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INFLUENCE OF FEEDING INTENSITY ON THE GROWTH OF DIFFERENT BODY MEASURMENTS

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ABSTRACT

Experiment with young female New Zealand White (NZW) rabbits was carried out to establish the live body measurements on function of feeding intensity. The animals (n=13) were fed ad libitum (Group 1), while their sisters' feeding was restricted (n=13) properly 70% of ad libitum (Group 2). The feeding trial lasted between 6 and 18 weeks of age. Average body weight at 18 weeks of age was higher in Group 1 (3.71±0.31 kg *vs* 3.14±0.24 kg). Water consumption was 3.5 times more than the dry matter intake (336±94 ml) in Group 2. The digestibility of crude protein was significantly better ($P<0.001$) in Group 2 (76,53±1,37% *vs* 73.01±2.72%). The heart girth and the rump width were significantly smaller in Group 1 than in Group 2 (29.3±0.8, 5.7±0.5 and 30.7±1.0, 6.2±0.3, respectively). The body of does in Group 2 is tended to be wider in order to reach the sexual and breeding maturity. As a consequence, the development of does fed restricted is tended to be unequal (allometric growth).

INTRODUCTION

The ad libitum feeding is commonly used in rabbit breeding. As a consequence of the favourable experiences in other species, studies on the application of restricted feeding have been initiated also in raising of futur breeding rabbits.

MAERTENS (1995) has given some practical nutritional recommendation. A longer reproductive life and a lower replacement level of does is desired. For young does, the feeding system, therefore, strongly depends on the age of the first mating. The *ad libitum* feeding together with early mating (75-80% of adult weight, 14-15 weeks of age) leads to favourable results in obtaining the first litter. However, in practice it is recommended to restrict the feeding of young futur does in order to postpone the first mating till the age of 17-18 weeks to prevent their extreme fattening. When restricted quantities are fed, they should be related to the weight of the rabbits, their body condition and to the dietary nutrient density. The recommended level of the restricted feeding is usually 35 g/day/ kg live weight. A 4-day flushing after a restriction period, can be proved to be efficient to induce the oestrus. However, MAERTENS (1997) found a non-expressed advantageous effect of flushing on reproduction performances in rabbits as well.

FEKETE and GIPPERT (1981) studied the effect of different restricted rations on broiler rabbit digestion and production. The 15% or 25% decrease in the ration resulted in 19% and 35% reduction in the weight gain, but in an improvement of digestibility. The 130 g/day restricted feeding was favourable at breeding time, the does proved to be in the best body condition and more prolific (EIBEN *et al.*, 1998). Since in case of restricted feeding it is a problem that the distribution of the daily rations is laboursome and inaccurate, SZENDRŐ *et al.* (1988) reduced the eating time in growing rabbits. Because of the average daily feed intake was reduced by 6 to 15% and feed conversion efficiency (FCE) is improved by 7 to 13% and the average daily

gain was practically unchanged, the authors recommended to apply the eating time restricted to 9-12 hours daily between 4 to 12 weeks of age. TAG-EL-DEN *et al.* (1988) also offered the restricted feeding in over fattened female rabbits, mainly out of breeding time.

It is a common agreement that feed efficiency is adversely linked with the dietary energy concentration. Rabbits try to adjust their feed intake in order to have the same daily DE-intake. However, if the diet is too diluted (below 9.3 MJ DE/kg), rabbits can no longer fulfil their energy requirements because of their limited feed intake anatomical capacity. On the contrary, if the diet is concentrated, the dietary energy content is high, the feed intake is reduced. Due to this characteristics, the change of the dietary energy content can not be applied in order to feed on a different energy level. Thus in the present study the quantitatively restricted feeding was used.

In the selection and breeding of Angora rabbits, it is not necessary to pursue a high increase of chest girth, since big chest girth may be disadvantageous to the increasing of wool yield (WANG and ZHENG, 1993). Findings of AYYAT *et al* (1995) that the live body weight to thigh lenght index could be used for classification of rabbits for production to different grades both at marketing and breeding. However, no data were available in the literature on development of body measurements in rabbits.

