

EFFECT OF FEED RESTRICTION DURING POST-WEANING GROWTH ON FIBER CHARACTERISTICS OF *BICEPS FEMORIS* MUSCLE IN THE RABBIT

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ABSTRACT

At weaning (five weeks of age), 50 hybrid rabbits were at random divided into five groups (labelled blocks). Block 1, which were fed *ad libitum* with a commercial diet during weaning period, were slaughtered. The remaining rabbits were placed in individual cages and fed the same amount of food until slaughter, but differently rationed. From 5 to 8 wk of age, the rabbits coming from blocks 2 and 4 received 70% of *ad libitum*, meanwhile those belonging to blocks 3 and 5 received 90% of *ad libitum*. Animals of blocks 2 and 3 were slaughtered at 8 wk of age, while those of blocks 4 and 5 received the reverse restriction level and were slaughtered at 11 wk of age. All the animals were weighed before slaughter and the *Biceps femoris* muscle was immediately dissected and thereafter its fibers were typed (β R, aR and aW) and mean cross-sectional area was determined for each muscle. As expected, at eight-weeks slaughter age, rabbits given for 3 weeks the strictest feed restriction (70% of the *ad libitum*) showed the lowest body weight but presented significantly higher ($P < 0.01$) body weights after successive 3 weeks of rationing at 90% of the *ad libitum*, if compared with the rabbits that followed the inverse feeding treatment. The 70-90% rationing mode reduced the proportion of oxidative fibers. No relationship was found between the enlargement of muscle fibers and body weight. At the light of actual knowledge further investigations are needed to better understand the relationship between feed restriction and fiber characteristics.

Key words: rabbit, feed restriction, post-weaning growth, muscle, fiber type.

INTRODUCTION

Several studies performed on pigs (SOLOMON *et al.*, 1988), beef (SEIDEMAN and CROUSE, 1986) and lambs (SOLOMON and LYNCH, 1988) have demonstrated that the restricted feed intake during growth seems to increase the percentage of oxidative fibers, indicating the enhancement of the oxidative metabolism pathway.

In the rabbit the early feed restriction, applied from post-weaning age, could affect the live performance, carcass yield, muscle/bone ratio and ultimate pH, in a different way according to the type of feed rationing (PERRIER and OUHAYOUN, 1996). In particular, if the rabbits are moderately feed-rationed during the post-weaning period, they show a large compensatory growth rate during the following fattening period, resulting in better weight gain and global feed efficiency and in reduced feed costs. Moreover, as the pHu of their thigh muscles is reduced (PERRIER and OUHAYOUN, 1996), it suggests a change in the energy metabolism to the favor of the glycolytic path (DALLE ZOTTE and OUHAYOUN, 1995).

The present work was undertaken to examine the effects of feed restriction on fiber characteristics of *Biceps femoris* (BF) muscle, using different feeding pattern in which the feed restriction was applied either during the post-weaning period or during the fattening period.

MATERIAL AND METHODS

Animals, housing and feeding treatment

At weaning (5 weeks of age), 50 hybrid rabbits were at random divided into 5 groups (labelled blocks), caged individually and differently feed-restricted (Table 1).

Table 1. Experimental design

Blocks	Age 5 wk	Feeding treatment 5 to 8 wk	Age 8 wk	Feeding treatment 8 to 11 wk	Age 11 wk
1	slaughter				
2		70	slaughter		
3		90	slaughter		
4		70		90	slaughter
5		90		70	slaughter

Block 1, which were fed *ad libitum* with a commercial diet during weaning period, were slaughtered at 5 weeks of age. From 5 to 8 weeks of age, the rabbits coming from blocks 2 and 4 received 70% of *ad libitum*, while those belonging to blocks 3 and 5 received 90% of *ad libitum*. Animals of blocks 2 and 3 were slaughtered at 8 weeks of age. On the remaining rabbits of blocks 4 and 5 the restriction levels were reversed until slaughter at 11 weeks of age. The rabbits of blocks 4 and 5 received the same total amount of food, but differently rationed. The feed restriction was estimated in a preliminary study by calculating the spontaneous weekly food consumption of 50 rabbits bred in the same conditions as the ones of our experiment. The administered pelleted feed contained 17.1% crude protein, 15.4% crude fiber and 10.17 MJ DE/kg.

The rabbits were weighed before slaughtering and their *Biceps femoris* (BF) muscle was immediately dissected. The BF muscle was frozen in isopentane cooled by liquid nitrogen and stored at -80°C until histochemical analysis.

Muscle analysis

For histochemical analyses, serial cross-sections were obtained with a cryostat and stained for fiber's classification according to ASHMORE and DOERR (1971) as βR , αR or αW . For each muscle fiber type the respective percentage and mean cross-sectional area (CSA; μm^2) were determined with a computerized image analysis system. Analysis of variance was performed using the GLM procedure of SAS (SAS Institute Inc., 1990) considering as fixed effect the combined effect of "age-feed restriction" (block). Variability was expressed as residual standard deviation (RSD) for each variable.

