al*., 2002). Texture, appearance and flavour seem to be mainly influenced by genotype, diet and age (Farmer *et al*., 1997).

The objectives of this study were set to analyse the effects of genotype, feed composition and access to free range on meat quality of broilers with different genotype. Furthermore, the impact of genotype, diet and access to free range on sensory attributes of broiler meat was to be assessed.

The achieved information is expected to help optimizing production conditions in organic broiler production (choice of breed, importance of feeding stuffs and pasture) and to more clearly define the differences between organic and conventional broiler meat.

Material and Methods

Four factors have been considered in the experiment: genotype, diet, free-range and age at slaughtering. Three different breeds were used: fast growth (Ross 708; FG), medium growth (Isa 657; MG), slow growth (Isa 757; SG). Of each genotype 20 birds of mixed gender were assigned to one group (in total 60 birds). The groups were kept without (OA) or with access to free range (MA) and were fed on conventional (KF) or organic diets (OF) resulting in a total number of 3 x 20 x 4 = 240 broilers per trial. Overall 3 trials were conducted with a total number of 720 broilers. Stocking density of each pen in the groups which had no access to free range was 6 birds per m^2. The MA groups were housed in similar indoor pens, but at the age of 6 weeks the birds had free access to a grass paddock ($5m^2$/bird). At night birds were confined to indoor pens. All birds were fed ad libitum. The nutrient contents of diets were adjusted to requirements of SG birds.

During the experiment live-weight measurements started with one day old broiler chicks and were then continued in a bi-weekly rhythm. Broilers were slaughtered at ages of 6, 9 and 12 weeks. For example, 50 per cent of the FG broilers (Ross 708) were slaughtered at the age of 6 weeks and the remaining at 12 weeks to compare meat quality with market weight on the one hand and age-effects in comparison with SG broilers (Isa 757) on the other hand.

Criteria of meat quality

The pH value and electrical conductivity were measured 15 minutes and 24 hours *post mortem* in the cranial part of the breast muscle (*Pectoralis major*) with digital pH-meter Testo 206 (Testo, Lenzkirch, Germany) and Conductometer WTW LF 191 (WTW, Weilheim, Germany), respectively. After 24 hours, color parameters (L*, a*, b*) of muscle *Pectoralis major* were determined using photometer color-guide 45/0 (byk-Gardner, Geretsried, Germany) according to the CIE-L*a*b* Colour System.

Cooking losses were estimated as percentage of weight loss during heating of samples to core temperature of 85°C. The cooked muscles were also used for texture measurements (Warner-Brazler Shear Tool). Texture measurements were done with an Instron Modell 5565 and with a head speed of 200 mm/min rectangular to the fibre direction.

Water holding capacity (WHC) was analysed with a modified method according to Grau and Hamm (1957).

Sensory Test

A triangle test was used to differentiate the taste of the meat from different treatments according to recommendations of WPSA (1987). Ten untrained sensory panelists assessed the samples. For sensory test chicken thighs without skin and bones were cooked in aluminium foil in a preheated oven at 180°C to core temperature 90°C. Meat was cut transversely into small slices. Panelists were presented a plate of samples, each plate was composed of three capped cups that contained cooked meat samples. Two of the three cups had the same content. Panelist were asked to taste the samples, select the different one and evaluate which one had the more typical chicken meat flavour.

Out of 10 panelists 4 answers had to be correct to get a significant ($P < 0.05$) difference (DIN 10953). The answer was counted as correct if the testperson detected the different sample in both plates (replication).

Four factors were tested with a replication by each panelist:

comparison of genotypes (FG vs MG, FG vs SG, MG vs SG),

comparison of diets (conventional vs organic),

comparison of free-range (with access vs without access) and

comparison of age (6 wk vs 12 wk, 9 wk vs 12 wk)

While one factor is tested the three other ones remain identical. A last sensory test was done with all factors together. Six weeks old FG broilers fed with conventional diets and without access to free range were compared with organic fed 12 weeks old SG broilers with access to free-range (extreme-test).

Statistical Analysis

Data analysis was done by three-factorial MANOVA using the statistical program JMP® version 8.0 (SAS Institute, Cary, NC).

Results

Meat Quality

In a first step, all breeds were compared with same slaughter age of 12 weeks.

After 12 weeks rearing average life weight was 4.9 kg for FG broilers, 3.7 kg for MG broilers and 2.1 kg for SG broilers. The effects of genotypes on meat quality are presented in Table 1. As expected, cooking losses were significantly ($P<0.05$) higher for FG broilers than for MG

and SG broilers. SG birds showed a better water holding capacity (WHC) than FG broilers and the meat was significantly darker. Furthermore, pH_{15}-value for FG broilers (6.45) was significantly higher than for SG broilers (6.29). Genotype did not significantly influence texture measurements, but there was a tendency for more tender meat in MG broilers than in other breeds.

Table 1. Effect of genotype on cooking loss, WHC and colour

	FG	MG	SG
Cooking loss (%)	25.9[a]	20.4[b]	18.9[c]
WHC (meat area/total area)	0.47[b]	0.56[a]	0.54[a]
L*	56.7[a]	56.4[a]	54.2[b]
a*	-2.6[b]	-3.2[c]	-2.2[a]

[a,b,c] Means within a row with differing superscript are significantly different ($P < 0.05$)

Table 2 presents the effects of diets. Birds fed with conventional diet showed significantly higher cooking losses, whereas, organic feed resulted in better water holding capacity (WHC). Meat of broilers fed with conventional diet was significantly paler and less red than from broilers fed with organic diet, whereas, meat from birds fed with organic diet was slightly more yellow. Access to free-range did not influence carcass and meat quality significantly.

