

## EFFECT OF MATERNAL FEED RESTRICTION ON MUSCULAR CHARACTERISTICS OF RABBIT OFFSPRING

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### ABSTRACT

Thirty hybrid female rabbits of 15 weeks of age were at random divided into three groups and fed with one of the 3 following diets: "C diet" for young females (DE = 11.71 MJ/kg DM) fed *ad libitum*; "R diet" was the C diet fed at 80% of *ad libitum*, "F diet" rich in fiber (24.6% vs 18.7% for C diet; DE = 9.77 MJ/kg DM) fed *ad libitum*. The does were inseminated at the 19<sup>th</sup> weeks of age. The 3 diets were administered until the first parturition, afterwards all the does received the C diet *ad libitum*. Three pups per litter were slaughtered at birth, at 35d of age (weaning) and at 81d of age, respectively. At the second parturition, another pup per litter was slaughtered at birth. Ten minutes *post mortem* the *Longissimus lumborum* (LL) muscle of each slaughtered rabbit was sampled and then underwent the histochemical treatment: mean cross-sectional area (CSA), compactness index (CI) and sphericity (SPH) of the fibers of the new-born rabbits; percentage of the fiber types ( $\beta$ R,  $\alpha$ R or  $\alpha$ W) and CSA for rabbits of 35 and 81d of age. At birth all the fibers of LL muscle were typed as aR. The maternal feed restriction, applied as qualitative restriction (diet F) or quantitative restriction (diet R) significantly increased the CI of LL fibers of newborn rabbits of the first kindling, while maternal feed restriction effect was not evident on young of second kindling. At weaning, the young rabbits belonging to the first kindling exhibited an effect of maternal feed rationing on fiber type distribution. R diet, compared with F and C diets, significantly increased the percentage of  $\beta$ R fibers, while F diet significantly reduced the percentage of aR fibers. The greatest effect of maternal feed restriction on weaning rabbit was observed on the percentage of  $\alpha$ W fibers ( $P < 0.01$ ), which was the highest for F diet (85.2%), intermediate for C diet (78.0%) and the lowest for R diet (71.8%). At 81d of age, no effect of maternal dietary treatment was found on offspring.

**Key words:** rabbit, doe, feed rationing, muscle, fiber type.

### INTRODUCTION

The young rabbit does fed *ad libitum* with diets of high energy level often show parturition problems, with the subsequent reduction of the number of newborn rabbits,

linked to excessive fatness (FORTUN-LAMOTHE and LEBAS, 1996). In order to reduce the excessive fatness of young rabbit does, restricted feeding is frequently applied.

Research on the effect of maternal restricted feeding on the possible influence on the offspring's productive performance are scarce and limited to birth-weaning period (EIBEN *et al.*, 1999; PASCUAL *et al.*, 1999; SZENDRÖ, 2000; DALLE ZOTTE *et al.*, 2001). The consequences of maternal feed restriction on the metabolic and contractile properties of muscle fibers of rabbit offspring have not been studied.

The aim of the present work was to evaluate the effect of a moderate feeding restriction of nulliparous does, applied until first parturition, on muscle fibers properties of rabbit offspring belonging to the first and the second kindling.

## MATERIAL AND METHODS

### Animals, housing and experimental diets

Thirty hybrid female rabbits of 15 weeks of age were at random divided into 3 groups and fed to one of the 3 following diets: "C" diet for young females (DE = 11.71 MJ/kg DM) fed *ad libitum*; "R" diet, was the C diet fed at 80% of *ad libitum*, "F" diet rich in fiber (24.6% vs 18.7% for the C diet; DE = 9.77 MJ/kg DM) fed *ad libitum*.

The young does were artificially inseminated at the 19<sup>th</sup> weeks of age. The 3 diets were administered until the first parturition, afterwards all the does received the C diet *ad libitum*. The second insemination occurred nine days after the parturition. All the lactating does were concurrently pregnant. At each birth, the litter size was equalized to eight.

### Slaughtering and sampling

Three pups per litter were chosen with liveweight corresponding to the average live weight of the whole litter, and slaughtered at birth, at 35d of age (weaning) and at 81d of age, respectively. At the second parturition, another pup per litter was slaughtered at birth. Ten minutes *post mortem* the *Longissimus lumborum* (LL) muscle was sampled (3<sup>rd</sup> to 7<sup>th</sup> lumbar vertebra).

### Histochemical analysis of the *Longissimus lumborum* muscle

Serial cross-sections from each LL sample, belonging to rabbits of 35 and 81d of age were obtained with a cryostat at -20°C and stained for fiber's classification according to ASHMORE and DOERR (1971) as  $\beta$ R, aR or aW. Percentage and mean cross-sectional area (CSA;  $\mu\text{m}^2$ ) of each fiber type were determined for each muscle with a computerized image analysis system. Fibers of the new-born rabbit's LL muscle were totally identified as aR type, so, only the histomorphological characteristics were determined: CSA, compactness index ( $\text{CI} = \text{perimeter}^2 / \text{area}$ ), sphericity ( $\text{SPH} = d/D$ ;  $d = \text{smallest diameter}$ ;  $D = \text{biggest diameter}$ ).

