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EFFECT OF GENOTYPE, AGE, BODY WEIGHT AND SEX ON THE BODY COMPOSITION OF GROWING RABBITS

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ABSTRACT : Body composition of 503 growing rabbits of both sexes was examined at the age of 6, 8, 10, 12, 14 and 16 weeks. The animals were of four genotypes: purebred Pannon White (PP) and Danish White (DD) and their reciprocal crossings: DP and PD. Between the ages of 6 and 16 weeks, dry matter of the empty body increased from 27.6% to 34.2%, fat from 5.4% to 10.1% and protein from 18.4% to 20.9%, whereas ash content decreased from 3.5% to 3.0%. The effect of body weight was greater than that of the age. The two groups containing the highest numbers of animals (PP and DP) had similar protein and ash content, but the DP genotype had a higher fat content than PP. Sex affected fat content only: the female rabbits contained significantly ($P < 0.01$) more body fat than the male rabbits but only at 12 weeks.

RESUME : Effets du génotype, de l'âge, du poids vif et du sexe sur la composition corporelle de lapins en croissance.
La composition corporelle de 503 lapins en croissance, des deux sexes, a été étudié à 6, 8, 10, 12, 14 et 16 semaines d'âge. Les animaux appartenaient à 4 génotypes : Pannon White pur (PP), Danish White (DD) et leurs croisements réciproques : DP et PD. Entre l'âge de 6 semaines et celui de 16 semaines, la matière sèche du corps entier augmente de 27,6 à 34,2%, le matière grasse de 5,4 à 10,1% et les protéines de 18,4 à 20,9%, tandis que les matières minérales diminuent de 3,5 à 3,0%. L'effet du poids vif est plus important que celui de l'âge. Les deux groupes comprenant le plus grands nombres d'animaux (PP et DP) ont des taux de protéines et de manières minérales comparables, mais le génotype DP a un taux de matière grasse supérieur à celui du génotype PP. Le sexe n'affecte que le taux de matières grasses : les femelles sont significativement plus grasses que les mâles mais seulement à 12 semaines d'âge (P<0,01).

INTRODUCTION

There are relatively few publications on the body composition of rabbits and on the influencing factors. The effect of age (PARIGI-BINI *et al.*, 1991), age and sex (FEKETE *et al.*, 1996), growth rate, breed, sex and starter feed composition (FRAGA *et al.*, 1978) have been investigated in suckling rabbits. SPENCER AND HULL (1984) performed a comparative study on the body composition of single- and double-fed rabbits (suckling from 2 lactating does). DE BLAS *et al.* (1977) examined the effect of age and body weight in 3, 4 and 5 month old rabbits. FERREIRA *et al.* (1996) compared the performance of groups fed *ad libitum* and restrictedly between 2.0 and 3.2 kg body weight. XICCATO (1996) summarized the results relating to changes in body composition during pregnancy and lactation.

The purpose of the experiment was to investigate the effect of genotype, age, body weight and sex on whole body composition of growing rabbits as a part of a bilateral project between Denmark and Hungary. The performance of Pannon White and Danish White purebred and reciprocal crossbred rabbits was examined by JENSEN *et al.* (1996 a,b) and SZENDRŐ *et al.* (1996).

These studies provide information on changes in body composition to be used for the determination of chemical maturity and nutrient requirement, and in topics related to veterinary science.

MATERIAL AND METHOD

Experimental design

503 growing rabbits, representing 4 genotypes, were used, i.e. purebred Pannon White (PP), and Danish White (DD), and the reciprocal crossings between these (DP, PD). Whole body composition was determined by a chemical procedure at 6 different ages (6, 8, 10, 12, 14 and 16 weeks), with the rabbits divided into 2 weight groups (below /LW/ and above /HW/ the mean) and according to sex (Table 1). The does were inseminated using the 2 breeds alternately; thus if the litter of one doe was purebred the first time, it was crossbred the next time.