RESULTS AND DISCUSSION

From five to eight weeks of age the rabbits belonging to the 70% restriction-group (block 2) consumed 95.8 g/d, while those of the 90% restriction-group (block 3) consumed 123.8 g/d. From eight weeks of age to slaughter (11 weeks) the rabbits belonging to the 70-90% rationing mode (block 4) consumed 151.9 g/d and those of the reverse rationing mode consumed 118.9 g/d (block 5). The overall feed consumption, from five to eleven weeks of age, was 123.7 and 121.1 g/d for 70-90 and 90-70 feed-rationing mode, respectively.

The distribution of the same quantity of food in two different modes (70-90% or 90-70% of the *ad libitum*) resulted in different weights at slaughter (Table 2). As expected, at 8 weeks the rabbits given for 3 weeks the strictest feed restriction (block 2 and 4) showed the lowest body weight than those given the 90% of the *ad libitum* diet (block 3 and 5; $P < 0.001$). However, these animals presented significantly higher body weights after successive 3 weeks of rationing at 90% of the *ad libitum* (block 4), if compared with the rabbits that followed the inverse feeding treatment (block 5). At the end of the fattening period, the rabbits that received the most liberal mode of rationing after 8 weeks of age showed the best growth due to the compensatory growth rate which occurs when animals are initially restricted.

Table 2. Slaughter weights of rabbits

	Blocks					P ⁽¹⁾ block	RSD
	1	2	3	4	5		
Slaughter age, wk	5	8	8	11	11		
Feed restriction	<i>ad lib.</i>	70%	90%	70-90%	90-70%		
Rabbits	10	10	10	10	10		
Slaughter wt, g:							
at 5 wk	1064	1061	1061	1063	1062	NS	83
at 8 wk	-	1536 ^a	1814 ^b	1567 ^a	1832 ^b	***	69
at 11 wk	-	-	-	2413 ^b	2216 ^a	***	72

⁽¹⁾ Level of significance: ***: P<0.001; a, b, c : P<0.05

On Table 3 are reported the data concerning the fiber characteristics of BF muscle. The aW fibers constantly increased (P<0.001) from block 1 to block 5. The percentage of aR fibers was significantly reduced (P<0.001) from block 1 to block 3 and remained stable afterwards. The BF muscle of rabbits of block 4, belonging to animals of 11 weeks of age and feed-restricted with the 70-90% feeding plan, showed significantly lower βR fibers (P<0.05) if compared with that of the other 4 blocks. These results suggest that early feed-restriction followed by a more liberal feeding treatment (block 4) induces, together with the compensatory growth rate, a significant reduction of the proportion of oxidative fibers.

Table 3. Fiber type distribution and fiber cross-sectional area of rabbit's *B. femoris* muscle

	Blocks					P ⁽¹⁾ Block	RSD
	1	2	3	4	5		
Slaughter age, wk	5	8	8	11	11		
Feed restriction	<i>Ad lib.</i>	70%	90%	70-90%	90-70%		
Rabbits	10	10	10	10	10		
Fiber type distribution, %:							
βR	4.9 ^b	6.3 ^b	5.8 ^b	2.1 ^a	5.0 ^b	*	3.1
αR	35.1 ^b	27.3 ^{ab}	25.9 ^a	22.6 ^a	23.5 ^a	***	4.4
αW	60.0 ^a	66.4 ^b	68.3 ^b	75.3 ^c	71.5 ^{bc}	***	5.1
Fiber cross-sectional area, μm ² :							
βR	605 ^a	990 ^b	997 ^b	1152 ^{bc}	1318 ^c	***	243
αR	599 ^a	1008 ^b	997 ^b	1117 ^b	1147 ^b	***	235
αW	986 ^a	1449 ^b	1526 ^{bc}	1774 ^{bc}	1783 ^c	***	271

⁽¹⁾ Level of significance: ***: P<0.001; **: P<0.01; * or a, b, c : P<0.05

DALLE ZOTTE and OUHAYOUN (1998) did not observe significant differences on fiber characteristics of *L. lumbrorum* m. of rabbits fed *ad libitum* a low-energy diet from weaning onwards, if compared to a control group of animals slaughtered at the same liveweight but at different age. Analogously, GONDRET *et al.* (2000) feeding restricted-diets to rabbits from 11 wk onward and slaughtering restricted and control rabbits at the same weight, did not find effects of feed restriction on fiber type composition of BF muscle.

The mean cross-sectional area (CSA) of the 3 types of fibers doubled from block 1 to block 5, but while the growth of β R and aW fibers continued till block 5 that of aR fibers stopped on block 2. However, in contrast with GONDRET *et al.* (2000), in the present work no difference seem to be evident for mean CSA of BF fiber types among rabbits differently feed-restricted. GONDRET *et al.* (2000) stated that the enlargement of muscle fibers is correlated with body weight rather than age; in the present study no relationship was found between these two variables.

CONCLUSIONS

In conclusion, the results reported herein have demonstrated that feed restriction during post-weaning period influences the commercial slaughter weight in different way according to the feed rationing mode (70-90% vs 90-70%), resulting in better performance with early feed restriction followed by quite-*ad libitum* feed intake.

The 70-90% rationing mode reduced the proportion of oxidative fibers. At the light of actual knowledge further investigations are needed to better understand the relationship between feed restriction and fiber characteristics.

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