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ORIGINAL ARTICLE

Growth and sensory characteristics of organically reared broilers differing in strain, sex and age at slaughter

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Abstract

The effects of strain, sex and age on live weight, slaughter weight and sensory characteristics of organically reared broilers in orchards are presented. A total of 450 broilers of three different strains (I 657, Light Sussex, New Hampshire) were reared in an organic research orchard. Half of each strain was slaughtered at 91 days and the other half at 120 days. All broilers were weighed and a clinical welfare assessment was made at slaughter. A trained sensory panel evaluated the breast meat in relation to flavour, smell and texture characteristics defined by the panel. At both 91 and 120 days of age the commercial breed I 657 was significantly heavier than the slower growing strains. Males were significantly heavier than the females across strains. Weight ratios between males and females were nearly the same at both slaughter ages in I 657, whereas weight ratios increased significantly at 120 days in Light Sussex and New Hampshire. No overall effect of strain was found on the flavour and smell of the breast meat. However, the age-related changes in tenderness and toughness differed significantly between strains, since the commercial strain tended towards a tougher and less tender consistency with age, whereas the opposite was the case for the slower growing pure breeds. The positive flavour of salt was significantly improved at 120 days across strains with females having a saltier flavour than the males with age. The positive flavour of sweet corn was improved in the meat from the males, whereas the positive smell of sweet corn was significantly improved in both males and females. No negative effects of age were found. In conclusion, broilers were tastier when slaughtered at 120 days compared with 91 days. The development in meat tenderness was related to strain, and weights at slaughter were related to both strain and sex.

Keywords: *Age, broiler production, strain, live weight, orchard, organic production, sex, sensory characteristics, slaughter weight.*

Introduction

Since very few artificial pesticides are allowed in organic fruit production, the need for an alternative pest control is considerable. It has been demonstrated that the co-rearing of chickens in an orchard is an opportunity to control weeds and pests (Clark & Gage, 1996; Pedersen et al, 2004). The chickens are, however, most efficient as pest controllers in the orchard when they reach the normal slaughter weight for organic broiler chickens at the age of approximately 81 days. For this reason it may be desirable to keep the chickens longer in the orchard. This may not be desirable for conventional broiler strains that are selected for their growth capacity and earlier maturing, and consequently are prone to different kinds of health problems such as dermal lesions and poor gait score (Bokkers & Koene, 2003; Nielsen et al., 2003; Sørensen et al., 2000). There is also a risk of deteriorating meat quality. Nielsen et al. (2003) found deep pectoral myopathy in some fast- growing ROSS birds reared outdoors that had been slaughtered at 84 days of age. Slow-growing chickens have also been found to be more active in an outdoor area compared with fast-growing chickens (Bokkers & Koene, 2003; Nielsen et al., 2003) and for that reason presumably better as pest controllers in the orchard. Thus, for a number of reasons it is relevant to consider breeds or strains that are slower growing than the strains normally used in organic broiler production.

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However, it is uncertain how the sensory characteristics of these slower growing chickens will develop under such circumstances compared with the traditional strains in organic broiler production. Castellini et al. (2002) found highly tender meat in both conventional and organic broilers but it decreased with age (56–81 days). A sensory panel test gave significantly higher scores for juiciness and overall acceptability for the breast muscles from organic broilers. In contrast, Lawlor et al. (2003) did not find any evidence that broiler breast meat from an organic source tasted better than free-range or conventionally produced broilers.

Even though several studies have identified growth and health characteristics for broilers intended for slaughter at approximately 80 days (Bokkers & Koene, 2003; Castellini et al., 2002; Quentin et al., 2003, 2005; Nielsen et al., 2003), very little has been published on these aspects for broilers that are even slower growing and have a longer growth period.

Against this background, the aim of this study was to investigate the effect of age at slaughter of three different strains of broilers kept in an orchard on the sensory characteristics of the broiler meat, weight gain and welfare characteristics.