Experimental conditions

The rabbits were weaned at the age of 42 days. The young of each litter were reared in flat-deck cages (5 rabbits/cage). They were fed a commercial diet *ad libitum* (CP : 16.5%, CF : 15.5%, DE : 10.3 MJ/kg) and had free access to weight-valved watering devices.

The randomly selected animals were weighed before and after a 24-hour fast. After slaughter, the content of the alimentary tract was removed for the purpose of calculating empty body weight. Then the whole empty body was ground twice, and samples were taken from the homogenate for chemical analysis. The samples were stored at -20 °C until being used.

Table 1 : Number and weight of the experimental animals

Age	Overall	Genotype								Sex				Weight			
		PP		DP		PD		DD		Male		Female		Above		Under	
weeks		n	Weight (g)	n	Weight (g)	n	Weight (g)	n	Weight (g)	n	Weight (g)	n	Weight (g)	n	Weight (g)	n	Weigh (g)
6	87	38	1149	38	1125	5	1062	6	1010	48	1115	39	1135	44	1220	43	1032
8	78	39	1722	33	1697	4	1703	2	1470	40	1702	38	1707	48	1759	30	1617
10	103	52	2243	44	2253	4	2473	3	2317	48	2255	55	2261	49	2414	54	2116
12	100	45	2718	37	2715	8	2681	10	2752	52	2692	48	2745	39	2916	61	2590
14	58	33	3165	22	3161	2	3180	1	3100	30	3151	28	3176	29	3309	29	3023
16	77	29	3308	32	3400	10	3571	6	3485	47	3421	30	3351	20	3754	57	3268
Total	**503**	**236**		**206**		**33**		**28**		**265**		**238**		**229**		**274**	

Chemical analysis

Dry matter was measured by drying the sample to constant weight in an oven. Crude protein was calculated from the nitrogen content (by a Kjel-Foss Fast Nitrogen Determiner) using the factor 6.25. Crude fat content was determined by means of Soxhlet extraction after hydrochloric acid digestion. Crude ash content was measured by burning the samples at 550°C.

Statistical analysis

The statistical calculations were performed using analysis of variance, assuming the following linear model:

$$Y_{ijklm} = \mu + g_i + a_j + w_k + s_l + e_{ijklm}, \text{ where}$$

Y_{ijklm} = experimental data
μ = overall mean
g_i = effect of i^{th} genotype (PP, DD, DP, PD)
a_j = effect of j^{th} age (6, 8, 10, 12, 14 and 16 weeks)
w_k = effect of k^{th} weight (LW, HW)
s_l = effect of sex (1, 2)
e_{ijklm} = residual random error

When data from the same age groups were compared the following formula was used:

$$Y_{iklm} = \mu + g_i + w_k + s_l + e_{iklm}$$

When the effects of age and weight were calculated in parallel the following animal model was used:

$$Y_{ijk} = \mu + a_i + w_j + s_l + e_{ijk}$$

In both models the 2- and 3-way interactions were also calculated, but these were not significant in any case. The differences detected between the experimental groups were verified by LSD testing.

Linear ($Y = a + bx$), exponential ($Y = e^{(a + bx)}$) and reciprocal ($Y = \frac{1}{a + bx}$) regressions of body weight and age on body composition were used.

RESULTS AND DISCUSSION

The effect of age (6, 8, 10, 12, 14 and 16 weeks) on each parameter was significant. Genotype (PP, DP, PD, DD) and body weight (LW, HW) had a significant effect on dry matter and crude fat content, whereas the effect of sex was significant only on crude fat content (Table 2).

