

EFFECTS OF A ONE WEEK INTENSIVE FEED RESTRICTION IN THE GROWING RABBIT. Part 3: MUSCLE FIBRE DEVELOPMENT

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ABSTRACT

The effect of a one week intensive feed restriction was studied on the muscle fibre development of the growing rabbit. Rabbits were divided into 3 groups. Group 1 (ADL) was fed *ad libitum*, group 2 (R50) was restricted on 50 g per rabbit per day and group 3 (R65) was restricted on 65 g per rabbit per day. Restriction was applied from 42 to 49 days of age. Before and following restriction, rabbits were fed *ad libitum*. Samples of *musculus longissimus dorsi* (MLD) were taken from slaughtered rabbit for determination of histochemical parameters (number of muscle fibres, cross sectional area, diameter and fibre type distribution) in a week interval from 49 to 70 days. Rabbits were selected according to similar live weight, so loin weight and proportion of loin were not influenced by feed restriction. The lowest ($P \leq 0.001$) number of αR fibres in MLD was in R50 group at 70 days of age (25 fibres per 1 mm²), it means decrease by – 48 % compare to control group. There were no differences between *ad libitum* fed and restricted group in fibre cross-sectional area (1057 – 1429, 1156 – 1321 and 2398 – 2692 μm^2 for βR , αR and αW at 70 days of age, respectively). Restricted rabbits had the ($P=0.010$) smallest percentage of αR muscle fibres (– 15 % for R50 or – 22 % for R65 compare to *ad libitum*). The lowest percentage of muscle fibres type αR was found for R50 group at 70 days of age (9.0 % vs 13 % in *ad libitum* fed rabbits). Restricted group R65 had ($P=0.009$) a higher contribution of αW muscle fibres (85 %) than the *ad libitum* group (82 %).

Key words: Rabbit, feed restriction, loin, muscle fibre.

INTRODUCTION

Restricted feeding induces compensatory growth in following period and enhances feed efficiency, reduces fat in carcasses and it also can prevent post-weaning digestive disorders (Gondret *et al.*, 2000; Gidenne *et al.*, 2012).

Feed restriction can modify morphological, physiological and biochemical characteristics muscles (Gondret *et al.*, 2000; Metzger *et al.*, 2009). Muscle consists of muscle fibres, whose characteristics and typology are important factors for meat quality. Fibre composition depends on types of muscles and its function. At the birth rabbits muscles have mainly oxidative muscle fibres (αR and βR , Ouhayoun and Dalle Zotte, 1993). Later αR changes to αW fibres that are glycolytical. Differentiation on individual types of fibres can be detected after 21 days of age (Gondret *et al.*, 1996; Picard *et al.*, 2002). Restricted feed intake during growth increases the percentage of oxidative fibres in cattle, pig and lamb (Seideman and Crouse, 1986; Solomon and Lynch, 1988; Solomon *et al.*, 1988). Oxidative muscle fibres contain higher levels of intramuscular fat than glycolytic (Picard *et al.*, 2002).

The aim of this study was to determine the effect of a one week intensive feed restriction on development muscle fibres of *musculus longissimus dorsi* in growing rabbits.

MATERIALS AND METHODS

At weaning (35 days of age) 192 hybrid rabbits Hyplus were housed in collective cages for three rabbits with a floor space 0.16 m² per rabbit (details in part 1 of this study). Rabbits were divided into 3 groups. Group ADL was fed *ad libitum*, group R50 was restricted on 50 g per rabbit per day and group R65 was restricted on 65 g per rabbit per day. Restriction was applied from 42 to 49 days of age (details are in part 1 of this study). Before and following feed restriction rabbits were fed *ad libitum*. The pelleted feed was detailed in the part 1 of this study. Animals had free access to water. The rabbits were fattened till 70 days of age.

Rabbits were slaughtered at 49th, 56th, 63rd and 70th days of age. Rabbits for slaughtering were selected on similar live weight. Slaughter characteristics and analysis of muscle fibres were performed in 8 rabbits from each group. The method of slaughter measurement was harmonised with Blasco and Ouhayoun (1996). Samples of *musculus longissimus dorsi* were taken from slaughtered rabbit for determination of histochemical parameters. Samples were frozen in isopentane cooled by liquid nitrogen and then stored at -80°C until analysis.

Cross-section (12 µm) were cut with a cryostat Leica at -20°C. Subsequently, it was performed staining for myofibrillar ATPase after preincubation in alkaline buffer according to methodology by Brooke and Kaiser (1970). Fibres were typed according to nomenclature of Ashmore and Doerr (1971) as αR, βR and αW. Characteristics of muscle fibres (number of muscle fibres per 1 mm², fibre cross sectional area, diameter) were determined by software NIS Elements AR 3.1 (Laboratory Imaging). Then the fibre type distribution was calculated.

Data were processed by two-way analysis of variance, treatment and age using ANOVA procedure (SAS Institute Inc, 2003).

RESULTS AND DISCUSSION

Loin weight was ($P \leq 0.001$) affected by age, while restriction had no significant effect. The proportion of the loin was similar among the groups (16.1 to 16.5 % at 70 days of age). However, Matics *et al.* (2008) in time restricted rabbits found ($P \leq 0.01$) higher proportion of *musculus longissimus dorsi* than in *ad libitum* fed rabbits (7.1 % vs. 6.8 %).

