EFFECTS OF A ONE WEEK INTENSIVE FEED RESTRICTION IN THE GROWING RABBIT: Part 1 - PERFORMANCE AND BLOOD BIOCHEMICAL PARAMETERS

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ABSTRACT

A total of 192 Hyplus rabbits (male and female ratio 1:1) of weaning age 35 d were randomly divided into three experimental groups (n=64 each), group 1 was fed *ad libitum* (control), group 2 (R50) was restricted from 42 to 49 d of age (50 g/d/rabbit), and group 3 (R65) was restricted from 42 to 49 d of age (65 g/d/rabbit). After the restriction time, all the groups were back to *ad libitum* feeding till the end of the experiment (70 d of age). Growth was recorded weekly. After restriction period, haematological and biochemical parameters were measured in a week interval. During the restricted period, the values of daily weight gain in restricted rabbits were lower than in full-fed rabbits, but after restriction, when animals were again fed *ad libitum*, a compensatory growth was found. Final body weight (at 70 d of age) tended to be lower in restricted groups (-9%, P=0.08). Blood plasma glucose, total protein and urea concentrations were not significantly affected by feed restriction in growing rabbits. However, feed restriction reduced blood plasma triacylglycerols (-23% in R50 and -16% in R65 vs control, P<0.05), and non-esterified fatty acids (NEFA, 19 % in R50 and 23% in R65) while increased cholesterol (+27 % in R50 and +29% in R65 vs control, P<0.01). Feed restriction reduced the erythrocyte number by 6 and 7% in R50 and 3 resp. (P<0.05) and haemoglobin concentration by 7 and 5% in R50 and R65, resp.(P< 0.01), meanwhile mean cell volume (MCV) was increased by 1.5 and 2.7% in R50 and R65, resp. (P<0.05). Feed restriction had no significant effect on leukocyte number and haematocrit value. It could be concluded that short-term limitation of the feed intake improved feed conversion ratio, had a limited negative effect on final body weight, reduced blood plasma TAG and NEFA, and seemed to produce normal blood picture in fattening rabbits.

Keywords: Feed restriction, growth, biochemical constituents, blood picture.

INTRODUCTION

Feeding strategy in growing rabbits could be used to produce animals with maximum lean body mass, the lowest feed conversion ratio, and the best meat quality. The early-life fast growth rate is accompanied by a number of problems, namely increased body fat deposition, high incidence of metabolic disorders, high mortality, and high incidence of skeletal diseases. In the growing rabbits, an early feed restriction applied around post-weaning age could be of interest to improve feed efficiency (Tůmová *et al.,* 2002; Yakubu *et al.,* 2007; Gidenne *et al.,* 2009; Gidenne *et al.*, 2012), induce compensatory growth (Tůmová *et al.,* 2002; Foubert *et al.,* 2008), reduce carcass fat deposition (Tůmová *et al.*, 2004), improve digestibility of nutrients during the restricted feeding period (Tůmová *et al.,* 2004; Di Meo *et al.,* 2007) and reduce post weaning digestive disorders namely the Epizootic Rabbit Enteropathy syndrome (ERE, Boisot *et al.,* 2003). In fact, digestive disorders are the main cause of morbidity and mortality in growing rabbits which are responsible for important economic losses in industrial rabbit farms. Therefore, early feed restriction could be used a useful tool to improve the biological and economic performance (Tůmová *et al.,* 2007), which consequently involved in reducing the costs of production (Yakubu *et al.,* 2007).

Since short-term intake restriction had positive impacts in growing rabbits, the objective of the present study was to investigate the effect of a one week intensive feed restriction on growth, blood biochemical parameters and blood picture in growing rabbits.