Table 2. Effect of diet on cooking loss, WHC, texture and lightness

	Conventional diet	Organic diet
Cooking loss (%)	22.5[a]	20.9[b]
WHC (meat area/total area)	0.52	0.54
Texture (N)	26.2	24.5
L*	56.6[a]	54.9[b]

[a,b] Means within a row with differing superscript are significantly different ($P < 0.05$)

As expected, FG broilers slaughtered at 12 weeks of age showed significantly higher cooking losses and texture values (Table 3) than when slaughtered at 6 weeks of age. But WHC-values were almost identical for both ages (0.47). No clear effects were observed for pH-values.
Meat of younger FG broilers was significantly darker and a*-value was higher.
Meat of MG broilers (slaughter age 9 and 12 weeks) nearly showed the same age effects.

Table 3. Effect of different slaughter ages on cooking loss, texture and colour measurements

	FG (6 weeks)	FG (12 weeks)
Cooking loss (%)	22.1[b]	25.9[a]
Texture (N)	22.5[b]	26.9[a]
L*	54.8[b]	56.6[a]
a*	-1.8[a]	-2.6[b]
b*	8.1	8.3

[a,b] Means within a row with differing superscript are significantly different ($P < 0.05$)

The comparison of meat of FG broilers slaughtered at 6 weeks of age with SG broilers at 12 weeks of age revealed significantly lower cooking losses and better WHC for the older broilers, whereas, in 6 weeks old FG broilers a significantly tender meat was observed. But there were no significant differences in meat colour.

Sensory

Significant sensory differences were noted for the factor free-range and slaughter-age (Table 4). Fifty and fourty percent of the panelists detected the individual sample from the triangle test, respectively, but there was no clear result, which meat was more tasty.

Panelists also detected significant taste differences in the extreme-test. In this case 6 week old FG broilers had a more typical chicken meat flavour than 12 weeks old SG broilers. Among the factors genotype and diet no differences were found.

Table 4. The compared factors with the number of correctly identified samples

Factor		Right answers (out of 10)
Genotype	FG vs MG	2
	FG vs SG	2
	MG vs SG	1
Diet	conventional vs organic	1
Free-range	with access vs without access	5*
Slaughter-age	6 weeks vs 12 weeks	4*
	9 weeks vs 12 weeks	0
Extreme-test	FG 6 weeks vs SG 12 weeks	5*

* significant difference ($P < 0.05$)

Discussion

Genotype mainly affected meat quality. The higher cooking loss in breast meat of FG broilers is due to the reduced WHC of the bigger meat parts. Furthermore, there have been no significant differences in pH-values, which might indicate that the differences in the WHC of the meat were more related to a physical than to a pH-induced effect.

The meat of FG broilers was more tender than meat of SG broilers as indicated by lower shear force values. According to Fletcher (2002), differences in tenderness may be due to the fact that older birds have more cross-linking of collagen.

Meat of birds with access to free-range did not differ from meat of birds without access to free-range. This is in accordance with Dou *et al.* (2009) and Fanatico *et al.* (2005) who demonstrated that production systems had no effect on tenderness of meat. However, Castellini *et al.* (2002a) showed that meat of broilers raised with access to free-range was firmer, presumably as a consequence of their greater locomotor activity.

Access to free-range had an impact on broiler meat flavour, whereas genotype and diet did not influence flavour. This is in contrast to Fanatico *et al.* (2006) who did not find effects of production systems on liking of flavour. But previous research reviewed by Farmer (1999) has shown that the impact of production system varies where free-range production results in either no change in flavour or an increase in flavour intensity.

Jahan *et al.* (2004) revealed that meat from conventionally reared broilers was perceived by consumers as more tender than meat of organically reared ones. In accordance with this study sensory differences were also found in the extreme test where panelists preferred meat of 6 week old FG broilers. One possible explanation for this consumer preference is a long-term consumption experience of soft conventional broiler meat. Consumers are accustomed to this meat what may cause a resistance to the firmer texture of organic broiler meat (Fanatico *et al.*, 2006).

In conclusion the results clearly show, that meat quality characteristics were mainly influenced by genotype and diets, whereas, husbandry systems had only a minor effect on these quality criteria.

Genotype and diet had only a little impact on the sensory attributes of the meat, but access to free-range had a greater impact. However, the sensory testing demonstrated the difficulty for untrained panelists to detect differences in meat flavour.

Abstract

Consumer interest in the quality attributes of organic food (including organic chicken meat) is growing. Therefore, an experiment was conducted to analyse the effects of genotype, feeding and access to free range on meat quality and sensory attributes.
Three different genotypes were used: fast growth (Ross 708; FG), medium growth (Isa 657; MG), slow growth (Isa 757; SG). Of each genotype 20 birds were assigned to one group. The groups were kept without or with access to free range and were fed on conventional or organic diets. Overall 3 trials were conducted with a total number of 720 broilers. After slaughtering and maturation of the meat several quality criteria were investigated. For sensory test (triangle test) only thighs were used. A 10-member untrained panel assessed the samples.
At 12 weeks of age cooking loss was higher and water holding capacity was lower for FG broilers. Organic feed resulted in reduced cooking loss and increased water holding capacity.
Meat of SG broilers and meat of broilers fed on organic diet was darker and more yellow. Sensory differences were noted for FG broilers fed with conventional diet compared to broiler fed on organic diet, whereas, FG broilers were assessed as more tasty.

Keywords: Broiler, genotype, organic feeding, meat quality, sensory

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