Dry matter

The dry matter content of the empty body increased by 6.6% between the ages of 6 and 16 weeks (Table 3). The relationship between age and dry matter content was described by linear, exponential and reciprocal models (Table 4). The determination coefficients of the three equations were very close to each other, which indicates that any of the three models describes the relationship with very similar accuracy, although, from the biological aspect, the curves of the exponential or reciprocal equations would seem more appropriate than the linear curve. The regression functions between body weight and dry matter content are shown in Table 5. Here, the R^2 values of the three models are also similar, but they verify a substantially closer relationship than in the case of age. It is true for both age and body weight

Table 2 : Mean squares for empty body composition

Main effect	Dry matter	Protein	Fat	Ash
Genotype	18.72***	1.30	25.79***	0.16
Age	544.11***	56.45***	297.03***	2.56***
Weight	175.74***	0.18	191.40***	0.52
Sex	12.55	0.54	15.99*	0.15
residual	3.38	0.59	3.05	0.14

*P< 0.05 ***P< 0.001

Table 3 : Effect of genotype, sex and weight on chemical composition of the empty body

	Overall		Genotype								Sex					Weight				
			PP		DP		PD		DD		Male		Female		P	Above		Under		P
Age weeks	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.	Mean	s.d.		Mean	s.d.	Mean	s.d.	
Dry matter (%)																				
6	27.6	1.5	27.6^{ab}	1.3	27.8^{a}	1.5	26.7^{ab}	0.5	26.5^{b}	2.2	27.6	1.4	27.5	1.6	-	28.1	1.2	27.1	1.4	***
8	29.3	1.7	29.4	1.3	29.2	2.0	29.1	1.4	27.3	1.6	29.0	1.7	29.6	1.7	-	29.5	1.6	28.8	1.8	-
10	31.3	2.0	30.9^{a}	2.2	31.9^{b}	1.7	30.9^{ab}	0.9	31.6^{ab}	1.2	31.2	2.2	31.4	1.8	-	31.9	1.5	30.8	2.2	**
12	32.3	2.1	32.5	2.1	32.3	2.0	31.0	1.3	32.5	2.4	31.8	2.0	32.9	2.0	**	33.2	2.3	31.7	1.7	**
14	33.6	2.3	33.2^{a}	1.9	34.5^{b}	2.5	30.9^{a}	0.7	30.2^{ab}	-	33.6	2.1	33.5	2.1	-	34.5	2.3	33.0	1.9	*
16	34.2	2.4	33.2^{a}	2.0	35.0^{b}	2.5	34.0^{ab}	2.0	34.9^{ab}	2.4	34.3	2.3	34.0	2.3	-	35.5	2.6	33.7	2.1	-
Crude fat (%)																				
6	5.35	1.15	5.38^{a}	0.99	5.60^{a}	1.20	4.60^{ab}	0.51	4.28^{b}	1.53	5.31	1.07	5.41	1.26	-	5.88	1.09	4.89	0.88	***
8	6.17	1.32	6.16	1.06	6.21	1.59	6.53	1.23	4.85	1.63	5.96	1.27	6.38	1.35	-	6.40	1.28	5.79	1.32	*
10	7.87	1.74	7.36^{a}	1.67	8.41^{b}	1.70	7.65^{ab}	1.46	9.23^{ab}	1.21	7.71	1.81	8.01	1.67	-	8.34	1.48	7.45	1.85	**
12	8.39	2.16	8.37	2.10	8.64	2.38	6.98	1.40	8.78	1.89	7.91	1.95	8.93	2.27	**	9.39	2.51	7.76	1.64	**
14	9.60	2.38	9.17^{a}	2.06	10.53^{b}	2.64	7.80^{ab}	4.56	7.00^{ab}	-	9.58	2.49	9.63	2.31	-	10.67	2.32	8.79	2.09	**
16	10.05	2.45	9.10^{a}	2.02	10.89^{b}	2.75	9.61^{ab}	1.76	10.93^{ab}	2.15	10.10	2.49	9.97	2.42	-	11.62	2.67	9.50	2.13	**
Crude protein (%)																				
6	18.4	0.8	18.5	0.9	18.4	0.7	18.3	0.5	18.1	0.8	18.5	0.8	18.4	0.8	-	18.5	0.8	18.4	0.8	-
8	19.5	0.7	19.5	0.7	19.5	0.8	19.1	1.1	18.9	0.6	19.4	0.9	19.5	0.6	-	19.6	0.7	19.3	0.9	-
10	19.9	0.8	19.9	0.7	19.9	0.8	19.9	0.7	19.1	0.2	19.8	0.8	20.0	0.7	-	20.1	0.7	19.7	0.8	*
12	20.2	0.8	20.3	0.7	20.0	0.9	20.5	0.5	20.3	0.7	20.3	0.8	20.1	0.8	-	20.0	0.8	20.3	0.7	-
14	20.4	0.7	20.5^{a}	0.7	20.3^{ab}	0.7	19.5^{b}	0.8	19.9^{ab}	-	20.4	0.7	20.3	0.8	-	20.2	0.5	20.6	0.9	-
16	20.9	0.8	20.9	0.7	20.8	0.9	21.2	0.9	20.8	0.8	21.0	0.8	20.6	0.9	*	20.5	1.1	21.0	0.7	*
Ash (%)																				
6	3.54	0.36	3.46^{a}	0.32	3.58^{ab}	0.36	3.58^{ab}	0.42	3.83^{b}	0.47	3.56	0.40	3.53	0.31	-	3.45	0.38	3.63	0.32	*
8	3.32	0.41	3.37	0.45	3.28	0.36	3.13	0.40	3.40	0.85	3.36	0.42	3.28	0.41	-	3.28	0.37	3.39	0.48	-
10	3.28	0.39	3.26	0.40	3.33	0.38	3.08	0.05	3.20	0.36	3.24	0.37	3.31	0.40	-	3.27	0.42	3.29	0.36	-
12	3.39	0.37	3.38	0.37	3.43	0.36	3.35	0.30	3.27	0.44	3.37	0.36	3.41	0.38	-	3.34	0.44	3.41	0.32	-
14	3.21	0.32	3.18	0.30	3.27	0.35	3.15	0.07	3.00	-	3.20	0.34	3.22	0.29	-	3.19	0.33	3.25	0.32	-
16	3.01	0.37	2.94	0.35	3.07	0.40	2.99	0.32	3.03	0.50	2.95	0.34	3.11	0.41	-	3.05	0.42	2.99	0.36	-

