CHANGES IN PURGE LOSS, WATER HOLDING CAPACITY AND TENDERNESS DURING AGING OF DIFFERENT MUSCLES FROM PIG CARCASSES

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Background

Pork shoulders and hams are traditionally used as raw material for further processing of meat products and often are considered to be lower value than other cuts such as the pork loin. Recently, the pork industry has been investigating the potential for adding value to the pork carcass by identifying individual muscles or muscle groups within the shoulder and ham that are well-suited for new uses in processed products or for new product development. However, while the general properties of primal cuts as a whole are understood, the characteristics of individual muscles making up the primal cuts are not well known. Therefore, there is a need for research on meat quality characteristics of individual muscles from pork shoulders and hams. Further, it is important to know the effects of aging on the specific muscles in order to make the best use of individual muscles in processed products.

Objectives

The objectives of this experiment were to determine the changes in purge loss, water holding capacity, and tenderness during aging for ten selected muscles dissected from pig carcasses following harvest.

Materials and methods

Animals, treatments and sample preparation: Seven barrows or gilts (Hampshire sire × crossbred dam) were humanely harvested at the Iowa State University Meat laboratory. Carcasses were chilled in a forced-air cooler at -5 ^{o}C for 24h. Live weights, carcass weights, 45-minute pH and 45-muscle temperatures were recorded and are shown in Table 1. At 1 day postmortem, the *biceps femoris* (BF), *gluteus medius* (GM), *gracilis* (G), *infraspinatus* (I), *longissimus dorsi* (LD), *pectoralis profundi* (Fan, PP), *rectus femoris* (RF), *semitendinosus* (ST), *spinalis* (S), *triceps brachii* (TB) were dissected from both sides of each carcass. Muscles were cut into 2.54 cm thick portions, vacuum-packaged and aged at 4 ^{o}C for 7days.

Purge loss, water holding capacity (WHC) and WB-shear force: Purge loss was determined by weighing the muscle portions before vacuum-packaging and after 1, 3 or 7 days of aging to calculate percentage weight losses. WHC was determined using the method described by Honikel and Hamm (1994). WB-shear force measurements were performed using cooked muscle portions (internal temperature at 71 ^{o}C) by a texture analyser (TA-XT2i texture analyser, USA). Preparation of the samples for the tenderness measurement was done in accordance to AMSA Guidelines (American Meat Science Association, 1995). The conditions for the texture analyser was a pre-test speed of 3.0mm/s, test speed of 3.3mm/s, post-test speed of 10.0mm/s, distance of travel at 80.0 %, and trigger force of 0.15kg.

Statistical analysis: Data were analyzed using PROC GLM (SAS, 1998).

Results and discussion

Purge loss (%) was significantly increased ($P < 0.05$) in all muscles during aging (Table 2). The GM had the highest ($P < 0.05$) purge loss, while the TB was significantly lower ($P < 0.05$) than the other muscles. After 7 days of aging, the range for purge loss values from all muscles was 3.46-8.93%.

The WHC value for GM and LD muscles was significantly increased by aging, but the G and S were decreased ($P < 0.05$) as the aging period increased (Table 3). The S had the highest WHC ($P < 0.05$), while the BF was lower in WHC than the other muscle after 7 days of aging. The range of WHC values in all muscles was 87.36-93.49% after 7 days of aging.

It is generally accepted that the source of drip from pork is intracellular water which is lost from the muscle fibre post-mortem, driven by a pH and calcium-induced shrinkage of myofibrils during rigor development (Offer et al., 1989). Moeseke and Smet (1999) reported an increase in WHC of fresh meat during aging using a traditional drip measurement where samples were taken several days after slaughter for comparison with samples taken at 1 day post-mortem. However, in our study, WHC of the G and S muscles decreased, and the I, RF, ST and TB muscles showed a tendency to decrease during aging. Honikel and Hamm (1994) reported that conventional drip losses during storage of pork were in the range of 1-10%.
The WB-shear force for the TB was significantly decreased ($P < 0.05$) during aging, but the other muscles were not affected during aging. After 7 days of aging, the WB-shear force value for the S was the lowest ($P < 0.05$) among the muscles studied, but the BF was higher than the other muscles. The range for WB-shear force in the 10 muscles studied was 3.29-7.10 kg after 7 days of aging.
It has been reported that pork was completed of aging-related changes within 4-6 days post slaughter (Rees et al, 2002). Also, Wheeler et al. (2000) reported that tenderness ratings from trained sensory evaluation were highest for *semitendinosus* (7.2) and *triceps brachii* (7.1), followed by *longissimus lumborum* (6.4) and *semimembranosus* (5.7) and were lowest for *biceps femoris* (4.0). In the current study, WB-shear force values were greatest for the BF and lowest for the S. The TB showed significant tenderization during aging but the 9 other muscles were not significantly affected during aging.
The simple correlations between WB-shear force and water holding were 0.26 (purge loss) and –0.41 (water holding capacity) ($P < 0.0001$).

