Improved texture of breast meat after a short finishing feeding period of broilers in an organic free-range system

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In order to develop an organic broiler product with high ethical value, high meat quality and based on locally produced feed, we tested if a long period without high quality protein feed followed by a finishing period with a high quality protein ration would affect the meat quality. Two genotypes were included in the experiment (The Hubbard breed 'JA757' and the Sasso breed 'T851'), and only female broilers were included. The chickens were raised in groups in a free range system with more than 10 square meters per chicken covered with grass and herbs. The chickens were offered free access to either an optimized organic concentrate ration (HP) or an organic ration based on locally produced ingredients (peas, rapeseed, lupine, wheat and oat) (LP). The broilers were slaughtered at 90 days (HP) or 118 days (LP). At 90 days the LP broilers were allocated to the high quality protein ration (HP) for either four weeks (LP4) or two weeks (LP2) before slaughter. At slaughter the JA757 HP broilers were the heaviest (2827 g), and the JA757 LP broilers were not able to catch up after either 2 or 4 weeks finishing feeding with the HP ration (2248 g and 2292 g, respectively). This was different for the T851 genotype where there was no difference in slaughter weight between the T851 HP and LP2 and LP4 (average 1592 g). A sensory panel evaluated the sensory quality of the breast meat and found less firmness and fibrousness, lower chewing time and more tenderness in both genotypes offered high quality protein feed in the finishing feeding for 2 weeks in comparison with the 4 weeks finishing feeding, with the HP in between. This pattern is reflected in the daily gains the last two weeks before slaughter and suggests a positive linkage between daily gain before slaughter and tenderness post mortem.

Keywords: **chicken; meat quality; tenderness; compensatory growth; feeding strategy**.

Introduction

The market share of organic broilers is below 1 % in Denmark, whereas the average organic marked share of basic food is around 7 % and still increasing. One of the reasons is the higher premium price necessary to cover the high production cost of organic broilers. Consumers link high eating quality with the organic label (Castellini et al., 2008; Marian and Thøgersen, 2013), thus to fulfil the consumer expectations the production process need to lead to high eating quality. At the same time organic broiler production is also associated with free range, high animal welfare and use of locally-produced feed. In some cases a fulfilment of these expectations may counteract the aim of high eating quality, as e.g. slow growth, which could be obtained by using slow growing genotypes or by allocating feed with a poorer amino acid profile. Slow growth resulting in a higher age of slaughter may cause less tender meat compared with e.g. conventional produced broilers having a considerable faster growth rate (Castellini et al., 2002; Sirri et al., 2011, Horsted et al., 2012). On the other hand a fast growth rate can be associated with animal welfare problems, such as dermal lesions and poor gait score (Nielsen et al., 2003; Sørensen et al., 2000). In the production of beef and pork the compensatory growth strategy has been shown to have a positive effect on tenderness development post mortem (Kristensen et al., 2004; Therkildsen et al., 2011), though a stimulation of protein turnover prior to slaughter. This strategy could also be introduced in organic broiler production, in order to obtain a high eating quality without compromising the ethical value traits.

In the present study we tested if a long period without high quality protein feed followed by a finishing period with a high quality protein ration would affect the meat quality.

Materials and methods

Two genotypes were included in the experiment (Hubbard JA757 and Sasso T851), and only female broilers were included in the sensory assessment. The chickens were raised in groups in a free range system with more than 10 square meters per chicken covered with grass and herbs. Two feeding strategies were included in the study, one of which (HP) is applied in practice, i.e. a pelleted organic standard feed (main ingredients: 38% wheat, 22% soy cake, 21% maize, 8% peas, 4% toasted soy beans and 2% rapeseed cake) and whole wheat (separate silos). In the second feeding strategy (LP), chickens were offered a choice feeding strategy based on 3 locally produced protein crops (coarsely grounded peas and lupins and whole rape seeds) and whole wheat, whole oats and lime stone in separate silos.

The broilers were slaughtered at 90 days (HP) or 118 days (LP). At 90 days the LP broilers were allocated to the standard feed (HP) for either four weeks (LP4) or two weeks (LP2) before slaughter. The broilers were weighed every second week.

The chickens were caught in the late evening and transported in crates to the slaughterhouse (2½ h) during the night, and slaughtered in the early morning. The broilers were slaughtered and bled, followed by scalding in water before the feathers were removed in the plucking machine. The carcasses were subsequently eviscerated and hung up in a cold storage room at 4°C until next day. Twenty-four hours post mortem the carcasses were weighed and 16 carcasses were randomly chosen from each combination of genotype and feeding strategy and used for the meat quality analyses.