a, b: Values within the same row with different superscripts differ significantly ($P < 0.05$). * $P < 0.05$; ** $P < 0.01$; *** $P < 0.001$

Table 4 : Regressions of age (weeks) on chemical composition of the empty body

Model	Genotype					
	PP			DP		
	a	b	R^2	a	b	R^2
			Dry matter (%)			
Linear	24.6	0.6	50.0	23.7	0.74	59.4
Exponential	3.22	0.02	50.1	3.20	0.023	59.6
Reciprocal	0.039	-0.0006	51.4	0.04	-0.0007	59.3
			Crude fat (%)			
Linear	3.0	0.42	379	2.3	0.56	44.9
Exponential	1.37	0.056	36.6	1.31	0.069	45.2
Reciprocal	0.231	0.008	28.6	0.236	0.009	41.3
			Crude protein (%)			
Linear	17.6	0.22	45.3	17.5	0.21	42.4
Exponential	2.87	0.011	45.3	2.87	0.011	42.2
Reciprocal	0.056	0.00057	45.2	0.057	0.00055	41.9
			Ash (%)			
Linear	3.72	-0.041	10.5	3.72	-0.036	9.4
Exponential	1.32	-0.013	10.8	1.31	-0.011	9.6
Reciprocal	0.266	0.0039	11.1	0.27	0.0035	9.8

that the correlation was stronger in the DP cross than in the purebred PP rabbits.

Taking into consideration the fact that age and body weight were effective simultaneously (older rabbits being heavier), the authors examined the effect of body weight on the dry matter content of the empty body for each age category using the 2 most populous genotypes (PP and DP).

The characteristic data of linear regression functions (a, b and r) are summarized in Table 6. The correlation between body weight and dry matter content was either weak or intermediate and the value of b was higher than the one calculated for the whole experimental period (Table 5).

