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ONE WEEK FEED RESTRICTION IN EARLY WEANED RABBITS: 1- PERFORMANCE AND INTERNAL ORGANS DEVELOPMENT

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ABSTRACT

The aim of the experiment was to compare the effects of *ad libitum* (AL) and two feed restriction levels applied for one week, on performance and internal organ development of rabbits weaned at 25 days of age. Ninety six rabbits were divided into three groups, group 1 (AL) was fed *ad libitum* from 25 to 81 days of age, R50 rabbits were restricted from 32 to 39 days and received 50 g daily of the same feed (46% of AL), R65 rabbits were restricted at the same age and were fed daily 65 g feed (60% of AL). In the first week after weaning and in the weeks after restriction all groups were fed *ad libitum*. Final live weight at 81 days of age and feed conversion ratio were not affected. Daily weight gain (DWG) was during the restriction period reduced to 61% and 67%, and the first week after restriction DWG increased to 118% in R50 and 110% in R65 group. There was no significant effect of feed restriction on kidney, heart and lung relative weights. However, liver relative weight was decreased by restriction (P<0.001) to 55% in R50 and 61% in R65 at 39 days, and at 81 days reached 98% and 102% respectively of the value in AL rabbits. Feed restriction in early weaned rabbits induced compensatory growth which was affected by the intensity of feed restriction. Liver was more influenced by feed restriction strategy than other internal organs.

Key words: rabbit, early weaning, feed restriction, growth, liver

INTRODUCTION

Limited feed intake in growing rabbits has been used to reduce the incidence of post-weaning digestive disorders. Different methods of feed restriction can be applied. French rabbit breeders widely practice a three to four week feed restriction of about 20% to 25% of free intake (Gidenne et al., 2012). A short intensive feed restriction can be beneficial for growing rabbits due to compensatory growth, improved feed efficiency (Tůmová et al., 2016). Feed restriction and realimentation period seem to have different effect on internal organ development. Tůmová et al. (2007) observed after a one or two weeks restriction, on maintenance level between 42 and 56 days of age, a higher percentage of heart (11% resp. 3%) and kidney (5% resp. 4%) and at the end of the experiment the percentage of both organs was lower compared to the *ad libitum* (AL) fed ones. However, liver percentage was after restriction lower (-25% resp. -15%) and higher at 84 days (+9% resp. +11%). The results were confirmed by another experiment with one week feed restriction (Tůmová et al., 2016). On the other hand, in rabbits with intermittent restriction (5 days of 7) liver weight was higher compared with those ration given daily (Gidenne et al., 2012). In other organs, Knudsen et al. (2015) did not find the effect of feed restriction and dietary energy on relative weight of spleen and appendix. All these data were

received in rabbits weaned around 35 days of age. However, there is lack of information about the effect of feed restriction in early weaned rabbits. The aim of the experiment was to evaluate the effect of AL and two feed levels applied for one week on performance and internal organ development in early weaned rabbits.

MATERIALS AND METHODS

Animals and experimental design

The experiment with Hyplus rabbits weaned at 25 days of age and restricted one week seven days after weaning was carried out. Ninety six weaned rabbits (sex ration 1:1) were randomly divided into three groups: group 1 was fed *ad libitum* (AL); group 2 (R50) rabbits were restricted from 32 to 39 days of age and received 50g of the same feed daily (46% of AL); and group 3 (R65), rabbits were restricted at the same age and were fed 65 g feed daily (60% of AL). Before and after feed restriction, rabbits were fed *ad libitum* until the end of the experiment at the age of 81 days. Water was available *ad libitum*. During the experiment, rabbits received feed mixture with analyzed nutrient content: 17.1% crude protein, 20.7% crude fibre and 2.8% ether extract. The feed composition was the same as in our previous experiment Tůmová et al. (2016). Rabbits were housed in group cages (4 rabbits per cage, 8 cages per group) with floor density of 0.12 m²/rabbit. A 12-h photoperiod was used, a temperature of 15 to 17°C and relative humidity of 55 to 60% were maintained. In the experiment, feed consumption was recorded daily and rabbit were weighed weekly.

Slaughter Analyses

For organ measurement, rabbits were slaughtered at 39 and 81 days of age (8 rabbits per group and age) in an experimental slaughterhouse. After slaughtering, carcass weight was done according to Blasco and Ouhayoun (1996). Internal organs, kidney, heart, liver and lung were collected and weighed individually from the hot carcass. Then the percentage from the hot carcass was calculated.

