The influence of breed and age at slaughter on carcass traits and pork quality

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Abstract

Many factors such as genetics, slaughter age, environmental factors and nutrition play a substantial role in the production of acceptable pork quality. Moreover, initial and ultimate pH (pH_u), color, intramuscular fat (IMF), subcutaneous fat, firmness, and drip loss of the meat can be used to estimate the pork quality. A total number of 305 pigs of four breeds, Landrace, Duroc, Hampshire and Noroc at different slaughter ages, 6, 7.5 and 9 months, were used in this study. The meat percentage declined more strongly with age for Duroc. The carcass weight was the least for Hampshire. Duroc had highest pH_u, and highest content of intramuscular fat. A significant effect of age on color characteristics was observed. The drip loss was reduced with age and was substantial for Landrace and Noroc, but less for Hampshire. The thickness of the subcutaneous tissue and protein content of the muscle increased and the water content decreased with age, except for Hampshire. The iodide value varied from 55.8 to 70.6 g iodine bound/100g fat.

Materials and Methods

Genetic material, slaughter and carcass evaluation. A total number of 305 pigs of four breeds, Norwegian Landrace, Norwegian Duroc, Hampshire and Noroc at different slaughter ages, 6, 7.5 and 9 months, were used in this study (Table I). Each of breeds was raised in the same farmhouse and fed with similar feed. Pigs were stunned by carbon dioxide (COMI88, Butina APS, Denmark) and slaughtered according to industry accepted procedures and EU regulations. Whole carcass data including meat percentage were recorded within 45 min *post-mortem*. The initial and the pH_u (pH_{45}, pH_5 and pH_u) of the *Semimembranosus* muscle were recorded at 45 min, 5 h and 24 h *post-mortem* using a portable pH meter (Knick-Portamess 751, Calimatic, Germany) with pH combination puncture electrode (Mettler-Toledo GmbH, Urdorf, Switzerland). Lean percentage was measured on the hot carcass using a HGP2Q pistol (Hennessy grading system, Auckland, New Zealand), measuring the depth of the loin muscle - *Longissimus dorsi* (LD) and backfat thickness (SC1 and SC2) including color reflectance of muscle according to an EU-approved method (EU Regulations No. 2967/85 and No. 3127/94).

Table I. Total number of pigs used in this study

Breed	Age (months)			Total
	6	7.5	9	
Landrace	29	30	28	87
Duroc	31	31	31	93
Hampshire	25	24	26	75
Noroc	14	22	14	50
Total	99	107	99	305

Pork quality analysis. Samples were excised from LD for color measurements, drip loss, IMF, protein and water content (Figure I). Surface reflectance (color) with the parameters L* (lightness), a* (redness) and b* (yellowness) was measured in three positions, lateral, middle and medial of LD after one hour of blooming at 4ºC, using a Minolta Chroma Meter CR 300 DP-301 (Minolta Osaka, Japan). Drip loss was measured in duplicate on a 2-cm thick slice of LD muscle 4 days after slaughter (Christensen 2003). The FoodScan™ Meat Analyzer was used to determine IMF, protein and water content in homogenized raw meat samples with preinstalled ready-to-use calibration for meat based on the chemometric methods (FOSS Analytical A/S, Denmark). The iodine number determinations were made by the Hanus methods on the lipids (ISO 3961:1996(E).

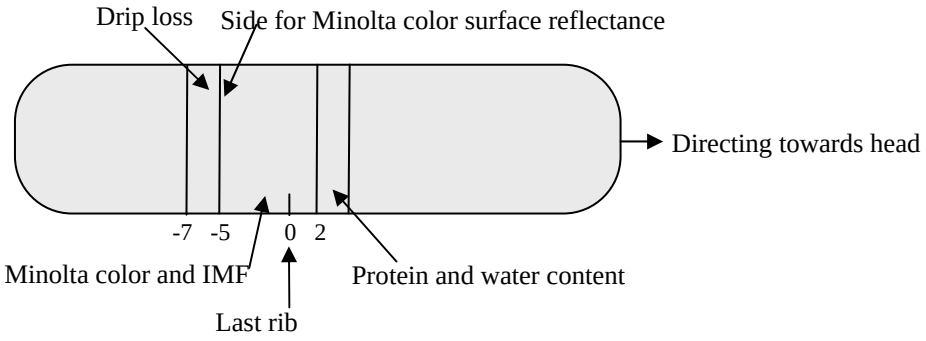

Figure I. Excised samples from the muscle *Longissimus dorsi* for pork quality analysis.

Results and Discussion

Growth performance, carcass traits, composition, and pork quality is influenced by breed, feeding, environment, transport, pre- and post slaughter handling, slaughter age and weight, (Virgili *et al.*, 2003, Cannon *et al.*, 1995). The meat percentage declined more strongly with age for Duroc compared to the 3 other breeds (Table II). The growth rate (in terms of carcass kg) were the least for Hampshire compared to the other breeds. The variations in the results could be due to feeding and animal genetics (Virgili *et al.*, 2003). There is a significant difference between the breeds in IMF content with Duroc harboring more fat than Hampshire and Landrace in all age groups, but no significant effect of age was observed. Previous investigator has indicated that IMF content is generally associated with improved sensory quality and better acceptability of fresh pork due to improved juiciness in the meat (Cannon *et al.*, 1995).