MATERIALS AND METHODS

This study was carried out at the Research Institute of Animal Production, Prague, the Czech Republic. A total of 192 Hyplus rabbits (male and female ratio 1:1) of weaning age 35 days were housed in commercial wired cages (3 rabbits per cage) with floor density 0.16 m^2/rabbit in 12 h photoperiod (lights were turned on at 8 a.m. and turned off at 8 p.m.). Rabbits were randomly divided into three experimental groups (n=64 each), group 1 was fed *ad libitum*, group 2 (R50) was restricted from 42 to 49 d of age (50 g/d/rabbit), and group 3 (R65) was restricted from 42 to 49 d of age (65 g/d/rabbit). Feed was given manually at 8:30 a.m. After the restriction time, all the groups were back to *ad libitum* feeding till the end of the experiment (70 d of age). Water was available all time *ad libitum*. Rabbits were fed pelleted commercial diets which were used in previous experiments (Tůmová *et al.,* 2007). Feed was analyzed using standard AOAC methods (2005) and analyzed nutrient concentration (% as fed) was 90.1 % dry matter, 17.1 % crude protein, 20.7 % crude fibre and 2.8 % fat. Rabbits were weighed individually and feed consumption was registered collectively per cage in week intervals. Daily weight gain and the feed conversion ratios (FCR) were calculated. Mortality rate was recorded daily. After restriction, from the age 49 d, 8 rabbits from each group were bled in a week interval to assess the haematological and biochemical parameters. Samples were taken every collection at the same time at 9 a.m. Haematology characteristics, including erythrocyte number, leukocyte number, mean cell volume (MCV), concentration of haemoglobin (Hb) and haematocrit value (PCV) were detected in blood stabilized by K_2EDTA. The analyses were done using a Coulter Model ZF (Coulter Electronics Ltd, England). Leukocyte counts were stained by Papenheim method. Biochemical blood plasma parameters, total protein, albumin, urea, glucose, cholesterol, triacylglycerols (TAG) and non-esterifed fatty acids (NEFA), were determined photo-metrically in a spectrophotometer Libra S22 (Biochrom Ltd., UK) by using a standard commercial kits (Randox Laboratories Ltd., Crumlin, UK). Data of growth performance were statistically analyzed by one-way ANOVA using the GLM procedure of SAS. The significance of difference among groups was compared using the Scheffe test on the level of significance $P \leq 0.05$. Data of haematological and biochemical parameters were statistically analyzed by two-way ANOVA, group and age interactions using the GLM procedure of SAS (SAS Institute Inc, Cary, Nc, 2003).

RESULTS AND DISCUSSION

Analyzing the daily weight gain (Table 1) indicated that during the restriction period (42-49 d of age), the daily weight gain was proportionally reduced (-80 to -89 %, $P \leq 0.001$) according to the level of feed restriction. The quantity of feed (50 or 65 g/d/rabbit for one week) and time of restriction was based on the results of our previous experiments (Tůmová *et al.,* 2002, 2007) where one week severe restriction produced compensatory growth. For instance after one week restriction, the animals showed a 49 to 65% ($P \leq 0.001$) higher weight gain compared with those always fed *ad libitum*. Over the the whole experiment (35 to70 d of age), a negative effect (-9 to -12%, $P<0.05$) of the level of feed restriction was found for the daily weight gain and led to a lower final weight (-10 to 12% at 70 days of age).These results were in agreement with Foubert *et al.* (2008) who referred that, during the whole fattening period (restriction plus realimentation), daily weight gain was lower (between -6.2 and -14.8%) for restricted groups. Tůmová *et al.* (2002) also reported that during the restriction period, weight gain in restricted rabbits was about 60-70% lower than in fullfed rabbits, however, in the week after feed restriction, weight gain was higher by 40% than in rabbits fed *ad libitum*.

During the whole experimental period (35-70 d), there was a positive effect of the level of feed restriction on the feed conversion ratio ($P<0.05$, Table 1). Similar findings were reported by Gidenne *et al.* (2009) who revealed that feed restriction during 21 days after weaning reduced linearly the feed conversion ratio over the whole fattening period. These results are in agreement with several authors who reported that a restricted feeding improved the feed efficiency (Tůmová *et al.,* 2002; Boisot *et al.,* 2003; Yakubu *et al.,* 2007; Gidenne *et al.,* 2012). It is assumed that such an improvement stems from an improved digestibility of nutrients, as decribed by Tůmová *et al.* (2004) and Di Meo *et al.* (2007). Moreover, Martignon *et al.* (2010) documented that short-term intake limitation may improved the immunological status of the gut.