Effect of restricted feeding on number of muscle fibres per 1 mm² was observed only in muscle fibres type αR. The ($P \leq 0.001$) lowest number αR muscle fibres (n=25) was found in R50 group at 70 days of age. Group restricted on 65 g per rabbit had the lowest number of muscle fibers regardless of the type. The number of muscle fibres is closely related to their area (Ryu and Kim, 2005). Oxidative fibres (αR and βR) have similar cross-sectional area, whereas αW fibres were larger (see table 2). There were no significant differences between fibre cross-sectional area individual types of muscle fibres in restricted and *ad libitum* fed rabbits. Likewise Dalle Zotte and Ouhayoun (1998) or Gondret *et al.* (2000) did not find differences in fibre cross-sectional area of *musculus longissimus lumborum* between rabbits with restriction and *ad libitum* fed rabbits.

Distribution of αR and αW muscle fibres was significantly influenced by feeding technique. We recorded a decreasing of αR muscle fibres by 15 % in R50 and by 22 % in R65 group compare to *ad libitum* fed rabbits. Group restricted on 65 g per rabbit per day had the ($P \leq 0.01$) lowest percentage of muscle fibres type αR, while distribution fibre type αW was in this group the ($P \leq 0.01$) highest. The lowest percentage of muscle fibre type αR was found in rabbits restricted on 50 g feed per rabbit per day at 70 days of age averaged 9 %, and percentage of muscle fibre type αW in 70 days of age was 89 %. Gondret *et al.* (2000) determined a reduced proportion of oxidative fibres in *musculus longissimus lumborum* of feed restricted rabbits (70 % of *ad libitum*) compared to control group (11.8 % vs. 16.9 % in ADL). Similar results detected Dalle Zotte *et al.* (2005b) in *biceps femoris* of rabbits restricted on 70 – 90 %.

Table 1: Effect of a one week intensive feed restriction on some slaughter parameters.

Treatment	Age (days)	Live weight (g)	Loin weight (g)	Proportion of loin (%)
Ad libitum	49	1624	118	14.8
	56	2237	178	15.9
	63	2526	217	16.2
	70	2915	260	16.5
R50	49	1660	136	16.5
	56	2294	179	15.9
	63	2501	208	16.1
	70	2713	229	16.3
R65	49	1751	133	15.9
	56	2271	167	14.8
	63	2510	206	16.3
	70	2744	233	16.1
SEM		157	24	1.6
Significance				
Treatment		0.14	0.34	0.51
Age		0.001	0.001	0.23
Treatment*age		0.15	0.13	0.36

Table 2: Effect of a one week intensive feed restriction on histomorphological characteristics of *musculus longissimus dorsi*

Treatment	Age (days)	Number of muscle fibres per 1 mm ²			Fibre cross-sectional area (µm ²)			Fibre type distribution (%)		
		βR	αR	αW	βR	αR	αW	βR	αR	αW
Ad libitum	49	18	115 ^a	365	1065	1023	1685	3.7	23.6	72.8
	56	9	43 ^{def}	298	1275	1077	2267	2.0	12.2	85.9
	63	10	46 ^{def}	293	1077	1236	2319	2.8	13.4	83.8
	70	9	48 ^{cde}	304	1057	1156	2398	2.6	13.1	84.3
R50	49	15	83 ^b	384	852	792	1684	2.8	17.2	79.9
	56	10	54 ^{cd}	371	1122	890	1822	2.2	12.3	85.6
	63	9	49 ^{cde}	280	1215	1128	2409	2.7	14.1	83.2
	70	8	25 ^f	249	1301	1321	2692	2.5	9.0	88.6
R65	49	12	68 ^{bc}	369	951	1009	1759	2.5	15.2	82.3
	56	10	44 ^{def}	351	1127	915	1875	2.4	10.7	87.0
	63	7	32 ^{ef}	256	1478	1364	2690	2.8	11.7	85.6
	70	6	35 ^{def}	274	1429	1244	2533	1.8	11.3	86.9
SEM		9	22	68	396	307	521	2.0	4.5	4.9
<i>Significance</i>										
Treatment		0.35	0.006	0.88	0.26	0.36	0.88	0.76	0.010	0.009
Age		0.017	<0.001	<0.001	0.043	<0.001	<0.001	0.42	<0.001	<0.001
Treatment*age		0.97	0.022	0.20	0.33	0.43	0.35	0.95	0.10	0.10

Means with different letters on the same row differ significantly (P≤0.05)

CONCLUSIONS

Results showed that an intensive one week restriction after weaning did not influence loin weight and proportion of loin from carcass. Most of muscle fibres characteristics were affected by age rather than group. In our experiment, interaction between treatment and age (P≤0.022) was found in number of αR muscle fibres. The lowest number αR muscle fibres had group restricted on 50 g per rabbit per day at 70 days of age (25) and the highest in ADL group at 49 days of age (115). Only number of muscle fibres type αR and the share of muscle fibres type αR and αW were influenced by group. Group restricted on 65 g per rabbit per day had the significantly lowest (P≤0.006) number and (P≤0.01) share αR muscle fibres.

Finally, quality of meat was affected by age rather than by feed restriction.

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