Variance analysis was performed using the GLM procedure of the SAS program (SAS Institute Inc., 1990), by including diet as fixed effect.

## RESULTS AND DISCUSSION

At birth all the fibers of LL muscle were typed as aR. The maternal feed restriction, applied as qualitative restriction (diet F) or quantitative restriction (diet R) significantly increased the CI of LL fibers of 1-day-old offspring coming from the first kindling, but unaffected the histomorphological characteristics of fibers of second kindling (Table 1).

**Table 1. Maternal feed restriction effect on fiber histomorphological characteristics of newborn rabbit's *Longissimus lumborum* muscle at the 1<sup>st</sup> and 2<sup>nd</sup> kindling**

	Diets			Probabilities	RSD
	C	F	R		
<u>First kindling:</u>					
No.	9	9	7		
Fiber cross-sectional area, $\mu\text{m}^2$	47	40	54	NS	14
Compactness index <sup>(1)</sup>	1.74 <sup>a</sup>	1.83 <sup>b</sup>	1.84 <sup>b</sup>	**	0.06
Sphericity <sup>(2)</sup>	0.64	0.66	0.68	NS	0.03
<u>Second kindling:</u>					
No.	8	9	7		
Fiber cross-sectional area, $\mu\text{m}^2$	41	43	49	NS	14
Compactness index <sup>(1)</sup>	1.93	1.92	1.98	NS	0.09
Sphericity <sup>(2)</sup>	0.63	0.65	0.65	NS	0.04

<sup>(1)</sup> (perimeter)<sup>2</sup>/area; <sup>(2)</sup> d/D; d = smallest diameter; D = biggest diameter; \*\* or a, b = P<0.01

According to VIGNERON *et al.* (1983), during the intra-uterine life the maternal feed restriction could reduce the total number of fibers of fetuses muscle, but this reduction is compensated by the increase of fiber CSA. In the present work the total number of fiber was not assessed, but the greater fiber CSA observed on R group, in which the maternal feed restriction was more severe, could indicate this kind of compensation.

At weaning, the young rabbits belonging to the first kindling exhibited an effect of maternal feed restriction on fiber type distribution (Table 2). R diet, compared with F and

C diets, significantly increased the percentage of  $\beta$ R fibers. On the contrary, F diet significantly reduced the percentage of aR fibers (10.2 vs 4.2%;  $P < 0.05$ ).

The greatest effect of maternal feed restriction was observed on the percentage of aW fibers ( $P < 0.01$ ), which was the highest for F diet (85.2%), intermediate for C diet (78.0%) and the lowest for R diet (71.8%). This reduction of the proportion of aW fibers induced by the quantitative feed restriction of the does indicates a decrease of their glycolytic metabolism of the offspring.

GONDRET *et al.* (1997) have demonstrated that nutrient deficiency induced by concurrent gestation and lactation, if compared with only gestation, delayed the myofibrillar maturation rate of offspring revealed at 29d of age, but at 70d of age no effect was found on fiber type proportion.

Analogously, in the present work the probable nutrient deficiency of does induced by feed restriction delayed the fiber's differentiation of offspring LL muscle, delay detectable until the weaning age of 35d.

**Table 2. Maternal feed restriction effect on fiber type distribution and mean cross-sectional area of rabbit's *Longissimus lumborum* muscle at weaning of litters belonging to the first kindling**

	Diets			Probabilities	RSD
	C	F	R		
No.	10	7	8		
Fiber type distribution, %:					
$\beta$ R	4.2 <sup>a</sup>	4.2 <sup>a</sup>	10.2 <sup>b</sup>	*	4.4
aR	17.8 <sup>b</sup>	10.5 <sup>a</sup>	18.0 <sup>b</sup>	*	5.7
aW	78.0 <sup>ab</sup>	85.2 <sup>b</sup>	71.8 <sup>a</sup>	**	6.9
Fiber cross-sectional area, $\mu\text{m}^2$ :					
$\beta$ R	311	376	348	NS	103
aR	300	318	382	NS	135
aW	498	494	608	NS	227

\* or a, b =  $P < 0.05$ ; \*\* =  $P < 0.01$

The histomorphological characteristics of LL muscle were not significantly influenced by the maternal dietary treatment. At 81d of age, no effect of maternal dietary treatment was found on offspring, indicating that the same diet administered to all rabbits from weaning to commercial slaughter age nullified the effect of maternal diet.

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