Table 1: Effect of a one week intensive feed restriction on performance in growing rabbits.

Group	Daily weight gain (g)						FCR 35-70 d (kg feed/Kg gain)	Mortality (%)
	35-42 d	42-49 d	49-56 d	56-63 d	63-70 d	35-70 d		
Ad libitum	40.4	75.0 a	54.5 b	54.7	51.6	55.2 a	3.17 a	0
R50	40.8	8.3 c	89.9 a	57.9	52.6	49.9 ba	2.98 b	0
R65	41.5	15.1 b	81.3 a	54.5	50.4	48.6 b	3.04 ab	0
RMSE	6.9	5.7	7.7	9.9	8.8	5.0	0.16	-
P - values	*0.941*	*0.001*	*0.001*	*0.699*	*0.849*	*0.014*	*0.033*	-

R50: Restriction 42-49 d of age (50 g/d/rabbit), R65: Restriction 42-49 d of age (65 g/d/rabbit), RMSE: root mean square error, FCR: feed conversion ratio. Means in the same row without common superscripts are significantly different.

As presented in Table (1), feed restriction had no effect on mortality of the animals. No mortality was detected during the experimental period. These results confirmed several previous studies which indicated that feed restriction did not influence mortality of rabbits (Tůmová *et al.,* 2002; Di Meo *et al.,* 2007; Foubert *et al.,* 2008). Di Meo *et al.* (2007) demonstrated that feed restriction had no significant effect on mortality rate in comparison to rabbits fed *ad libitum*. Tůmová *et al.* (2002) documented that a short feed restriction (50 g/d/rabbit from 35 to 42 d of age or 65 g/d/rabbit from 42 to 49 d of age) did not affect mortality, while a more long restriction (for 2 or 3 weeks) reduced mortality and morbidity from digestive troubles (Gidenne *et al.,* 2012).

Table 2: Effect of a one week intensive feed restriction on live body weight and daily feed intake in growing rabbits

Group	Live body weight (g)				Daily feed intake			
	35 d	42 d	49 d	70 d	35-42 d	42-49d	49-56 d	35-70 d
Ad libitum	1011	1294	1819^{a}	2944	104	174^{a}	181	175^{a}
R50	1006	1286	1344^{b}	2747	102	50^{b}	177	148^{b}
R65	1000	1281	1387^{b}	2690	100	65^{b}	176	147^{b}
RMSE	*118*	*119*	*138*	*254*	*5.9*	*28.8*	*10.2*	*9.9*
P - values	0.928	0.969	0.001	0.081	0.445	0.001	0.496	0.001

R50: Restriction 42-49 d of age (50 g/d/rabbit), R65: Restriction 42-49 d of age (65 g/d/rabbit), RMSE: root mean square error.
Means in the same column without a common superscripts are different at the level $P<0.05$.

Blood plasma glucose concentration was not significantly affected by feed restriction in growing rabbits (Table 3). Similarly, Van Harten and Cardoso (2010) observed that feed restriction did not reduce plasma glucose and this might be attributed to no need for an increase in catabolizing glucose. This result is corroborated with the level of glucose 6-phosphate that also did not change with feed restriction and with the increase in glucose-6-phosphatase activity. Also, Rajman *et al.* (2006) demonstrated that concentrations of plasma glucose were not altered by feed restriction in meat type chickens. Our data showed that feed restriction resulted in reducing blood plasma TGA, NEFA and cholesterol, indicating lipid depletion of animals. These results are in accordance with the report of Van Harten and Cardoso (2010) who stated that feed restriction reduced significantly TGA, NEFA and free fatty acids in rabbits and induced a higher lipidic depletion in these animals. Also, Rajman *et al.* (2006) confirmed that feed restriction decreased plasma concentrations of total lipids, TGA, cholesterol, high density lipids, total protein and albumin. However, in the present study no significant effect in plasma total proteins and urea (Table 3) were found.

