E35

MYOFIBRIL FRAGMENTATION AND TEXTURE PROFILE OF PIG LONGISSIMUS DORSI MUSCLE AS AFFECTED BY DIFFERENT WEIGHT AND AGE AT SLAUGHTER

ČANDEK-POTOKAR, M[1]., ŽLENDER, B[2]., BONNEAU, M.[3]
1 Kmetijski institut Slovenije, Hacquetova 2, 61000 Ljubljana, Slovenia
2 Biotehniška fakulteta, Oddelek za živilstvo, Jamnikarjeva 101, 61000 Ljubljana, Slovenia
3 INRA, Station de Recherches Porcines, St. Gilles, 35590 L'Hermitage, France.

SUMMARY
A total of 92 castrated males were used to study the effect of weight and dietary restriction (age) on myofibril fragmentation post-mortem and texture profile in pig longissimus dorsi muscle. Restricted pigs had longer myofibril fragments 1 day post-mortem than ad libitum fed pigs ($p<0.05$). Heavier pigs had longer myofibril fragments 4 days post-mortem than ad libitum fed pigs ($p<0.01$). Extent of myofibril fragmentation was significantly higher in 100 kg compared to 130 kg pigs ($p<0.01$). Data on texture profile indicate a slightly less tender and less chewy meat ($p<0.10$) in 130 kg than in 100 kg pigs, which corresponds with lower rate of fragmentation occurring in these pigs.

INTRODUCTION

Tenderness is probably the most important eating quality for a consumer. The process of tenderization can be evaluated by studying the myofibril fragmentation post-mortem. Degree of myofibril fragmentation is highly correlated with sensory scores for tenderness in beef Olson and Parrish 1977; Parrish et al, 1979; Culler et al, 1978; Olson and Tornberg 1992) and in pork (Fjelkner-Modig 1984, Fernandez and Tornberg, 1994) although the relationship in case of pork is not so strong. Different biological factors as animal age, species, sex, muscle type influence tenderization process. In pork, it is faster than in beef, veal, lamb; 50% of tenderization is completed in 2 days and 80% in about 5 days (Dransfield et al. 1980-81). To our knowledge the effect of age and/or weight on the process of myofibril fragmentation post-mortem in pork has not been studied.

The aim of this work was to differentiate the effect of weight at slaughter from the effect of age (effect of dietary restriction) on the extent of myofibril fragmentation and consequently texture profile in pig longissimus muscle.

MATERIAL AND METHODS

Animals. Ninety-two castrated males, crossbred (Landrace x Large White) x Duroc, four siblings from 23 litters, were allocated to 4 experimental groups: pigs slaughtered at 100 kg live weight either fed ad libitum (A100) or restricted (R100) and pigs slaughtered at 130 kg either fed ad libitum (A130) or restricted (R130). Average ages at slaughter were 160.6, 187.0, 210.7, 241.3 days, respectively. Pigs were individually logged penned and started the experiment at 30 kg. Feed consumption and feed conversion ratio were recorded for each pig. Pigs were slaughtered in a commercial slaughterhouse by a routine procedure (electrically stunned, chilled at 4°C).

Chemical, physical and sensory analysis. Samples were taken from longissimus dorsi muscle (LD) at the level of 6-14 vertebra thoracica. pH was measured one (pH1) and twenty-four hours post-mortem (pH24) at level of 13-14th rib. Water (%), crude proteins (%) (Neumann and Bassler, 1976) and intramuscular lipids (IMFAT%) (Folch et al., 1957) were determined on a first sample taken 1 hour post-mortem. Drip loss (%) (modified method of Taylor, 1972 and Penny, 1977), length of myofibrils (μm) (LMF1) (Olson et al, 1976 and Fernandez and Tornberg, 1994) and collagen content (Matissek et al., 1992) were measured on a second sample taken 24 hours post-mortem. A third sample, also taken 24 hours post-mortem was left to age at 4°C in the laboratory until 96 hours post-mortem. Length of myofibrils 96 hours post-mortem (μm) (LMF4) was then measured and the remaining sample was vacuum-packed and freeze-stored at -20°C until used for sensory and instrumental analysis. A myofibril index (MFI) was calculated as the ratio of LMF4 to LMF1. The samples for sensory and instrumental analysis were roasted at 175°C to an internal temperature of 70°C. Five panelists were asked to evaluate tenderness, oral sensation, chewiness, mouth coating and juiciness on a seven-point scale with intensity of appreciation ranging from 1 to 7. Cutting force was measured perpendicular (cut_perp) and parallel (cut_para) to muscle fibers using an INSTRON Universal Testing machine (Model 1111).