Generally, pH has little economic importance, but is often used as a predictor of other measures of pork quality including color, moisture, water holding capacity (WHC) and sensorial properties (Melody *et al.*, 2004). A significant effect of breed could be observed on the pH measurements at 45 min, 5 and 24 h after slaughter. Duroc had the highest pH_u but an effect of age on pH_u was only observed for Hampshire and Landrace. A normal pH decrease from pH 7.2 in the living muscle to an ultimate pH of 5.5 can be observed in well-fed unstressed pigs, depending on the muscle and muscle glycogen level (Lawrie, 1991). A significant effect of age on color characteristics was observed with a more pronounced color in meat from the older pigs. The lightness variable L* increased with age for Hampshire, while the meat from Noroc and Landrace became darker comparatively Duroc. Previous investigators have reported meat color as an important technological pork quality characteristic that influences the purchase decision of consumers (Bryhni *et al.*, 2002; Ngapo *et al.*, 2004). In this study, the drip loss was reduced with age. This reduction in drip loss was substantial for Landrace and Noroc, but less for Hampshire. Moreover, the drip loss after freezing and thawing cycle was reduced with age, but no breed differences were observed. Drip loss from fresh pork is a result of shrinkage of muscles protein and the subsequent expressing of juice from the meat. Inferior color and WHC leads to loss of meat juice in package (Otto *et al*., 2004). Moreover, such an unattractive appearance and limits the yield in further processing, which leads to loss of sales and thus has high economic importance.

The protein content of the muscle increased and the water content decreased with age, except for Hampshire. The thickness of the subcutaneous tissue increased with age, but no differences were detected among the breeds. The iodide value varied from 55.8 (g iodine bound/100 g fat) to 70.6 (g iodine bound/100g fat) (Table III). However, the present study indicates some significant influences of pig breeds at different slaughter ages on carcass traits, technological aspects and pork quality. The variations in the results could be due to pre-slaughter meat properties and depends upon characteristics of processing methods and animal genetics (Virgili *et al.*, 2003).

Table II. Effect of breed and age on pork quality characteristics and composition of *Semimembranosus* and *Longissimus dorsi* muscles

Breed	Landrace			Duroc			Hampshire			Noroc			A	B
Age (months)	6	7.5	9	6	7.5	9	6	7.5	9	6	7.5	9		
Number (n)	29	30	28	31	31	31	25	23	26	14	22	13		
Hot carcass wt, kg	64.58	88.12	122.39	61.02	88.83	108.10	71.60	95.65	113.77	66.88	101.90	124.02	*	*
meat %	58.54	59.23	56.18	56.64	53.87	52.59	59.84	57.48	55.54	57.57	56.27	55.08	*	ns
pH45 SM	6.58	6.60	6.57	6.71	6.78	6.68	6.58	6.69	6.64	6.64	6.58	6.62	ns	ns
pH5 SM	6.26	6.12	6.17	6.52	6.44	6.42	6.29	6.21	6.18	6.41	6.23	6.17	ns	ns
pH24 SM	5.58	5.56	5.64	5.67	5.67	5.66	5.57	5.52	5.54	5.53	5.61	5.65	*	*
pHu LD	5.54	5.50	5.57	5.60	5.62	5.63	5.50	5.47	5.51	5.54	5.51	5.62	ns	ns
Lightness[2] (L*)	47.56	46.70	43.36	47.55	46.10	46.42	46.02	47.75	47.67	47.29	46.62	43.08	*	*
Redness[2] (a*)	6.66	7.46	8.71	7.93	9.42	9.50	8.19	9.26	10.59	7.77	8.48	8.89	ns	*
Yellowness[2] (b*)	1.74	3.29	3.07	3.18	4.18	4.61	2.76	4.70	4.59	3.02	3.59	3.07	*	*
Backfat thickness	10.41	10.61	16.04	13.27	19.13	20.00	15.04	18.50	21.05	12.29	17.09	18.85	ns	ns
Fat (IMF)	1.48	1.46	1.71	3.19	3.52	3.76	1.52	1.26	1.96	1.65	2.21	2.14	ns	ns
Water content %	74.81	73.81	73.68	73.63	72.96	72.30	74.63	74.55	74.22	74.30	73.59	73.23	*	*
Protein %	22.74	23.76	23.96	22.01	22.45	23.18	22.39	22.46	22.08	22.80	23.53	23.94	*	*
Drip loss %	7.06	5.78	4.63	3.04	3.46	1.96	5.57	4.72	5.21	6.14	3.91	4.03	*	*

All numbers are mean values. (n): total number of pigs used in this study, Lightness[2] (L*): Measure of darkness to lightness (larger values indicates a lighter color; Redness[2] (a*): Measure of redness (larger values indicate a redder color); Yellowness[2] (b*): Measures of yellowness (larger values indicates a more yellow color). A: age, B: breed, ns: not significant, * $p \leq 0.05$.

Table III. Effect of breed and age on iodine value

Breed	Landrace			Duroc			Hampshire			Noroc			A	B
Age (months)	6	7.5	9	6	7.5	9	6	7.5	9	6	7.5	9		
Number (n)	5	7	7	6	6	7	6	8	8	4	6	7		
Iodine value	63.16	64.79	62.02	62.42	63.15	61.90	63.28	63.46	63.22	58.73	63.56	64.07	*	*

All numbers are mean values. (n): total number of pigs used to determine iodine value in backfat, A: age, B: breed.

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Refernces

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