EFFECT OF COMPENSATORY GROWTH ON PORK MEAT QUALITY

Margrethe Therkildsen[1], Niels Oksbjerg[1], Bent Riis[1], Anders Karlsson[1], Lars Kristensen[2], Per Ertbjerg[2] and Peter Purslow[2]

[1]Danish Institute of Agricultural Sciences, Department of Animal Product Quality, P.O. Box 50, DK-8830 Tjele, Denmark, [2]The Royal Veterinary and Agricultural University, Department of Dairy and Food Science, Rolighedsvej 30, DK-1958 Frederiksberg C, Denmark

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Background

Tenderness is regarded as one of the most important aspects of eating quality of meat. Several studies on ruminants indicate that the rate of protein degradation *in vivo* may reflect the tenderization of meat post mortem, and the protein degradation *in vivo* seems to be regulated through energy intake i.e. high-energy intake results in a high muscle protein turnover. Compensatory growth following a period with restrictive feeding has been shown to increase both muscle protein synthesis and degradation (Jones et al., 1990). In Denmark the traditionally feeding system of slaughter pigs is based on ad libitum feeding with concentrate. On the other hand, in organic pig production high prices of organic protein sources and cereal grain and a demand of access to roughage due to welfare and health of the animals leads to a restriction on energy intake compared with ad libitum feeding with concentrate. Meat from restrictively fed pigs has been found to be less tender than meat from ad libitum fed pigs (Danielson et al. 1999).

Objective

The objective of the study was to examine how different lengths of restrictive feeding, followed by ad libitum feeding, affect the growth rate and quality characteristics of pork meat.

Methods

The experiment was carried out on 10 litters of 5 pigs (Duroc X Landrace X Large White crosses) from day 70 (30 kg live weight) to day 140 (100 kg live weight). Within litter pigs were allocated to five treatment groups of different periods of restrictive and ad libitum feeding as shown in table 1. Each litter constituted of either 2 female and 3 castrated male pigs or 3 female and 2 castrated male pigs, leading to 5 female and 5 castrated male pigs on each treatment. The pigs were weighed at the beginning of the experiment and at every change in feeding level in one of the treatment groups. At day 140 the pigs were slaughtered and the weight of the carcass, *M. semitendinosus* and *M. biceps femoris* was recorded and samples for RNA and DNA concentration in ST and LD and for myofibril fragmentation in LD (day 0) were snap frozen in liquid nitrogen and stored at –80°C. Twenty-four hours post mortem, pH, meat percentage and fat thickness were measured in *M. longissimus dorsi* (LD). Samples for MFI (day 1) were removed from LD and stored as described previously. Drip-loss and colour traits (L*, a* and b*) were measured on LD samples (last rib). MFI was measured according to Culler et al. (1978) and RNA and DNA concentrations were measured according to Oksbjerg et al. (2000). Data were analysed using the Mixed procedure of SAS (SAS Inst. Inc., 1992), by means of a model including the fixed effect of treatment group and sex within treatment and the random effect of litter. Weight at beginning of the experiment was included in the model as a covariant.

Table 1 Feeding level in treatment groups 1 to 5 at different ages

Treatment Age days	1	2	3	4	5
70 – 98	Ad libitum	Restrictive	Restrictive	Restrictive	Restrictive
99 – 113	Ad libitum	Ad libitum	Restrictive	Restrictive	Restrictive
114 – 121	Ad libitum	Ad libitum	Ad libitum	Restrictive	Restrictive
122 – 129	Ad libitum	Ad libitum	Ad libitum	Ad libitum	Restrictive
130 – 140	Ad libitum	Ad libitum	Ad libitum	Ad libitum	Ad libitum

Results and discussion

All pigs, which had been restrictively fed for a period (treat. 2 to 5), showed superior growth rate in the following ad libitum period compared with pigs fed ad libitum in the whole experimental period (treat.1)(Table 2), but none of the previously restrictively fed pigs were able to fully compensate with regard to live weight at slaughter compared with treatment group 1. However, when the cold carcass weight and muscle mass (cold carcass weight X meat percentage) was evaluated (Table 3), pigs from treatment groups 2 and 3 did not differ from treatment group 1, showing that feeding strategy 2 and 3 allowed the pigs to fully compensate with regard to carcass weight and muscle mass. The weight of *M. biceps femoris* and *M. semitendinosus* decreased with the length of the restrictive period, however the difference in weight of *M. semitendinosus* between treatment groups was not significant, whereas the weight of *M. biceps femoris* from treatment groups 4 and 5 differed significantly from treatment groups 1 and 2. Thus it seems as *M. semitendinosus* was less affected by the restrictive feeding period or that compensatory growth was more efficient in *M. semitendinosus* than in *M. biceps femoris*. Meat percentage and fat thickness was also affected by the treatment, thus the meat percentage increased and the fat thickness decreased with the length of the restrictive period. However, the meat percentage and fat thickness were also affected by sex, the female pigs generally having a higher meat percentage and less subcutaneous fat than the castrated male pigs.