Conclusions

Purge loss of the TB was significantly less than for the other muscles in this study, while the GM had higher purge loss than the other muscles during aging. The WHC of GM and LD was significantly increased, but that of the G and S was decreased as the aging period increased. The S had the greatest WHC, while the BF had lower WHC than the other muscles after 7 days of aging. The purge loss and WHC values suggest that individual muscles will perform quite differently in processes utilizing differential amounts of added water and will affect expected yields depending on how individual muscles may be used Tenderness of the TB was significantly increased by aging, but the other muscles were not affected during the aging period. After 7 days of aging, the S remained the most tender, while the BF remained tougher than the other muscles studied. Thus, tenderness differences in pork muscles appear to largely retain the differences inherent to individual muscles and do not show a great deal of change as a result of aging.

References

American Meat Science Association. 1995. Research guidelines for cookery, sensory evaluation and instrumental tenderness measurements of fresh meat. National Livestock and Meat Board. Chicago, IL.

Honikel, K. O. and Hamm, R. 1994. Advances in meat research. Vol 9 (eds. A. M. Pearson and T. R. Dutson) Chapman and Hall, Glasgow, UK.

Moeseke, W. V., and Smet, S. D. 1999. Effect of time of deboning and sample size on drip loss of pork. Meat Science. 52, 151-156.

Offer, G., Knight, P., Jeacocke, R., Almond, R., Cousins, T., Elsey, J., Parsons, N., Sharp, A., Starr, R., and Purslow, P. 1989. The structural basis of the water-holding, appearance and toughness of meat and meat products. Food Microstructure, 8, 151-170.

Rees, M. P., Trout, G., and Warner, R. D. 2002. Tenderness, ageing rate and meat quality of pork M. longissimus thoracis et lumborum after accelerated boning. Meat Science, 60, 113-124.

Wheeler, T. L., Shackelford, S. D., and Koohmaraie, M. 2000. Variation in proteolysis, sarcomere length, collagen content, and tenderness among major pork muscles. J. Anim. Sci. 78, 958-965.

SAS. SAS/STAT. (1998) Software for pc, SAS/STAT user's guide: Statistics. SAS inst., Cary, NC.

Table 1. Information of pork carcasses used in the experiment (n=7).

Item	Live weight (kg)	Hot Carcass weight (kg)	pH $_{45\ min}$	Temp.(℃) $_{45\ min}$
Mean±SE	111.59±15.47	85.34±10.90	6.43±0.26	39.01±1.62

Table 2. Changes of purge loss (%) for 10 muscles from pork carcasses during aging.

Muscle***	Ageing time (day)		
	1	3	7
BF	4.00 ± 0.39^{BCc}	5.51 ± 0.51^{BCb}	7.12 ± 0.62^{BCa}
GM	5.42 ± 0.45^{Ab}	7.99 ± 0.49^{Aa}	8.93 ± 0.57^{Aa}
G	1.44 ± 0.20^{Dc}	2.55 ± 0.34^{Eb}	3.88 ± 0.49^{EFa}
I	3.03 ± 0.36^{Cb}	4.39 ± 0.45^{CDa}	5.43 ± 0.57^{CDEa}
LD	3.70 ± 0.60^{BCb}	4.99 ± 0.68^{BCab}	6.97 ± 0.88^{BCDa}
PP	3.07 ± 0.43^{Cc}	4.95 ± 0.51^{BCb}	6.59 ± 0.58^{BCDa}
RF	3.20 ± 0.52^{BCb}	4.98 ± 0.68^{BCab}	5.14 ± 0.65^{DEFb}
ST	4.46 ± 0.61^{ABb}	6.12 ± 0.42^{Bab}	7.66 ± 0.83^{ABa}
S	1.58 ± 0.21^{Db}	2.43 ± 0.36^{Eb}	3.56 ± 0.36^{EFa}
TB	1.51 ± 0.19^{Db}	3.08 ± 0.35^{DEa}	3.46 ± 0.31^{Fa}