Statistical Analysis

Data of the experiment were processed by ANOVA procedure (SAS Institute Inc., 2003), growth and feed intake by one-way analysis of variance and organ percentage by two-way analysis of variance with the group and age interaction. The statistically significant differences (P<0.05) in rows are indicated by a different superscript.

RESULTS AND DISCUSSION

Final live weight (Table 1) was not significantly affected by feeding regime and intensity of the restriction. Rabbits of both restricted groups reached 99% and 97% of the weight of AL rabbits. In our previous experiment with rabbits weaned at 35 days of age final live weight remained 7 to 10% below AL group (Tůmová et al., 2016). Lower differences between AL and restricted rabbits compared to the previous experiment were presumably related to the longer realimentation period. Daily weight gain (DWG) was during the restriction period reduced to 61% and 67% when feed intake (FI) was decreased to 46% and 60% of the AL rabbits. In the following weeks of the re-feeding period restricted rabbits had a non-significantly higher DWG compared to AL rabbits, group R50 5%, and group R65 4%. FI non-significantly differed only in the group R50 (3%). In our previous experiment with short intensive restriction (Tůmová et al., 2016) compensatory growth was not associated with overfeeding described by Knudsen et al. (2014) in 4 week restriction on 75% of AL. It is possible to assume that in the short intensive feed restriction compensatory growth is related to changes in digestive physiology observed in our previous experiment (Tůmová et al., 2016). Results of the whole experiment show that feed intake was non-significantly lower about 4% in both restricted groups, DWG was similar in all groups, FCR was reduced by 3% to 4%, and no mortality was observed which corresponds with the early study (Tůmová et al., 2016).

	AL	R50	R65	RMSE	Prob.
Live weight at 25 days (g)	510	514	510	57	ns
Live weight at 81 days (g)	2893	2856	2788	278	ns
25 to 32 days of age					
Feed intake (g)	61.3	61.2	61.3	5.6	ns
Daily weight gain (g)	44.0	45.4	43.3	9.8	ns
32 to 39 days of age					
Feed intake (g)	108.9	50.0	65.0	3.4	nc
Daily weight gain (g)	53.4 ^a	32.4 ^b	36.0 ^b	14.0	***
39 to 81 days of age					
Feed intake (g)	149.2	153.2	149.3	10.3	ns
Daily weight gain (g)	41.0	43.1	42.6	5.5	ns
25 to 81 days of age					
Feed intake (g)	133.1	128.7	127.4	8.2	ns
Daily weight gain (g)	42.9	42.3	41.2	4.7	ns
FCR (kg/kg)	3.13	3.00	3.05	0.33	ns
Mortality	0/32	0/32	0/32		

Table 1. The effect of *ad libitum* and restricted feeding on live weight, feed intake and daily weight gain

* P < 0.05, ***P < 0.001, NS-non significant, NC non calculable for zero variance of feed intake in restricted groups; ADL=*ad libitum*; R50= 50 g of feed per day and rabbit; R65= 65 g feed per day and rabbit; restriction period from 32 to 39 days of age; FCR=feed conversion ratio; ^{a,b} Values within a row with different superscripts differ significantly at P < 0.05.

Percentage of internal organs (Table 2) was reduced by feed restriction; however, only liver percentage was significantly lower. At the end of feed restriction, at 39 days of age, kidney, heart and lung percentage was reduced to 80% - 88% of the AL group. At the end of the experiment, kidney percentage was higher in restricted rabbits (7% in R50 and 6% in R65) than those of the AL. Heart and lung percentage remained below the percentage of the AL ones. Presumably, the results were affected by intensity of restriction because in other study Tůmová et al. (2007) with one or two week restriction in rabbits weaned at 35 days, at the end of the experiment kidney percentage was 2% to 10%, heart 7% to 9% lower, and lung 2% to 12% higher compared to the AL group. The liver percentage was significantly decreased by restriction to 55% in R50 and 61% in R65 at 39 days and at 81 days reached 98% respectively 102% of the percentage in AL rabbits. In the previous experiments with rabbits weaned at 35 days (Tůmová et al., 2007; Tůmová et al., 2016) liver percentage after feed restriction was only moderately or not affected but at the end of the experiment was higher than in AL rabbits. It seems that liver as an early developing organ is more affected by feed restriction in early weaned rabbits than in rabbits weaned later.