The pH was measured in *M. pectoralis major* (PM) from 8 carcasses of each combination with a PHM201 pH meter (Radiometer, Denmark) equipped with Metrohm probe type glass electrode WOC (Metrohm, Switzerland). The electrode was calibrated in pH 4.01 and 7.00 IUPAC buffers equilibrated to 4°C. Percentage drip loss was determined as described by Young et al. (2004) over 48 h in PM. From 8 carcasses both breast filets were cut off, vacuum packed and stored at -20°C until sensory analysis.

The sensory evaluation was done by an 8 membered trained panel at Danish Meat Research Institute, Roskilde, Denmark (ASTM-MNL 13, ISO 4121 and ISO 13299). The filets were defrosted at 4°C for 18 h, and placed in roasting bags and heated in a convection oven at 150°C until the internal temperature reached 72-75°C measured with a handheld probe. The filets were cut in 4 slices, and the assessor always received the same section of the filet for each assessment. The panel evaluated aroma, colour, taste and texture traits on a continuous scale from 0 (no intensity) to 15 (high intensity).

Data was analysed using the mixed model in the Statistical Analysis System version 9.2 (SAS Institute, Cary, NC, USA), with the fixed effects of genotype (JA757 and T851), finishing strategy (HP, LP2 and LP4) and the interactions. For the analysis of the sensory data the model also included assessor as a random effect.

Results and discussion

At slaughter the JA757 HP broilers were the heaviest (2827 g), and the JA757 LP broilers were not able to catch up after either 2 or 4 weeks finishing feeding with the HP ration (Table 1 and Figure 1). For the T851 genotype there was no difference in slaughter weight between the T851 HP and LP2 and LP4 (average 1592 g). The daily weight gain is shown in Figure 2, and it is very characteristic that the LP2 broilers show a very large gain in the final 2 weeks before slaughter, whereas the LP4 broilers have a large gain right after their change to the HP ration, but after 4 weeks on this diet the daily gain decreases again. Ultimate pH and drip loss is shown in Table 1. JA757 on 2 weeks HP had higher ultimate pH than the other broilers and also a larger drip loss. The ultimate pH can be affected by stress level at slaughter as also discussed by Castellini et al. (2002), however usually higher pH would be related to less drip loss (Young et al., 2004).

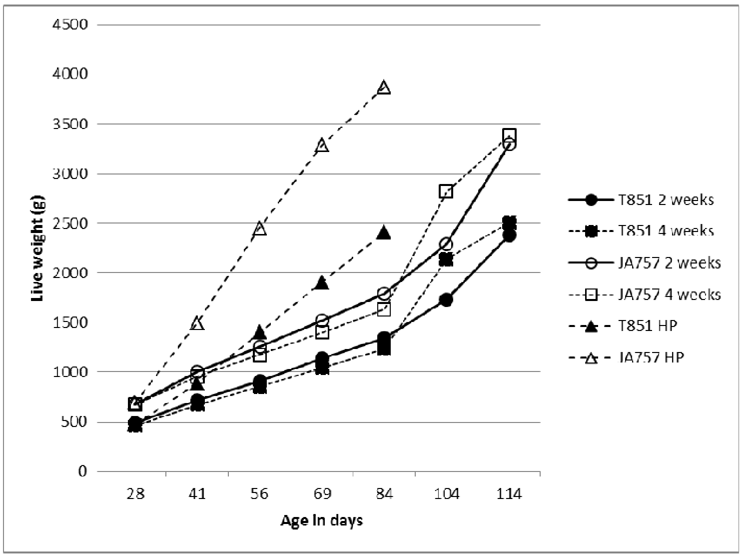

Figure 1 Live weight of JA757 and T851 broilers on three different feeding strategies

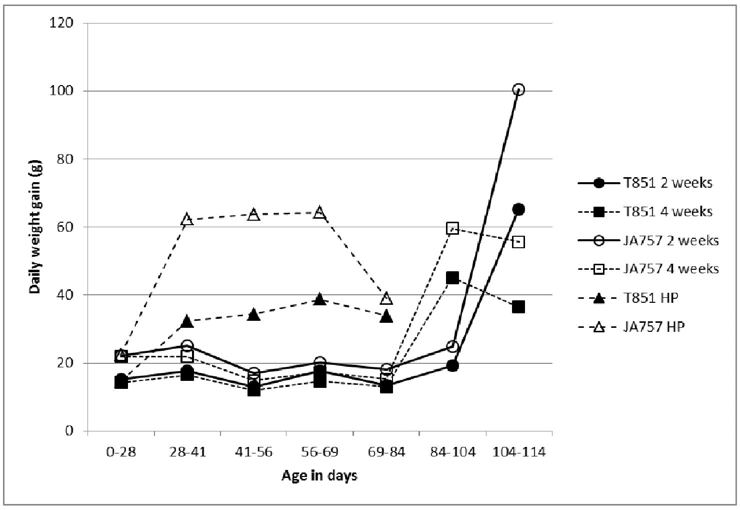

Figure 2 Daily gain of JA757 and T851 broilers on three different feeding strategies

