THE EFFECT OF RESTRICTION ON DIGESTIBILITY OF NUTRIENTS, ORGAN GROWTH AND BLOOD PICTURE IN BROILER RABBITS

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ABSTRACT

The effect of quantitative restriction in growing rabbits on digestibility of nutrients, internal organs growth and blood picture was investigated in two experiments. Rabbits in experiment 1 were fed *ad libitum,* or restricted one week at the age 42 to 49 days (50 g of feed per day per rabbit), or restricted two weeks (50 g in the first week and 75 g of feed per day per rabbit in the second week) between 42 and 56 days of age. In the second experiment the restriction period was 2 weeks, between 42 and 56 days of age and the rabbits were divided in three groups. The group 1 was fed *ad libitum*, the rabbits in group 2 got 50 g at the age 42 to 49 days and 65 g of feed at the age 49 to 56 days and in group 3, 50 g and 75 g of feed at the two periods, respectively. Compensatory growth was recorded mainly in group restricted one week. Restriction decreased daily feed intake. The digestibility of nutrients significantly improved only in restriction period, in re-feeding period there were no differences between restricted and *ad libitum* fed rabbits. The organs growth was affected by restriction and re-feeding period. At the end of restriction we found higher share of heart and kidney. The liver and stomach significantly ($P \leq 0.05$) increased their weight during re-feeding period. Most parameters of blood picture were not influenced by feeding regimens.

Key words: rabbit, quantitative feed restriction, digestibility of nutrients, internal organs, blood picture.

INTRODUCTION

There has been an increased interest in studying feed restriction in broiler rabbits in recent years. During the period of feed restriction, growth rate is slower than that of rabbits given *ad libitum* access to feed but in realimentation period when rabbits are fed *ad libitum* the rabbits exhibit an accelerated rate of body weight gain typical of compensatory growth (SCHLOLAUT and LANGE, 1990; PERRIER and OUHAYOUN, 1996; TŮMOVÁ *et al*., 2002, 2003). Restricted rabbits improve feed efficiency (MAERTENS and PEETERS, 1988; PERRIER and OUHAYOUN, 1996; TŮMOVÁ *et al*., 2002, 2003). Improved digestibility of nutrients at restricted feeding period was found in rabbits by LEDIN (1984a, b), GIDENNE, (1993) and TŮMOVÁ *et al*., (2003).

There are differences in the relative growth rates of internal organs and skeletal muscles or renal fat in restricted or non-restricted rabbits. According to Pálsson´s hypothesis of differential growth (PÁLSSON, 1955), bones and internal organs are not affected by feed restriction to the same degree as muscles and fat. Thus the digestive tract ought to be better developed in relation to body weight in restricted animals, allowing them to consume more feed/kg live weight than *ad libitum* fed animals. In agreement with this hypothesis LEDIN (1984b) reported in rabbits that the internal organs were appreciably affected by restriction and realimentation. At the beginning of realimentation period, the stomach grew very rapidly and after 7 days of realimentation in the restricted group all organs except kidneys had grown to the same size or higher as in the *ad libitum* fed rabbits at the same weight. SUSBILLA *et al.* (1994) described in broiler chickens that the growth of internal organs as heart, lungs, liver and gastrointestinal tract during the restricted period was reduced slightly in comparison with the growth rate of muscles. At 12 days of age, relative weight of empty digestive tract was higher in restricted chickens than that on the group fed *ad libitum*. PERRIER and OUHAYOUN (1996) found out that the rabbits at the end of the restriction period lower weight of full digestive tract and livers, but there was relatively fast growth of these organs in the realimentation period.

The objective of the present study was to investigate the effect of quantitative restriction on the digestibility of nutrients, the growth of digestive tract, liver, kidney and lung, blood picture in broiler rabbits.