Materials and methods

Genotypes and rearing of experimental birds

Three strains were used, the commercial strain I 657, which is almost the only strain used in commercial organic broiler production in Denmark and two slow-growing breeds, Light Sussex and New Hampshire. The chickens were hatched at the Danish Institute of Agricultural Sciences and reared for the first five weeks at an organic producer of fruit and broilers. All strains were reared in the same flock and had, from one week of age, access to an outdoor area with apple trees and a low protein food mixture produced on-farm composed of rapeseed cake, barley, oats, wheat, lupins, peas, calcium carbonate and mono calcium phosphate.

Experimental design

The chickens were moved to Fejoe Research Orchard on 1 July 2003 at five weeks of age and randomly, within strain, allocated to one of ten plots ranging from 304 to 388 m^2 in area. Five plots had apple trees and five plots pear trees and each plot had five rows of trees with ten trees to a row. Fifteen chickens of each strain, i.e., a total of 45 chickens were placed in each plot. Average weights at grouping were 482 g, 284 g and 260 g for I 657, New Hampshire and Light Sussex, respectively. The chickens had access to a chicken house with perches while feed and water were given outside the house.

At 91 and 120 days of age, respectively, half of the broilers were slaughtered. The broilers were caught in the morning before sunrise while they were still sitting on perches inside the houses, and kept in transport crates until they were slaughtered during the morning at the orchard without any further transport. After the chickens had been slaughtered and bled, the carcasses were placed in a vat with scalding water to ease the feather plucking in a plucking machine. The chickens were then placed in a vat with cooling water and subsequently eviscerated. The carcasses were then weighed and stored in a freezer at −18°C. Two weeks after the last slaughtering, 10–16 carcasses of each group (strain × sex × age) according to carcass weight were transported to the Sensory Laboratory at the Royal Veterinary and Agricultural University in Copenhagen where they were stored at −18°C until the sensory assessment took place one week later.

Feeds, feeding and recordings on live birds

During the experimental period at Fejoe Research Orchard the feed consisted of a commercial concentrate mixture of wheat, barley, oats, sunflower cake, fishmeal, peas, wheat bran, grass meal, calcium carbonate, mono calcium phosphate, vitamins and rock salt, containing 160 g crude protein, 7 g lysine, 3.1 g methionine, 3.0 g cystine total and 11.1 MJ ME per kg feed. The crude protein and total amino acid concentration was reduced compared with the traditionally used starter and grower feeds for organic broiler chickens containing 21% and 18% crude protein, respectively, because the chickens should be stimulated to forage in the orchard and thus receive their protein in the form of insects, larvae and grass-clover in the plantation. Feed and water was given *ad libitum* outside the chicken house.

Feed consumption was recorded for each pen. On three days in July and three days in August the number of birds of each genotype in each pen that were more than 2 m away from the house were monitored once in the morning (7–10 am) and once in the afternoon (2–3 pm). Live weight and slaughter weight of each bird were recorded at slaughter, and a clinical welfare assessment was carried out at the same time. This included an evaluation of foot health, keel bone, colour and wounds of the comb and the plumage condition using the standardized methods described by Gunnarson et al. (1995) and Tauson et al. (1984). At each day of slaughter, samples from the cloacae of 60 randomly chosen birds were taken and analysed for Salmonella.

Sensory assessment

Cooking of the samples. Carcasses were thawed at a low temperature (5°C) for 24 h before the carving up that began 2 h before the assessment. Samples of breast meat were put into separate foil trays, covered and placed in a refrigerator until roasting the same day in 180°C pre-heated fan ovens. The samples were taken out of the ovens 1 min before serving and cut into ten pieces, ensuring that each judge in the panel received the same part of the samples for each assessment (ASTM, 1986; ISO, 1988).

Sensory method. The sensory profiling of the breast meat was made by a trained sensory panel consisting of two men and eight women at the Sensory Laboratory at the Royal Veterinary and Agricultural University in Copenhagen. A preliminary test was made to determine the cooking time of each sample. From each group a representative sample was roasted to a core temperature of 75°C and from this the cooking time was calculated.