The present study is aimed to establish the live body measuments deriving from feeding intensity in young New Zealand White females.

MATERIAL AND METHODS

Animals

A total of 26, five-week-old female NZW rabbits were involved into the study. The experimental animals originated from the stock of LAB-NYÚL BT, Gödöllő.

Housing

The experiment was carried out at the Faculty of Veterinary Science, Budapest, Department of Animal Breeding, Nutrition and Laboratory Animal Science (Budapest). The animals were individually kept in wire mesh cages. The temperature was 20 ±2 °C and the humidity approx. 70% in the animal room. The controlled lighting period was applied (16 hrs light : 8 hrs dark). The rabbits were allowed to drink *ad libitum* from drinking bowls tap water.

Nutrition

All of the rabbits were fed a commercial diet (Table 1 and 2) containing 15.2% crude protein, 14.1% crude fiber and 11.5 MJ/kg DE (Bácska ltd). The feeding trial lasted from the weaning up to the 18th week of age.

Table 1. Ingredients of commercial diet

Ingredients	%
Barley	10
Wheat	18
Maize	17.5
Wheat bran	10
Extracted sunflower meal (40% CP)	7
Alfalfa meal (19% CP)	30
Lysine	0.2
Limestone	1.5
Salt	0.3
Vitamin-mineral premix	0.5
Total	**100.0**

Experimental Design

According to the used feeding intensity there were two groups designed. There were the rabbits (n=13) fed *ad libitum* in Group 1, and their feed intake was daily measured (Table 3).

Their sibs (n=13) were fed restricted in Group 2, properly 70% of *ad libitum* (pair-feeding).At the 6th week of age the rabbits were weighed, and according to their measured body weight the sisters were randomly distributed into groups to obtain the identical average weights with minimum variance.

Table 2. Chemical composition of the diet

Chemical composition	%
Dry matter	88.8
Ash	7.08
Ether extract	3.25
Crude fiber	15.77
Crude protein	14.96
NFE	47.74

Metabolic Experiment

At the 11th week of age of rabbits a metabolic experiment was carried out to determine the apparent digestibility of nutrients (Table 4) of the diet fed (FEKETE and GIPPERT, 1981). During this test water consumption was also measured.

Table 3. Average feed consumption (g) of rabbits fed *ad libitum* (mean and ±SD)

Weeks	**6.**	**7.**	**8.**	**9.**
	106.9±2.5	142.5±1.3	143.6±1.1	140.9±1.3
Weeks	**10.**	**11.**	**12.**	**13.**
	145.5±1.5	150.1±1.2	170.3±1.4	166.0±1.7
Weeks	**14.**	**15.**	**16.**	**17.**
	163.2±1.8	182.1±2.3	191.4±1.8	177.2±1.6
Weeks	**18.**	**Average**		
	176.9±2.3	158.2±1.1		

Live Body Measurements

The following measurements on the living animals were weekly recorded (Table 6):

body weight (BW);
trunk lenght (TL), from base of tail to *tuber scapulae*;
head length (HL), from nose to nape (1th *cervical vertebra*);
head height (HH), between the top of head and the lower jaw;
head width (HW), between the left and right margo infraorbitalis;
ear length (EL), in case of both ears from base to top of ear;
ear width (EW), in case of both ears between the margins at the widest points;
heart girth (HG), thoracic circumference behind the shoulder-blade;
rump width (RW), between the left and right tuber coxae;
fore cannon (*antebrachium*) lenght (FCL), in case of both arms from elbow to wrist;
rear cannon (*crus*) lenght (RCL), in case of both legs from knee to ankle.

From the given data, the following indices were calculated (Table 7):

index 1: head capacity = $[(HW * HH) / 2 * \pi] * HL$;
index 2: ear surface = $(EL * EW) / 2$;
index 3: fore cannon-rear cannon proportion = $FCL/RCL * 100$;
index 4: fore cannon-body weight proportion = $FCL/BW * 10$;
index 5: body capacity = $(TL * \pi) / 3 * (R^2 + R * r + r^2)$
$R = 1/2 * HG / \pi$,
$r = 1/2 * RW$;
index 6: head capacity-body capacity proportion = (index 1/index 5) * 100
index 7: body weight-heart girth proportion = $(BW/HG) * 1000$;
index 8: trunk length-rump width proportion = $(TL/RW) * 10$;
index 9: extremities-trunk proportion = $(FCL + RCL) / TL$.