Statistical analysis. Data were subjected to an analysis of variance (GLM procedure by SAS) evaluating the effects of weight (W), restriction (R), interaction between weight and restriction (W*R) and litter. Multiple comparison of means of four treatment groups was made (GLM, MEANS, Scheffe's test, by SAS). Since the parameters of myofibril fragmentation were pH1 dependent, pH1 was included as a covariate in a model for LMF1, LMF4 and MFI.

RESULTS AND DISCUSSION

Chemical composition. Water, protein and intramuscular fat contents were significantly affected by weight at slaughter. Water content was lower in 130 kg than in 100 kg pigs (73.57 vs. 74.37, $p<0.001$), whereas protein (22.38 vs. 22.01, $p<0.01$) and intramuscular fat (2.60 vs. 2.12, $p<0.001$) contents were higher in 130 kg than in 100 kg animals. Collagen and intramuscular fat contents were significantly affected by restriction (age at slaughter). Both parameters were lower in restricted (older) than ad libitum fed (younger) animals. For intramuscular fat, the effects of weight and feeding regime were additive. The highest levels were observed in A130 pigs (2.88%) and the lowest in R100 animals (1.92%), while A100 and R130 pigs exhibited similar intermediate contents (2.31-2.32%).

pH and drip loss. pH1 was not affected by weight or dietary restriction. pH24 was significantly lower in 130 kg than in 100 kg pigs (5.54 vs. 5.61, $p<0.05$). We observed a significant effect of dietary restriction on drip loss (%), restricted pigs had higher drip loss than ad libitum fed pigs (10.97 vs. 8.70, $p<0.001$)

Myofibril fragmentation. Animal age and/or dietary restriction had a significant effect on LMF1; older, restricted pigs exhibiting longer fragments than younger, ad libitum fed pigs (20.15 vs. 18.41, $p<0.05$). pH1 had a significant effect on LMF4 ($p<0.001$), the fragments being shorter with increasing pH1. In PSE pork there was nearly no fragmentation (MFI index app. 1.00). LMF4 (13.15 vs. 10.77, $p<0.01$) and MFI (0.70 vs. 0.55, $p<0.001$) were higher in 130 kg than in 100 kg pigs. Neither LMF4, nor MFI were significantly affected by restriction (age) within weight group. This result is indicative of a slower tenderization process in heavier pigs. On the other

hand, age at a given weight does not seem to affect the rate of myofibril fragmentation.

Sensory and instrumental analysis. No significant effect of weight or dietary restriction on texture profile was observed. However, tenderness (5.44 vs. 5.24, $p<0.10$) and chewiness (4.90 vs. 4.80, $p<0.10$) tended to be slightly lower in 130 kg than in 100 kg pigs. These results correspond with the data obtained on LMF4. Cut_para was significantly higher in 130 kg than in 100 kg pigs (45.6 vs. 43.4, $p<0.05$), while cut_perp tended to be higher in restricted than in ad libitum fed pigs. These results are indicative of a slightly less tender and less chewy meat in heavier pigs, in close accordance with the slower process of tenderization occurring in these animals. On the other hand, age at given weight does not seem to affect pork meat texture.

CONCLUSION

Meat from pigs slaughtered at 130 kg live weight was slightly less tender and less chewy than that of pigs slaughtered at 100 kg live weight, irrespective of their age at slaughter. The reduced tenderness of heavier pigs can be related to the lower extent of myofibril fragmentation post-mortem observed in these animals. The reason why myofibril fragmentation was affected by weight at slaughter remains to be investigated.