The panellists in the sensory panel were trained on three successive days. On the first day of training, the samples were served in pairs so that the same strain and sex but different ages at slaughter were presented simultaneously. The panellists recorded taste sensations and defined the characteristics. On day two of training, the panellists were presented with samples from all 12 treatments (strain × sex × age) one at a time. The defined characteristics from day 1 were discussed and the characteristics of the samples were graded on a 15 cm open scale from low to high degree of the individual characteristics. Finally, the characteristics were discussed again, including whether the characteristics were perceived as positive or negative. On day 3 of training, the panellists were served three samples plus reference samples consisting of 'liver roasted in oven', 'pork chop roasted in oven', 'chicken bouillon dissolved in water (strong)', 'chicken bouillon dissolved in water (weak)', 'bunch of potherbs boiled with carrot, leek and celeriac', 'maize water from tin blended with water' and 'smoky cotton cloth'. After a short break the panellists were served a further six samples of breast meat that were evaluated on a 15 cm open scale for the characteristics shown in Table I. As part of the objective vocabulary development sessions, panellists assigned the term positive or negative to each descriptor to enable a subsequent subjective interpretation of the sample characteristics.

After the training, each member of the sensory panel assessed samples of all combinations of strain, age and sex on three successive days following a new preparation, i.e., one assessment/replication daily for three days. The panellists had the samples served in

Table I. Specifications of characteristics (positive and negative) used in the training of the sensory panel and for the final assessment.

Smell	
Chicken (positive)	Smell of fresh chicken meat
Sweet/maize (positive)	Sweetish smell of e.g. maize water from tinned maize
Greenery (positive)	Smell of greenery e.g. grass, apples, carrots
Bouillon (positive)	Smell of chicken bouillon
Neck of pork (negative)	Smell of neck of pork cut into chops and roasted in oven
Sourish (negative)	Smell of sourish chicken meat
Flavour	
Chicken (positive)	Flavour of fresh chicken meat
Sweet/maize (positive)	Sweetish flavour of e.g. maize water from tinned maize
Greenery (positive)	Flavour of greenery e.g. grass, apples, carrots
Bouillon (positive)	Flavour of chicken stock cube
Salt (positive)	Flavour of salt
Neck of pork (negative)	Flavour of neck of pork cut into chops and roasted in oven
Fat (negative)	Flavour of chicken fat
Iron/liver (negative)	Flavour of iron/softly roasted liver roasted in oven
Sourish (negative)	Flavour of sourish chicken meat
Smoked (negative)	Flavour of smoke
Texture	
Tenderness (positive)	The extent of tenderness in the sample
Juiciness (positive)	The extent of meat juice which come out during chewing
Softness (positive)	The extent of softness in the sample
Hardness (negative)	The extent of hardness in the sample
Sticking (negative)	The extent of a sticking sensation from the sample
Crumbling (negative)	The extent of a crumbling sensation in the sample
Stringy (negative)	The length of shreds of meat in the mouth during chewing
Toughness (negative)	The extent of toughness in the sample

the same order, but the order varied between the three replications. All samples were evaluated at aforementioned 15 cm unstructured scale (ISO, 1991, 1992, 1993). The average of the assessments of the ten panellists was used in the statistical analysis.

Statistical methods

The analysis on weight and sensory characteristics was carried out as a $3 \times 2 \times 2$ arrangement of strain (I 657, New Hampshire, Light Sussex), sex (males and females) and age at slaughter (91 days and 120 days). The data were analysed by analysis of variance using the General Linear Models procedure (SAS Institute Inc., 1990) by the following model:

$$Y_{iikl} = \mu + \alpha_i + \beta_j + \gamma_k + (\alpha\beta)_{ij} + (\alpha\gamma)_{ik} + (\beta\gamma)_{jk} + (\alpha\beta\gamma)_{ijk} + \varepsilon_{ijkl}$$

where Y_{ijkl} = sensory characteristics, live and slaughter weight; μ = mean; α = strain ($i = 1,3$) β = sex ($j = 1,2$); γ = age at slaughter ($k = 1,2$) $(\alpha\beta)_{ij}$ = interaction of strain and sex; $(\alpha\gamma)_{ik}$ = interaction of strain and age at slaughter; $(\beta\gamma)_{jk}$ = interaction of sex and age at slaughter; $(\alpha\beta\gamma)_{ijk}$ = interaction of strain, sex and age at slaughter; ε_{ijkl} = random error.