* A-F : Means±SE in a column with different letters are significantly different (p<0.05).
** a-c : Means±SE in a row with different letters are significantly different (p<0.05).
*** Muscles are biceps femoris (BF), gluteus medius (GM), gracilis (G), infraspinatus (I), longissimus dorsi (LD), pectoralis profundi (Fan, PP), rectus femoris (RF), semitendinosus (ST), spinalis (S) and triceps brachii (TB)

Table 3. Changes of water holding capacity (%) for 10 muscles from pork carcasses during aging.

Muscle	Ageing time (day)		
	1	3	7
BF	87.06 ± 1.07^{CD}	87.76 ± 0.80^{C}	87.36 ± 0.57^{E}
GM	85.83 ± 0.67^{Db}	87.45 ± 0.80^{Cab}	88.72 ± 0.59^{DEa}
G	92.79 ± 0.45^{Ba}	92.71 ± 0.86^{Ba}	89.33 ± 0.73^{CDb}
I	92.18 ± 0.72^{B}	91.93 ± 0.82^{B}	91.38 ± 0.72^{B}
LD	85.03 ± 0.69^{Db}	87.79 ± 0.42^{Ca}	87.92 ± 0.41^{DEa}
PP	90.59 ± 0.71^{B}	90.79 ± 0.59^{B}	91.25 ± 0.43^{B}
RF	91.65 ± 0.97^{B}	91.83 ± 0.89^{B}	89.55 ± 0.44^{CD}
ST	88.50 ± 0.73^{C}	88.58 ± 0.84^{C}	88.35 ± 0.68^{DE}
S	96.35 ± 0.44^{Aa}	96.16 ± 0.40^{Aa}	93.49 ± 0.62^{Ab}
TB	92.10 ± 0.73^{B}	92.07 ± 0.63^{B}	90.46 ± 0.34^{BC}

* A-E : Means±SE in a column with different letters are significantly different (p<0.05).
** a-b : Means±SE in a row with different letters are significantly different (p<0.05).

Table 4. Change of WB-shear force (kg) for 10 muscles from pork carcasses during aging.

Muscle	Ageing day (day)		
	1	3	7
BF	7.32 ± 0.20^{A}	7.31 ± 0.21^{A}	7.10 ± 0.19^{A}
GM	5.95 ± 0.18^{B}	5.80 ± 0.15^{B}	5.75 ± 0.17^{B}
G	3.91 ± 0.12^{D}	3.97 ± 0.10^{E}	3.93 ± 0.13^{D}
I	4.27 ± 0.12^{D}	4.30 ± 0.10^{DE}	4.00 ± 0.12^{D}
LD	5.95 ± 0.15^{B}	5.59 ± 0.18^{BC}	5.55 ± 0.18^{B}
PP	5.66 ± 0.11^{B}	5.70 ± 0.12^{B}	5.67 ± 0.10^{B}
RF	5.22 ± 0.22^{C}	5.20 ± 0.16^{C}	5.35 ± 0.20^{B}
ST	4.82 ± 0.12^{C}	4.61 ± 0.15^{D}	4.80 ± 0.11^{C}
S	3.34 ± 0.13^{E}	3.25 ± 0.13^{F}	3.29 ± 0.15^{E}
TB	5.75 ± 0.14^{Ba}	5.76 ± 0.09^{Ba}	5.41 ± 0.12^{Bb}

* A-F : Means ± SE in a column with different letters are significantly different ($p<0.05$).
** a-b : Means ± SE in a row with different letters are significantly different ($p<0.05$).