ACKNOWLEDGMENT

Authors wish to thank the management of pig farm Emona, Farma IHAN, Domzale, Slovenia, who made this work possible by offering animals, installations and technical help during the experiment.

REFERENCES

Culler, R.D./Parrish, F.C.Jr./Smith, G.C./Cross, H.R. 1978. J. Food Sci., 43, 4 p.1177-1180.

Dransfield E./ Jones, R.C.D./MacFie, H.J.H.1980-81. Meat Sci. 5, 139.

Fernandez, X./Tornberg, E. 1994. Meat Sci. 36, 3, p.345-363.

Fjelkner-Modig, S. 1984. Proc. 30th Symp. Europ. Meat Res. Workers, Bristol, UK, 2, p.174-175.

Folch J./Lee, M./Sloane Stanley, G.H. 1957. J. Biol. Chem., 226, p.497-509.

Matissek, R./Schnepel, F.M./Steiner, G. 1992. Lebensmittelanalytik. Grundzüge-Methoden-Anwendungen, 2. Auflage. Berlin-Heidelberg, Springer-Verlag, p. 107-111.

Neuman, K./ Bassler, R. 1976. Methodenbuch, Band 3. Die chemische Untersuchung von Futtermitteln, Verlag Neumann-Neudamn, 265 p.

Olson, D.G./Parrish, F.C.Jr. 1977. J. Food Sci., 42, 2, p.506-509.

Olson, D.G./Tornberg,E. 1992. Proc. 38th ICoMST, Clermont-Ferrand, France, 3, p.399-402.

Parrish, F.C.Jr./Vandell, C.J./Culler,R.D. 1979. J. Food Sci., 44, 6, p.1668-1671.

Penny I.F 1977. J. Sci. Fd. Agric., 28, p.329.

Taylor, A.A. 1972. Proc. MRI Symp. No.2,Langford, Bristol.

Table 1: Chemical, phisical and sensory traits of LD muscle in pigs of different weight and age groups

Slaughter weight	100 kg		130 kg		EFFECTS				
Feeding regime	ADLIB	RESTR	ADLIB	RESTR					
Treatement group	A100	R100	A130	R130	W	R	R*W	Litter	pH1
Traits									
Age at slaughter (days)	160.6 a	187.0 b	210.7 c	241.3 d	***	***	NS	NS	
Water (%)	74.33 a	74.41 a	73.39 b	73.75 ab	***	NS	NS	*	
Proteins (%)	21.99	22.03	22.49	22.27	**	NS	NS	*	
Collagen (%)	0.50 a	0.46 b	0.48 ab	0.47 ab	NS	**	NS	**	
IMFat (%)	2.32 a	1.92 a	2.88 b	2.31 a	***	***	NS	***	
pH1	6.05	6.07	6.08	6.02	NS	NS	NS	NS	
pH24	5.64	5.58	5.54	5.55	*	NS	NS	NS	
Drip (%)	9.02 ab	10.67 bc	8.36 a	11.26 c	NS	***	NS	*	
LMF1 (um)	19.37	20.01	17.40	20.29	NS	*	NS	NS	NS
LMF4 (um)	11.21 ab	10.33 a	11.69 ab	14.55 b	**	NS	+	NS	***
MFI	0.57 a	0.53 a	0.67 ab	0.73 b	***	NS	NS	NS	***
Tenderness(1-7)	5.50	5.39	5.24	5.23	+	NS	NS	NS	
Oral sensation (1-7)	5.06	5.09	5.15	5.18	NS	NS	NS	NS	
Chewiness (1-7)	5.12	4.89	4.79	4.80	+	NS	NS	NS	
Mouth coating (1-7)	3.93	3.68	3.62	3.60	NS	NS	NS	NS	
Juiciness (1-7)	4.94	5.10	5.08	5.07	NS	NS	NS	**	
Cut_perp (N)	57.0	62.0	60.2	61.4	NS	+	NS	***	
Cut_para (N)	40.8	44.0	45.2	46.0	*	NS	NS	NS	

\+ $p < 0.10$
* $p < 0.05$
** $p < 0.01$
*** $p < 0.001$