Table 2 Weight and average daily gain (ADG) in different periods of treatment groups 1 to 5

Treatment	1	2	3	4	5	SEM[d]	Treatment	Sex(treatment)
Weight at start (70 days)	30.6	29.8	28.8	29.4	29.6	1.53	0.88	0.90
Weight at slaughter (140 days)	107.7[a]	100.8[b]	98.6[b]	91.8[c]	95.1[bc]	3.07	0.001	0.47
ADG (70 – 98) g/d	954[a]	666[b]	649[b]	643[b]	651[b]	48	0.001	0.88
ADG (99 – 113) g/d	1286[a]	1330[a]	895[b]	780[b]	839[b]	65	0.001	0.63
ADG (114 – 121) g/d	1293[a]	1254[a]	1664[b]	961[c]	984[c]	76	0.001	0.28
ADG (122 – 129) g/d	1202[ac]	1357[ab]	1351[ab]	1558[b]	1080[c]	105	0.009	0.54
ADG (130 – 140) g/d	1106[a]	1094[a]	1284[b]	1139[ab]	1663[c]	77	0.001	0.03

[d]Standard error of mean; [abc]within a row, means lacking a common superscript differ ($P < 0.05$)

Table 3 Slaughter quality characteristics, myofibril fragmentation index in *M. longissimus dorsi* (LD) at slaughter (day 0) and 24 h *post mortem* (day 1) and concentration of RNA and DNA in *M. semitendinosus* (ST) and *M. longissimus dorsi* (LD) at slaughter

	1	2	3	4	5	SEM[d]	Treatment	Sex(treatment)
Carcass weight 24 h, kg	79.4[a]	75.3[a]	74.2[ac]	66.9[b]	68.9[bc]	2.5	0.001	0.36
Muscle mass, kg	47.1[a]	45.5[a]	45.1[ac]	41.5[b]	42.2[bc]	1.4	0.005	0.32
Weight M. *semitensdinosus*, g	443	448	436	414	399	20	0.17	0.90
Weight *m. biceps femoris*, g	1593[a]	1526[a]	1484[ab]	1369[b]	1386[b]	29	0.004	0.27
Meat percentage, %	59.4	60.6	60.8	62.2	61.3	0.55	0.001	0.003
Fat thickness, mm	15	14	14	11	14	1.0	0.001	0.004
Drip loss, %	6.05	5.38	5.93	6.65	6.25	0.63	0.62	0.72
pH_{24}	5.61	5.64	5.56	5.57	5.57	0.04	0.13	0.93
L*	54	54	55	55	55	0.8	0.50	0.90
a*	8.0	8.6	8.6	7.8	7.6	0.38	0.12	0.69
b*	6.8	7.1	7.5	6.7	6.6	0.35	0.22	0.88
MFI LD day 0	49	46	47	47	47	2.3	0.58	0.47
MFI LD day 1	73	74	73	66	60	2.4	0.06	0.27
RNA LD, µg/g	2375[a]	2629[b]	2381[a]	2494[ab]	2465[ab]	64	0.04	0.52
DNA LD, µg/g	390	438	405	418	411	16	0.22	0.81
RNA ST, µg/g	2379	2265	2258	2337	2456	80	0.22	0.12
DNA ST, µg/g	404	392	405	428	409	14	0.35	0.03

[abcd] see table 2

RNA and DNA concentrations in muscles are related to the capacity of protein synthesis. In the present experiment the RNA concentration was higher in LD from pigs that had been restrictively fed for a period, however only the level in treatment group 2 were significantly higher than in treatment group 1 (Table 3). There were no effect of feeding strategy in the DNA concentration in LD or in the RNA and DNA concentration in ST. This support the idea, that ST is less affected by restrictive feeding and/or compensatory growth than the other muscles studied. Myofibril fragmentation index can be used as an indicator of the degree of proteolysis in the muscle and have been found to correlate with tenderness of meat. Thus we measured MFI to examine if compensatory growth has any effect on the degree of muscle protein degradation post mortem. There were no difference in the MFI at time of slaughter, however after 24 hours there were a tendency ($P = 0.06$) of a smaller MFI with increased restrictive feeding period and /or decreased length of ad libitum feeding (Table 3). This suggest a smaller degree of proteolysis in this meat, which would lead to less tender meat.

The data suggest that pigs fed restrictively for 28 to 42 days are able to compensate in regard to carcass weight and muscle mass when the following ad libitum period are 26 to 42 days. Drip loss, pH and colour traits were unaffected by restrictive feeding and compensatory growth.

Conclusion

The present study showed that compensatory growth, depending on the length of the restrictive period or finishing ad libitum period may affect the capacity of muscle protein synthesis and muscle proteolytic activity. Thus, compensatory growth may be a means to improve tenderness of pig meat.

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