The number of birds of each genotype in each pen that were more than 2 m away from the house was estimated by a χ^2 test.

Results

No type of Salmonella was found in the cloacae samples at slaughter. The mortality rate was 5% and cause of death was mainly attacks by sea gulls in the first weeks after grouping in the orchard. A few died because of transport injuries. There were no deaths due to disease. All broilers were given maximum scores for plumage condition and foot health and none had skin lesions or keel bone deviations. Some of the female broilers, especially the Light Sussex females, were given a minor reduction in score for the colour of the comb. This was, however, not due to poorer health or welfare but because the comb was not particularly well developed at this stage. A very few of the I 657 males had at the age of 120 days smaller wounds at the comb. This was probably due to the fact that they had reached sexual maturity and for that reason started pecking each other.

The Light Sussex strains were better at using the entire area compared with the two other strains. During six censuses in July and again in August, the proportion of Light Sussex staying more than 2 metres from the house was 37.4% in July versus 21.8% and 23.0% for I 657 and New Hampshire, respectively (χ^2 68.9; df = 2, $p < 0.001$), and 34.3% in August versus 27.3% and 27.8% (χ^2 25.7; df = 2, $p < 0.001$).

Feed consumption, live weight and slaughter weight

The experimental design did not allow recordings of feed intake separately for the respective strains. The overall feed consumption from grouping at 35 days of age to the first slaughtering at 91 days of age was 115 g/broiler daily. In the period from 91 days of age to 120 days of age the feed consumption was also 115 g/bird per day. Since feed was given outside, consumption of feed by wild birds cannot be ruled out.

Live weight at slaughter and carcass weight were significantly affected by strain, age, sex and age × sex, strain × sex, as well as the three-sided interaction sex × strain × age. Table II shows the live weights and carcass weights.

As expected, I 657 was significantly heavier than the pure breeds. We also found that all strains continued to grow well in the period from 91 days to 120 days of age. Thus I 657, New Hampshire and Light Sussex were, respectively, 24.8%, 38.7% and 40.0% heavier at 120 days of age. However, as indicated by the significant interaction between

Table II. Live weight and slaughter weight of different strains and sex at different ages, LS-means (SEM), g/bird.

	New Hampshire		I 657		Light Sussex	
	Live weight	Slaughter weight	Live weight	Slaughter weight	Live weight	Slaughter weight
Males						
91 days	1639 (31)	1073 (24)	2590 (28)	1867 (22)	1764 (30)	1168 (23)
120 days	2406 (30)	1623 (23)	3257 (28)	2430 (22)	2671 (34)	1851 (27)
Females						
91 days	1331 (34)	870 (27)	1957 (28)	1399 (22)	1432 (39)	939 (30)
120 days	1714 (44)	1168 (35)	2417 (37)	1776 (29)	1804 (46)	1225 (36)

Significant effects: Strain $p < 0.0001$; age $p < 0.0001$; sex $p < 0.0001$; sex × age $p < 0.0001$; strain × sex $p < 0.0001$; strain × sex × age $p < 0.05$.

Table III. Calculated ratio between male and female live weights for each strain at different ages.

	Weight ratio	
	91 days	120 days
New Hampshire	1.23	1.40
I 657	1.32	1.35
Light Sussex	1.23	1.48

sex × age and strain × sex × age, male chickens grew faster in this period, particularly the male chickens of Light Sussex and New Hampshire. Table III shows that the male chickens of these slow growing strains were 40–48% heavier than the females at 120 days compared with 23% at 91 days of age, whereas the weight ratio of male to female chickens of I 657 was nearly the same at both times of slaughter. The average weight gain per day from 91 days of age to 120 days of age varied from 12.8 g to 31.3 g, with the Light Sussex males having the largest weight gain and the Light Sussex and New Hampshire females having the lowest weight gain.