Statistical Analysis
Student's *t*-test and one way analysis of variance according to the procedure of SPSS (SPSS Inc., 1988) were used for the data.

RESULTS AND DISCUSSION

In case of both groups the digestibility of nutrients were similar, except the crude protein,which was found significantly better (P<0.001) in Group 2 (76,53±1,37 % *vs* 73.01± 2.72 %). This result slightly disagree with FEKETE and GIPPERT (1981) because on two different rations (*ad libitum* and minimal) statistically the same digestibility coefficients were estimated by them.

Table 4. Digestibility of nutrients, %
(mean and ±SD)

Nutrients	Group 1	Group 2	NS
Dry matter	58.51±2.26	59.17±1.41	NS
Ether extract	79.25±1.51	80.04±1.59	NS
Crude protein	73.01±2.72	76.53±1.37	***
Crude fiber	14.72±3.92	14.72±3.72	NS
NFE	70.87±1.91	71.48±0.97	NS

NS: P≥0.05; ***: P≤0.001

Table 5. Body weight (kg), ratio of BW and daily weight gain (g) in the groups
(mean and ±SD)

	Body weight			Weight Gain	
Weeks	Group 1	Group 2	Group 2 : Group 1	Group 1	Group 2
6.	0.99±0.08	1.01±0.08	102.47		
7.	1.36±0.16	1.26±0.14	92.47	53.08±16.43	39.64±11.07
8.	1.74±0.17	1.54±0.12	88.23	54.51±6.43	39.84±12.12
9.	2.03±0.23	1.77±0.11	86.92	35.49±8.44	32.75±6.83
10.	2.22±0.17	2.00±0.12	89.89	32.53±6.19	32.53±7.71
11.	2.48±0.20	2.15±0.14	86.74	36.92±6.90	22.03±6.88
12.	2.69±0.20	2.37±0.14	88.32	29.56±5.24	31.70±4.02
13.	2.89±0.24	2.51±0.17	86.92	29.12±8.62	19.95±10.06
14.	3.14±0.26	2.68±0.20	85.33	35.05±7.63	25.42±6.15
15.	3.21±0.27	2.72±0.18	84.72	15.06±10.27	11.29±5.69
16.	3.41±0.27	2.88±0.19	84.51	28.68±6.35	23.30±9.45
17.	3.53±0.26	2.99±0.20	84.63	24.16±13.17	15.05±7.90
18.	3.71±0.31	3.14±0.24	84.66	28.57±7.98	21.87±12.36
	***	***			

***: P≤0.001

Average body weight at 18 weeks of age was significantly (P≤0.001) higher in Group 1 (3.71±0.31 kg vs 3.14±0.24 kg). Otherwise, average body weight at 18 weeks of age in Group 2 was approx. 85% of that in Group 1.
The daily water intake was 267.81±51.16 ml in Group 1. It was approx. double the dry matter intake. On the other hand, the daily water consumption was significantly (P≤0.05) higher

(335.71±93.70 ml) in Group 2, which was 3.5 times of the dry matter intake (98.83±10.48). The increased water consumption may have improved the satiety in rabbits.
Since the increase in body weight of Group 2 was relatively higher (78% respect to Group 1) than the restriction (70%), in our opinion, it is due to the higher digestibility of crude protein, the increased water consumption and probably the improved caecothrophy.
The average body weight in Group 2 at 18 weeks was as much as that in Group 1 at 14 weeks (3.14 kg), in which the females had already reached their sexual maturity. Otherwise, according to the body weight the development of the 18-week old females fed restricted has corresponded to that of the 14-week old rabbits fed ad libitum. Therefore, the comparison of the live body measurements and indices has been based on these ages.

Table 6 and 7 show averages of traits studied on live animals.