MATERIAL AND METHODS

Experimental animals and design

In two feeding experiments Hyplus rabbits (male and female ratio 1:1) of weaning stage (35 days of age) were used. The rabbits were from a commercial farm and were placed in individual metabolism cages with separation of urine and feaces in experiment 1. The floor density was 0.15 m^2 per rabbit. In the second experiment the rabbits were housed in commercial cages for two rabbits with the space floor 0.09 m^2 per rabbit. A temperature of 16 ^oC and relative humidity of 55% were maintained for the whole fattening period. A twelve-hour photoperiod was used. Water was available *ad libitum*. The rabbis were fattened till 84 days of age.

In experiment 1 (the balance experiment), 30 rabbits were divided into 3 groups of 10. Group 1 was fed *ad libitum*, group 2 was restricted from 42 to 49 days of age (50 g per day per rabbit), and group 3 was restricted from 42 to 56 days of age (50 g at the age 42 to 49 days, 75 g at the age 49 to 56 days). After the restriction time, *ad libitum* feeding followed up to the end of the experiment.

In experiment 2 (fattening experiment), 108 rabbits were divided into 3 groups of 36. The rabbits in group 1 were fed *ad libitum*, in group 2 were restricted from 42 to 56 days of age (50 g at the age 42 to 49 days, 65 g at the age 49 to 56 days) and in group 3 were

restricted at the same period (50 g at the age 42 to 49 days, 75 g at the age 49 to 56 days). Following the restriction period, the rabbits were fed *ad libitum*.

In both experiments, the rabbits were fed on commercial diets which we used in previous experiments (TŮMOVÁ *et al*., 2003). The analyzed content of nutrients in 1 kg of feed mixture was 173.9 g of crude protein, 26.3 g of fat, and 199.3 g of crude fibre. Growth and feed consumption were measured individually in weekly intervals. In experiment 1, the digestibility of nutrients was determined by an in vivo method. There were three collection periods from 42 to 63 days of age, each collection period lasted for 7 days. During the collection period, the total feaces excretion was collected daily to plastic bags and stored at -18 ^{o}C until analysis. Feaces were analysed for dry matter, crude protein, fat and crude fiber.

In experiment 2 the rabbits were slaughtered at the age of 49, 56, 63 and 84 days in an experimental slaughterhouse, six rabbits from the group and from each age. They were fasted overnight, and slaughtered the following morning by electric stunning and bleeding by jugular cut. Slaughter measurements included ratio of heart, kidney, liver, lung and stomach from carcass weight, length of the small intestine, large intestine and caecum with appendix. In blood haematology parameters, namely erythrocyte number (ER), leukocyte number (Le), lymphocyte number (Ly), neutrophile number (PMN) mean cell volume (MCV), concentration of haemoglobin (Hb) and haematocrite (PCV) were determined.

Analytical methods

The feed and feaces were analysed using standard AOAC methods (AOAC, 1980). All haematology characteristics were detected in blood stabilized by K_2EDTA. The analyses were done using a Coulter Model ZF (Coulter Electronics Ltd, England).

Statistical analysis

Data were processed by one-way analysis of variance by the GLM procedure of SAS (SAS Institute Inc, Cary, Nc). The significance of differences among groups was tested by the Scheffe or Duncan test on the level of significance $P \leq 0.05$.

RESULTS AND DISCUSSION

In the experiment 1 average daily weight gain and feed conversion in the fattening period were not significantly ($P \leq 0.05$) affected by feeding regimens (Table 1). Higher daily weight gain in group 2 (restriction one week) showed compensatory growth. Daily weight gain in the second experiment (Table 2) was significantly reduced in group with stronger restriction. In both experiments daily feed intake in restricted rabbits was lower than in rabbits fed *ad libitum*. The same trends were recorded by PERRIER and OUHAYOUN (1996), JEROME *et al*. (1998), TŮMOVÁ *et al*. (2002, 2003).