Sensory characteristics

Physical characteristics. To illustrate the relative importance of the independent factors on the physical characteristics, the sources of variance in relation to physical characteristics are given in Table IV.

The crumbly, juicy, sticky and stringy characteristics were not significantly affected by any of the factors investigated. The major source of variance for softness was breed, whereas the major sources of variance for hardness, tenderness and toughness were interactions between strain and age. The least square means of these characteristics are given in Table V for each breed and age.

Light Sussex was found to be the least tender and soft as well as tougher compared to the two other strains. This result was, however, mainly due to the assessment of Light Sussex at the age of 91 days, since at 120 days the results were comparable to the results for I 657, but still poorer than New Hampshire (Table V). It is notable that we found significant differences in the development of the physical characteristics with age of the different strains. Where the breast meat from I 657 tended to be tougher and of a harder consistency with age, the opposite was the case for the New Hampshire and Light Sussex breeds.

Flavour and smell. Table VI gives the mean values and the sources of variance for flavour and smell.

The flavours bouillon, chicken, fat, greenery, neck of pork, smoked, and sourish were not significantly affected by the variables in the model. It should be noted that, apart from the flavours bouillon, chicken and greenery, these characteristics were determined with a comparatively huge random error, the coefficient of variation being more than 35%. The major source of variation of the positive flavour 'salt' was sex, whereas the major source of variation of the positive flavour 'sweet corn' was age interacting with sex.

As regards smell, only the positive smell 'sweet corn' was significantly affected by the factors investigated. The least square means of the significant effects are given in Table VII.

The positive flavour of salt was significantly improved at the age of 120 days compared with 91 days across strains and sexes. Moreover, the flavour of salt was significantly better in the meat from the females compared with the males from all strains and ages.

The positive flavour of sweet corn was significantly improved in the meat from the males at 120 days compared with 91 days of age, whereas no improvement was found in the hens, suggesting that males

Table IV. Mean values and sources of variance of physical characteristics of breast meat ($n = 36$).

	Mean Squares								
Dependent variable	Mean	Strain	Sex	Age	Strain × sex	Strain × age	Sex × age	Strain × sex × age	Error
Texture									
Crumbling	5.1	1.0	0.8	0.4	2.0	1.3	0.2	2.8	1.1
Hardness	4.8	2.8	0.9	1.4	1.9	5.4*	0.4	1.1	1.2
Juiciness	8.7	0.4	0	0	0.1	0.6	0.1	1.3	0.9
Softness	8.6	5.2*	0.2	0.8	2.3	2.8	0.1	1.3	1.3
Sticking	7.7	0.4	0	0	0.2	0.6	0.7	0.6	0.4
Stringy	4.2	0.6	3.9	0.1	2.3	3.7	0.4	0.3	1.5
Tenderness	9.9	5.0*	0	0.8	1.7	4.6*	0	0.6	1.0
Toughness	4.4	4.9*	0.2	0.1	1.7	8.9**	0.4	2.5	1.4

(* $= p \leq 0.05$, ** $= p < 0.01$)

Table V. Influence of strain and age on texture and physical characteristics, LS-means.

	Softness (positive)	Hardness (negative)	Tenderness (positive)	Toughness (negative)
Strain: (p)	$p < 0.05$	NS	$p < 0.05$	$p \approx 0.05$
New Hampshire	9.3	4.3	10.4	4.0
I 657 (Scan Labelle)	8.5	5.0	10.0	4.0
Light Sussex	7.9	5.2	9.2	5.1
Strain × age: (p)	NS	$p < 0.05$	$p < 0.05$	$p < 0.01$
New Hampshire:				
91 days	8.6	5.1	9.9	4.5
120 days	9.7	3.5	11.0	3.5
I 657 (Scan Labelle):				
91 days	8.8	4.5	10.5	3.0
120 days	8.1	5.5	9.4	4.9
Light Sussex:				
91 days	7.8	5.5	8.7	5.7
120 days	8.1	5.0	9.6	4.5

Each response variable is expressed on a scale from 0–15 where 15 corresponds to most pronounced.

obtain a sweeter flavour when reaching maturity. The positive smell of sweet corn was, however, significantly improved at 120 days of age for both males and females and across strains.