Table 6. Means and standard deviations of traits studied in New Zealand White female rabbits

Live Body measurements	(n=26) **6. week**		**Group 1.** (n=13) **14. week**		**Group 2.** (n=13) **18. week**		**t-test (between 1-2)**	
							t-value	**P**
	X	**±SD**	***X***	**±SD**	***X***	**±SD**		
Body Weight (kg)	1.02	0.13	3.14	0.27	3.14	0.25	-0.067	0.947
Trunk Lenght (cm)	23.9	1.8	36.3	1.4	37.5	1.8	-1.894	0.070
Head Lenght (cm)	11.6	0.7	15.3	0.5	14.9	0.6	1.880	0.072
Head Height (cm)	4.8	0.3	6.3	0.3	6.1	0.3	1.761	0.091
Head Width (cm)	3.6	0.2	4.7	0.1	4.7	0.1	1.265	0.218
Ear Lenght (cm)	10.2	0.5	14.0	0.8	13.6	0.5	1.496	0.148
Ear Width (cm)	6.0	0.3	7.8	0.4	7.3	0.2	3.177	0.004
Heart Girth (cm)	18.6	0.8	29.3	0.8	30.7	1.0	-4.022	0.000
Rump Width (cm)	3.9	0.3	5.7	0.5	6.2	0.3	-2.719	0.012
FCL(cm)	5.6	0.2	8.4	0.3	8.4	0.3	-0.196	0.846
RCL (cm)	8.9	0.3	12.9	0.4	13.0	0.4	-0.578	0.569

FCL: fore cannon lenght; RCL: rear cannon lenght; Group 1: *ad libitum*; Group 2: restricted

Table 7. Means and standard deviations of traits studied in New Zealand White female rabbits

Indices	(n=26) **6. week**		**Group 1.** (n=13) **14. week**		**Group 2.** (n=13) **18. week**		**t-test (between 1-2)**	
							t-value	**P**
	X	**±SD**	***X***	**±SD**	***X***	**±SD**		
Index 1	159.28	14.6	361.0	24.0	336.7	27.9	2.378	0.026
Index 2	30.6	2.6	54.4	5.7	49.8	3.1	2.534	0.018
Index 3	63.8	2.8	65.1	2.6	64.9	1.2	0.284	0.779
Index 4	56.3	5.9	26.8	1.9	27.1	2.1	-0.298	0.769
Index 5	462.5	58.0	1653.1	134.5	1913.7	168.7	-4.365	0.000
Index 6	34.9	5.4	22.0	2.5	17.7	1.9	4.893	0.000
Index 7	54.6	7.5	107.0	7.6	102.4	7.8	1.519	0.141
Index 8	60.4	6.4	63.9	8.3	60.7	2.4	1.338	0.194
Index 9	61.5	5.1	58.5	1.9	56.8	3.1	1.718	0.099

Index 1: head capacity (HC); Index 2: ear surface; Index 3: fore cannon lenght (FCL)/ rear cannon lenght*100; Index 4: FCL/body weight (BW)*10; Index 5: body capacity (BC);

Index 6: HC/BC*100; Index 7: BW/heart girth*1000; Index 8: trunk length/rump width*10; Index 9: extremities/trunk lenhgt; Group 1: *ad libitum*; Group 2: restricted

Animals fed *ad libitum* or restricted in most live body measurements have not shown any differences at the defined age except the heart girth and the rump width, which were significantly smaller in Group 1 than in Group 2 (29.3±0.8, 5.7±0.5 and 30.7±1.0, 6.2±0.3, resp.).

Most of the indices calculated are also same. Although, the index 5 was significantly smaller in Group 1, as the index 6 was significantly higher in Group 1 than that of Group 2 (1653.1±134.5, 22.0±2.5 and 1913.7±168.7, 17.7±1.9, resp.).

Due to the restricted feeding the growth of the certain body measurements has changed. The growth of the head proved to be less intense than that of the body at the same body weight. The body in these does tended to be wider in order to reach the sexual and breeding maturity. Since the head in comparison to lenght or capacity of the body was smaller in does fed 70% of *ad libitum,* it can be concluded that the development of does fed restricted is tended to be unequal (*allometric growth*).

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