The digestibility of nutrients (Table 1) was higher during the restriction period, crude protein, fat and crude fiber significantly (P ≤ 0.05) in restricted rabbits than in *ad libitum* fed ones. In the realimentation period there were no differences found between restricted and non-restricted rabbits. Improved feed digestibility at restricted feeding has been found by LEBAS (1979), LEDIN (1984a, b) and TŮMOVÁ *et al*. (2003). In the *ad libitum* fed group, the digestibility of dry matter, crude protein and fat significantly (P ≤ 0.05) improved with the age but digestibility of crude fiber declined.

Table 1. Results of the experiment 1.

		Group (mean±SD)		
		1	**2**	**3**
		Ad libitum	**Restriction 42 – 49 days**	**Restriction 42 – 56 days**
Weight gain 35 – 84 days of age (g)		37.4±6.37	40.1±2.74	35.8±4.38
Feed intake per day per rabbit (g)		153.3^{a}±12.59	152.3^{a}±8.06	136.5^{b}±12.14
Feed conversion (kg)		3.71±0.63	3.23±0.36	3.33±0.26
Digestibility of nutrients (%):				
42 – 49 days	Dry matter	39.2^{b}±7.57	44.2±11.73	56.7±10.88
	Crude protein	68.6^{bB}±4.30	70.6^{abB}±5.56	76.5^{A}±5.86
	Fat	84.4^{bB}±2.30	85.8^{bAB}±4.77	88.8^{A}±2.29
	Crude fibre	16.5^{a}±9.03	23.1^{a}±12.41	24.2^{a}±13.93
49 - 56 days	Dry matter	48.7^{a}±10.76	42.5±8.11	58.3±9.81
	Crude protein	74.6^{aAB}±4.23	69.4^{bB}±5.33	75.4^{A}±3.36
	Fat	89.5^{aA}±4.28	85.5^{bB}±2.24	90.8^{A}±2.14
	Crude fibre	14.9^{aA}±12.28	23.3^{aA}±8.73	21.8^{aB}±12.44
56 – 63 days	Dry matter	53.9^{a}±8.51	46.3±6.84	61.8±6.66
	Crude protein	77.2^{a}±3.36	75.0^{a}±4.19	78.6±3.23
	Fat	91.9^{a}±3.03	89.7^{a}±1.96	91.1±1.89
	Crude fibre	10.7^{b}±9.03	7.9^{b}±9 .61	9.1^{b}±7.34

^{A,B,C} P≤ 0.05 between groups
^{a,b} P≤ 0.05 between collection periods

The development of internal organs was followed in experiment 2, the organs growth was affected by restriction and realimentation period (Table 2). During the restriction period the share of liver was significantly (P≤0.05) decreased. There were no differences in the other organs but at the end of restriction we found higher share of heart and kidney. The liver and stomach significantly (P≤0.05) increased their weight during realimentation period. At the end of experiment non-significantly higher share of liver and stomach was recorded. In our previous experiments (TŮMOVÁ *et al*. 2003) we observed similar tends in the share of liver, heart and kidney from carcass. This suggests that priority is given to the development of the internal organs. Our observation agrees with results of LEDIN (1984a) and PERRIER and OUHAYOUN (1996).

Table 2. Results of the experiment 2.