Table 1 Slaughter weight, pH 24 h post mortem and drip loss in breast filet from JA757 and T851 broilers fed three different feeding strategies

Genotype (G)	**JA757**			**T851**			**SEM**	**P-value**		
Feeding strategy (F)	**HP**	**LP2**	**LP4**	**HP**	**LP2**	**LP4**		**G**	**F**	**GxF**
Age at slaughter, d	90	118	118	90	118	118				
Slaughter weight, g	2827[a]	2248[b]	2292[b]	1618[c]	1555[c]	1600[c]	61	0.001	0.001	0.001
pH 24 h post mortem	5.83[b]	6.11[a]	5.81[b]	5.81[b]	5.78[b]	5.84[b]	0.05	0.005	0.02	0.001
Drip loss, %	1.36[b]	2.56[a]	1.53[b]	1.56[b]	1.45[b]	1.60[b]	0.28	0.22	0.12	0.05

a,b,c Means with different superscript in the same row are significantly different ($P < 0.05$).

The sensory evaluation of the breast filet is shown in Table 2. The chicken and sweetness aroma and chicken taste was more intense in the JA757 genotype, and the meat was more gray and less yellow compared with the T851 genotype. Finishing feeding for 4 weeks resulted in more gray meat, and less sweet flavor in contrast to the two other finishing strategies. Otherwise genotype and finishing feeding did not affect any taste characteristics. In contrast texture traits were affected both by the genotype and the finishing strategy. JA757 was less tender, but more firm and fibrous, and the chewing time was increased compared with the T851 genotype. Variation between genotypes in final texture traits has also been demonstrated by Horsted et al. (2005; 2010), who showed that age is not always the main factor determining the texture. On the other hand the present experiment showed that finishing feeding is important for the final texture. The panel found less firmness and fibrousness, a lower chewing time and more tenderness in filet from both genotypes offered the finishing feeding for 2 weeks in comparison with the 4 weeks finishing feeding, with the HP in between. This pattern is reflected in the daily gains the last two weeks before slaughter (Figure 2) and suggests a positive linkage between daily gain before slaughter and tenderness post mortem related to the degree of proteolysis at the time of slaughter as discussed by Castellini et al. (2008).

Table 2 Sensory profiling of breast filet from JA757 and T851 broilers feed three different feeding strategies

Genotype (G)	JA757			T851			SEM	P-value		
Feeding stategy (F)	HP	LP2	LP4	HP	LP2	LP4		G	F	GxF
Age at slaughter, d	90	118	118	90	118	118				
Cooking loss	16.8	18.1	17.4	15.1	14.9	14.9	1.2	0.02	0.89	0.81
Aroma										
Chicken	6.1	5.3	6.5	4.9	4.9	4.5	0.4	0.001	0.51	0.16
Sweet	3.8	3.3	3.1	2.9	3.1	2.9	0.2	0.02	0.20	0.20
Colour										
Yellow	1.0	2.0	1.1	3.4	3.7	3.3	0.4	0.001	0.24	0.62
Grey	2.9	2.9	3.6	1.7	1.8	2.0	0.2	0.001	0.03	0.56
Taste										
Chicken	7.3	6.4	7.4	6.0	5.6	5.6	0.4	0.001	0.23	0.42
Acid	4.1	4.4	4.2	4.2	4.3	4.5	0.2	0.54	0.57	0.69
Sweet	3.2	3.2	2.8	3.4	3.1	2.9	0.1	0.53	0.01	0.48
Bitterness	3.6	4.0	3.4	3.6	3.6	3.8	0.2	0.66	0.36	0.10
Metal	2.4	2.5	2.2	2.4	2.5	2.3	0.2	0.66	0.43	0.95
Cardboard	1.9	1.7	1.4	2.2	1.8	2.0	0.2	0.10	0.25	0.57
Texture										
Firmness	7.4	6.0	6.7	5.4	4.5	5.9	0.4	0.001	0.005	0.22
Tenderness	7.6	8.5	7.8	9.0	9.1	8.4	0.4	0.01	0.14	0.48
Fibrousness	4.8	4.1	4.9	3.2	3.3	4.3	0.4	0.002	0.06	0.25
Chewing time	7.5	6.4	7.3	5.7	5.4	6.4	0.3	0.001	0.005	0.27
Juiciness	5.5	6.0	5.8	5.3	5.8	5.2	0.4	0.34	0.38	0.87

Conclusions

Not only genotype but also growth rate is important for the final meat texture in broilers. The present experiment shows that texture of breast filet can be optimised in broilers raised on locally produced protein sources with a short period of 2 weeks with free access to an optimised organic feed, and suggests that compensatory growth in broilers can be used to optimise the final texture of the meat.

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