The negative characteristic flavour of iron/liver was significantly related to strain × age and strain × sex interactions, suggesting that there was a difference in how the strains developed over time. These interactions related to the New Hampshire and Light Sussex strains but had different directions. The flavour of iron diminished with age in Light Sussex, whereas the opposite was the case in New Hampshire. The Light Sussex female birds also tasted less of iron/liver than males, whereas the opposite was the case for New Hampshire.

Discussion

The clinical welfare assessment suggests an excellent welfare of the broilers when kept in an orchard, since maximum scores were given for nearly all characteristics.

Table VI. Mean values and sources of variance of flavour and smell of breast meat ($n = 36$).

	Mean Squares								
Dependent variable	Mean	Strain	Sex	Age	Strain × sex	Strain × age	Sex × age	Strain × sex × age	Error
Flavour:									
Bouillon	4.1	0.1	0.3	0	0.6	0.9	0.5	0.5	0.4
Chicken	9.0	0.7	0.6	5.3	2.0	1.0	1.6	3.2	1.4
Fat	1.7	0.3	0.1	0	1.0	0.2	0.3	0.5	0.4
Greenery	4.8	0.2	0.1	0	0.4	0.2	1.1	0.3	0.7
Iron/liver	2.9	1.1	0	0.5	2.1*	1.6*	0.1	0.6	0.4
Neck of pork	3.2	2.2	0.5	0.2	0.7	1.1	0.4	2.3	1.3
Salt	3.0	0.1	2.6**	1.3*	0	0.4	0	0.1	0.3
Smoked	1.5	0.3	0.8	0.2	0.2	0.4	0	0.7	0.4
Sourish	1.5	0.6	0.1	0.9	0.2	0.3	0.7	1.2	0.5
Sweet corn	5.6	0.5	0	6.2**	0.1	0.9	5.0**	1.1	0.4
Smell:									
Bouillon	5.1	0.4	0.6	0.4	0.2	0.5	1.3	2.3	0.9
Chicken	9.2	1.2	3.9	9.0	0.7	1.4	0.4	6.4	2.6
Greenery	5.6	0.4	0.7	0.5	1.1	0.5	0.1	0.5	0.8
Neck of pork	3.3	0.2	0	0.3	0.1	1.7	0.1	3.5	1.6
Sourish	1.2	0.1	1.3	1.7	0	0	0.5	1.1	0.7
Sweet corn	6.0	0.7	1.0	7.7**	0.6	1.2	0.6	2.0	0.7

(* $= p \leq 0.05$, ** $= p < 0.01$)

Table VII. Influence of sex, age and strain on selected characteristics of flavour and smell, LS-means.

	Smell of sweet corn (positive)	Flavour of sweet corn (positive)	Flavour of salt (positive)	Flavour of iron/liver (negative)
Sex: (p)	NS	NS	$p < 0.01$	NS
Males	5.8	5.6	2.7	2.9
Females	6.1	5.5	3.2	2.9
Age: (p)	$p < 0.01$	$p < 0.01$	$p < 0.05$	NS
91 days	5.5	5.2	2.8	3.0
120 days	6.4	6.0	3.2	2.7
Strain × age: (p)	NS	NS	NS	$p < 0.05$
New Hampshire:				
91 days	5.5	5.3	2.7	2.4
120 days	6.4	6.2	3.2	2.7
I 657 (Scan Labelle):				
91 days	6.1	5.2	3.1	3.0
120 days	6.4	5.5	3.1	3.1
Light Sussex:				
91 days	5.0	4.9	2.6	3.5
120 days	6.6	6.3	3.2	2.4
Strain × sex: (p)	NS	NS	NS	$p < 0.05$
New Hampshire:				
Males	5.7	5.8	2.6	2.1
Females	6.1	5.7	3.2	3.0
I 657 (Scan Labelle):				
Males	6.3	5.4	2.9	3.1
Females	6.2	5.3	3.3	3.0
Light Sussex:				
Males	5.4	5.5	2.6	3.4
Females	6.1	5.7	3.2	2.6
Sex × age: (p)	NS	$p < 0.01$	NS	NS
91 days:				
Males	5.2	4.8	2.5	3.0
Females	5.8	5.5	3.1	2.9
120 days:				
Males	6.4	6.4	2.9	2.7
Females	6.5	5.6	3.4	2.8