		Group (mean±SD)		
		1	**2**	**3**
		Ad libitum	**50 + 65 g feed**	**50 + 75 g feed**
Weight gain 35-84 days of age (g)		40.1[a]±28.10	35.8[b]±11.03	38.6[ab]±11.60
Feed intake per day per rabbit (g)		111.1[a]±51.15	70.4[b]±	80.8[ab]±53.03
Feed conversion (kg)		2.82±1.24	2.38±1.42	2.62±1.55
49 days	Live weight (g)	1418[a]±216	1180[b]±188	1191[b]±184
	Heart (%)	0.68±0.08	0.67±0.07	0.67±0.33
	Kidney (%)	1.64±0.25	1.52±0.13	1.48±0.66
	Liver (%)	7.05[a]±0.95	5.32[b]±0.41	6.04[b]±0.73
	Lung (%)	1.46±0.56	1.23±0.15	1.48±0.34
	Stomach (%)	3.35±0.32	3.30±0.47	3.16±0.52
	Small intestine (cm)	304.8±23.37	293.8±28.10	277.9±22.99
	Large intestine (cm)	113.6[a]±7.16	100.2[b]±11.01	106.2[ab]±8.77
	Ceacum (cm)	44.3±3.20	43.7±2.99	46.8±5.25
56 days	Live weight (g)	1748[a]±237	1222[b]±197	1261[b]±214
	Heart (%)	0.59±0.05	0.66±0.11	0.61±0.11
	Kidney (%)	1.40±0.16	1.47±0.34	1.46±0.11
	Liver (%)	6.45[a]±0.57	5.34[b]±0.86	5.50[b]±0.53
	Lung (%)	1.02±0.15	1.12±0.24	1.02±0.15
	Stomach (%)	3.34±0.37	3.39±0.42	3.23±0.50
	Small intestine (cm)	312.9±26.85	306.3±28.64	292.8±19.25
	Large intestine (cm)	116.4±7.34	115.3±5.44	109.2±6.25
	Ceacum (cm)	41.2±1.66	48.7±3.01	47.2±2.46
63 days	Live weight (g)	1918[a]±263	1606[b]±345	1671[b]±262
	Heart (%)	0.76±0.17	0.72±0.16	0.77±0.11
	Kidney (%)	1.49±0.16	1.78±0.34	1.91±0.50
	Liver (%)	8.12[b]±2.11	10.32[a]±2.94	10.73[a]±2.65
	Lung (%)	1.36±0.25	1.22±0.13	1.38±0.18
	Stomach (%)	3.02[b]±0.22	3.76[a]±0.33	3.86[a]±0.53
	Small intestine (cm)	350.8[a]±22.21	339.1[ab]±16.60	327.4[b]±11.48
	Large intestine (cm)	121.8±7.81	124.2±9.19	123.8±8.84
	Ceacum (cm)	43.5±3.04	43.3±3.09	42.4±3.98
84	Live weight (g)	3111[a]±369	2650[b]±471	2762[ab]±358
	Heart (%)	0.57±0.07	0.53±0.06	0.52±0.15
	Kidney (%)	1.26±0.14	1.24±0.06	1.14±0.17
	Liver (%)	5.50±1.21	6.01±0.80	6.14±1.51
	Lung (%)	1.01±0.33	1.13±0.20	1.03±0.09
	Stomach (%)	2.08±0.19	2.44±0.27	2.34±0.37
	Small intestine (cm)	363.7[a]±17.89	338.6[b]±19.07	335.0[b]±10.11
	Large intestine (cm)	141.5[ab]±16.52	148.1[a]±21.47	125.5[b]±7.12
	Ceacum (cm)	55.8±4.24	58.7±1.67	54.1±0.91

[a,b] $P \leq 0.05$

There has been observed significantly (P≤0.05) lower number of neutrophiles (20.04% in group 3 vs. 29.91 % in group 1) and higher number of lymphocytes (79.65% in group 3 vs. 69.49% in group 1). Contemporary we have not recorded differences in the other characteristics of blood picture between groups. All measurements of blood picture were in the physiological range.

CONCLUSION

Feed restriction resulted in accelerated growth, but compensatory growth was observed only in rabbits restricted one week. Rabbits restricted two weeks did not compensate live weight. The lack of compensatory growth in two weeks restricted rabbits was probably connected with lower feed consumption. The study confirms that nutrient digestibility improves only in the restriction period. In the realimentation period no differences were found between *ad libitum* and restricted rabbits. Restriction regiment increased the share of internal organs as liver, stomach, heart and kidney. Higher digestibility of nutrients and heavier organs as liver, stomach and kidney may be an important impulse for compensatory growth after restriction.

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