Table 2. The effect of *ad libitum* and restricted feeding on internal organ relative weight (%)

	Α	L	R50		R65			Prob.		
Age (d)	39	81	39	81	39	81	RMSE	Group	Age	G x A
LW	1291 ^b	2857 ^a	987 ^c	2903 ^a	1043 ^c	2969 ^a	148	ns	***	***
CW	600^{b}	1521 ^a	493 ^c	1561 ^a	517 ^{bc}	1591 ^a	95	ns	***	*
KP	1.85	1.04	1.64	1.12	1.70	1.11	0.19	ns	***	ns
HP	0.73	0.53	0.64	0.52	0.72	0.50	0.08	ns	***	ns
LP	9.76 ^a	7.52 ^b	5.38 ^c	7.37 ^b	5.94 ^c	7.69 ^b	1.06	***	ns	***
LuP	1.32	0.92	1.07	0.80	1.06	0.90	0.16	***	***	ns

* P<0.05, ***P<0.001, NS-non significant; ADL=*ad libitum*; R50= 50 g of feed per day and rabbit; R65= 65 g feed per day and rabbit; restriction period from 32 to 39 days of age; ^{a,b,c} Values within a row with different superscripts differ significantly at P<0.05. GxA=group x age interaction. LW=live weight, CW= hot carcass weight, KP=kidney percentage from hot carcass, HP=heart percentage from hot carcass, LP=liver percentage from hot carcass

CONCLUSIONS

Results of the study show that one week feed restriction in early weaned rabbits induced compensatory growth at the realimentation period and restricted rabbits reached similar final weight like ad libitum

fed rabbits. A higher restriction intensity increased compensatory growth which was not associated with feed intake. Feed conversion was lower in restricted groups. From internal organs, liver percentage was more affected by feed restriction than other organs. Presumably, the combination of the feed restriction and early weaning has higher impact on liver development than feed restriction in later weaned rabbits.

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ONE WEEK FEED RESTRICTION IN EARLY WEANED RABBITS: PERFORMANCE AND INTERNAL ORGANS DEVELOPMENT



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The Message		Introduction
 Intensive feed restriction in early weaned r Compensatory growth affected by intensity Feed restriction decreased relative liver weaned relative live	rabbit y of restriction eight	Limited feed intake in growing rabbits has been used to reduce the incidence of post-weaning digestive disorders. Different methods of feed restriction can be applied. A short intensive feed restriction can be beneficial for growing rabbits due to compensatory growth, improved feed efficiency (Tůmová et al., 2016). Feed restriction and realimentation period seem to have different effect on internal organ development.

Methods

- Weaning age 25 days, end of the experiment 81 days
- Group 1 ad libitum (AL), group 2 (R50) restriction from 32 to 39 days of age and received 50g of the same feed daily (46% of AL), group 3 (R65) restriction at the same age, 65 g feed daily (60% of AL)
- Group cages (0.12 m²/rabbit)
- Slaughtering 8 rabbits per group (Blasco and Ouhayoun, 1996)
- Kidney, heart, liver and lung, percentage from the hot carcass

Results

Figure 1: Feed intake during feed restriction and the realimentation period



Figure 2: Daily weight gain during feed restriction and the realimentation period



25 to 32 32 to 39 39 to 46 46 to 53 53 to 60 60 to 67 67 to 74 74 to 81 Days of age

 Table: The effect of ad libitum and restricted feeding on internal organ relative weight (%)

	AL		R50		R65		DNACE	Significance	
Age (d)	39	81	39	81	39	81	RIVISE	G x A	
КР	1.85	1.04	1.64	1.12	1.70	1.11	0.19	ns	
НР	0.73	0.53	0.64	0.52	0.72	0.50	0.08	ns	
LP	9.76ª	7.52 ^b	5.38 ^c	7.37 ^b	5.94°	7.69 ^b	1.06	***	
LuP	1.32	0.92	1.07	0.80	1.06	0.90	0.16	ns	

***P<0.001, NS-non significant; AL=ad libitum; R50= 50 g of feed per day and rabbit; R65= 65 g feed per day and rabbit; restriction period from 32 to 39 days of age; KP=kidney percentage from hot carcass, HP=heart percentage from hot carcass, LP=liver percentage from hot carcass, LuP=lung percentage from hot carcass





Conclusion

- Higher intensity of feed restriction increased compensatory growth
- Feed intake was not affected by feeding regime
- Feeding regime did not affect heart, kidney and lung percentage
- Feed restriction decreased liver percentage after restriction and did not affect it after realimentation

The present study was supported by the Ministry of Agriculture of the Czech Republic (Project NAAR No. QJ1510192).