Each response variable is expressed on a scale from 0–15 where 15 corresponds to most pronounced.

In another study, the I 657 chickens were demonstrated to have a slightly faster growth capacity when fed a ration for growers with normal protein levels (Hermansen et al., 2004). Moreover, Nielsen et al. (2003) found that a slow growing experimental cross that had access to an outdoor area during the last 42 days was only 180 g heavier at 84 days of age when fed a diet with a higher protein to energy ratio. We suggest that the chickens in our study, for each breed, only had a slightly slower growth rate due to the restriction in protein, but comparative studies have to be made to verify this.

According to Shalev (1990), the weight ratio between male and female chickens increases during the growing period, with males being about 25% heavier at 70 days of age. If this curve is assumed to increase continuously until the bird is full-grown, we would expect the ratio to be more than 25% at 91 days of age. We observed males being 23–32% heavier at 91 days with the lowest ratio for New Hampshire and Light Sussex, indicating that growth rates are important factors when weight ratios between male and females are determined. At 120 days of age, New Hampshire and Light Sussex males were 40–48% heavier than the females, whereas I 657 males were only 35% heavier, which was nearly the same weight ratio as at 91 days of age. This further indicates that growth curves have different courses according to strains.

Nakamura et al. (1975) found that meat from spent fowls became tougher with age, resulting in a less profitable meat product. Breast meat from fast-growing female ROSS broilers was more tender compared to a slow-growing experimental cross when slaughtered at 84 days of age (Nielsen et al., 2003). In our experiment we found a tendency for the faster-growing I 657 to be tenderer compared with the slower-growing genotypes when slaughtered

at 91 days of age. However, when the broilers were kept 29 days longer before slaughtering we found a significant change in the development of tenderness and toughness. Thus, the slower growing strains tended to have a more tender breast meat consistency, whereas the opposite was the case for the faster-growing I 657. Since we only found high growth rates in this last period among the cockerels from the slower-growing strains and the interaction between strain and sex concerning meat tenderness turned out to be not significant, the development in meat tenderness seems not to be correlated with a fast growth rate alone. Probably the Light Sussex and New Hampshire strains are simply better suited for slaughtering at a later age compared with I 657. A reason may be less heavy breast meat of the pure breeds.

In our experiment the positive flavour of salt and the positive smell of sweet corn were significantly improved in both the female and the male birds, whereas the positive flavour of sweet corn was only improved in the male birds. The flavour of salt was found to be better in the breast meat from the females across ages. These sex differences are not supported by Poste et al. (1996) who did not find any effect of sex on the sensory properties in broilers fed different levels of hulless oats. These broilers were, however, slaughtered at the age of 40 days and changes in the sensory profile of the male broilers in our study could probably be due to them reaching sexual maturity.

We conclude that it is possible to produce broilers in an orchard with a high meat eating quality, even though broilers are kept considerably longer before slaughtering than in conventional commercial broiler production. Since we did not find any negative consequences of age on the sensory characteristics, we suggest that broiler breast meat becomes tastier if the broilers are kept until they are 120 days old rather than 91 before slaughtering. Development in meat tenderness is related to strain. Weight gain is related to both strain and sex. Therefore, if meat production is the main purpose, then the commercial genotype I 657 probably will be preferable because of a higher meat production. The other strains can be used for a longer period, since they can be kept until 120 days of age with favourable impact on the eating quality.

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