Table 3: Effect of a one week intensive feed restriction on blood biochemical parameters in growing rabbits

Group	Age (d)	Glucose (mmol/l)	TAG (mmol/l)	NEFA (mmol/l)	Cholesterol (mmol/l)	Total proteins (g/l)	Urea (mmol/l)
Ad libitum	49	7.95	0.91	0.61	2.37 c	50.95	7.88
	56	7.93	0.60	0.44	3.69 ab	55.25	7.59
	63	7.29	1.58	0.55	1.30 d	47.51	6.03
	70	8.71	1.34	0.45	1.43 d	54.70	7.79
R50	49	7.63	0.46	0.54	3.31 b	44.46	6.77
	56	7.79	0.48	0.39	4.41 a	50.23	7.55
	63	8.03	1.23	0.35	1.55 d	44.88	6.59
	70	7.09	1.27	0.39	1.95 cd	59.42	7.04
R65	49	6.71	0.56	0.45	4.24 a	49.09	8.09
	56	7.24	0.64	0.48	4.22 a	48.74	7.43
	63	8.35	1.46	0.37	1.56 d	46.58	6.90
	70	8.55	1.07	0.28	1.31 d	50.70	7.46
RMSE		*1.22*	*0.41*	*0.14*	*0.78*	*7.21*	*1.19*
P - values	Group	0.582	0.048	0.003	0.001	0.158	0.252
	Age	0.337	0.001	0.001	0.001	0.001	0.007
	Group * Age	0.053	0.591	0.129	0.007	0.127	0.352

R50: Restriction 42-49 d of age (50 g/d/rabbit), R65: Restriction 42-49 d of age (65 g/d/rabbit), RMSE: root mean square error, TAG: triacylglycerols, NEFA: non-esterifed fatty acids. Means in the same column without a common superscripts are different at the level P<0.05.

Table 4: Effect of a one week intensive feed restriction on haematological parameters in growing rabbits.

Groups	Age (d)	Leukocytes (G/l)	Erythrocytes (T/l)	Haematocrit %	MCV (fl)	Hemoglobin (g/l)
Ad libitum	49	3.23	5.80	45.38	78.13	12.51
	56	3.80	5.65	42.90	76.00	11.89
	63	4.95	6.10	44.86	73.50	12.36
	70	5.53	6.25	46.03	73.88	12.65
R50	49	2.95	6.20	47.66	77.25	13.10
	56	3.58	5.02	38.76	77.25	10.81
	63	3.78	5.46	42.09	77.13	11.23
	70	5.16	5.67	41.04	74.13	12.10
R65	49	3.60	5.70	43.95	77.25	11.91
	56	4.71	5.06	41.04	79.63	11.23
	63	4.70	5.54	42.45	77.00	11.51
	70	5.34	5.76	43.56	75.88	11.95
RMSE		*1.57*	*0.61*	*4.91*	*3.12*	*0.94*
P - values	Group	0.191	0.011	0.113	0.033	0.008
	Age	0.001	0.001	0.013	0.002	0.001
	Group x Age	0.218	0.392	0.248	0.095	0.911

R50: Restriction 42-49 d of age (50 g/d/rabbit), R65: Restriction 42-49 d of age (65 g/d/rabbit), RMSE: root mean square error, MCV: mean cell volume. Means in the same column without a common superscripts are different at the level P<0.05

Blood picture shows the metabolic status of an organism. Data describing the effect of feed restriction on haematological parameters in fattening rabbits indicates that due to feed restriction, erythrocyte number and haemoglobin concentration were significantly reduced while MCV was significantly increased (Table 4). This reduction in haemoglobin content was suggested to be due to the observed reduction in erythrocytes' counts. Feed restriction had no significant effect on leukocyte number and haematocrit value (Table 4). The values of the haematological characteristics were within the physiological range described by Tůmová *et al.* (2007). El-Moty and El-Moty (1991) concluded that haematocrit was significantly decreased by feed restriction in rabbits.

CONCLUSIONS

Based on the data presented above, it could be concluded that a hard one-week limitation of feed intake improved feed conversion ratio, had a limited effect on final body weight, reduced blood plasma TGA, and NEFA , and seemed to have normal blood picture in fattening rabbits.

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