Figure 1 : Linear regressions of body weight on the dry matter content of the empty body in the rabbits at 6, 8, 10, 12, 14 and 16 weeks (PP ______ DP ______)

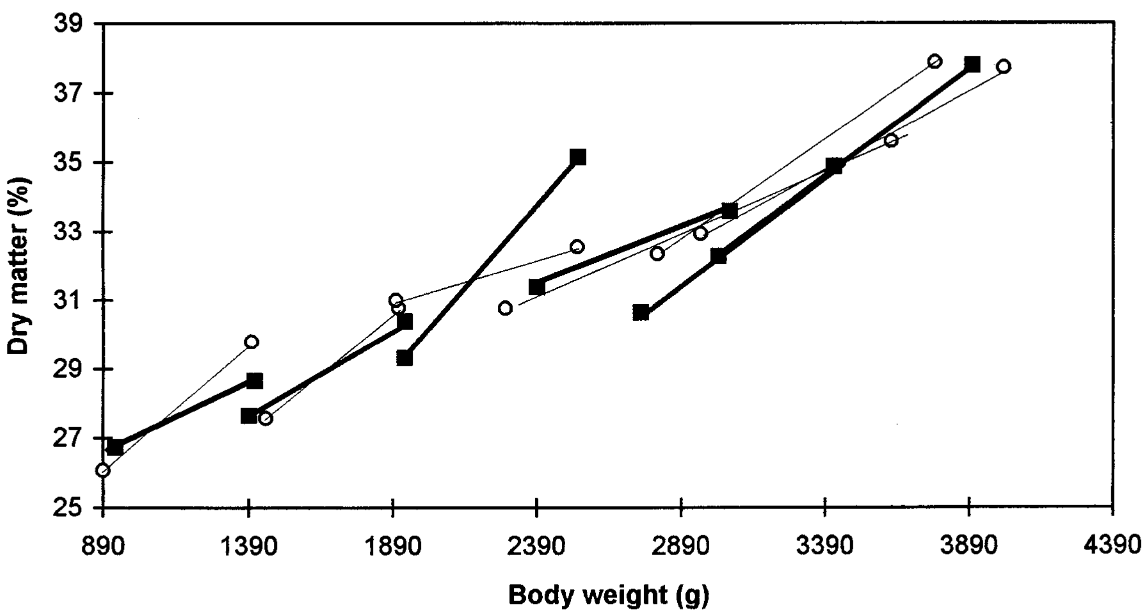

Table 5 : Regressions of body weight (kg) on chemical composition of the empty body

	Genotype					
Model	**PP**			**DP**		
	a	b	R^2	a	b	R^2
			Dry matter (%)			
Linear	24.6	2.76	58.2	24.1	3.22	64.4
Exponential	3.22	0.09	59.3	3.21	0.102	65.9
Reciprocal	0.039	-0.003	60.0	0.04	-0.033	65.9
			Crude fat (%)			
Linear	2.9	1.96	45.8	2.4	2.50	52.4
Exponential	1.36	0.265	44.2	1.33	0.309	52.9
Reciprocal	0.233	-0.037	34.5	0.234	-0.042	48.6
			Crude protein (%)			
Linear	17.7	0.93	45.0	20.9	-0.51	14.4
Exponential	2.88	0.047	45.4	3.04	-0.26	14.6
Reciprocal	0.056	-1.0024	45.6	0.048	0.0014	14.7
			Ash (%)			
Linear	17.7	0.93	45.0	20.9	-0.51	14.4
Exponential	2.88	0.047	45.4	3.04	-0.26	14.6
Reciprocal	0.056	-1.0024	45.6	0.048	0.0014	14.7

A similar relationship is shown in Figure 1. Nevertheless, it can also be seen that the dry matter content changed less in the case of a weight difference between two age groups than within a single age group. The findings, similarly to the R^2 values shown in Tables 3 and 4, support the conclusion that the effect of body weight is greater than that of the age. This is confirmed by the data of Table 7.

Within the same group the HW rabbits were found to contain significantly more dry matter than the LW rabbits (Table 3).

At the ages of 6, 10, 14 and 16 weeks, the effect of genotype was significant (Table 3). Data for the 2 most populous groups (i.e. PP and DP) showed the superiority of the crossbreds regarding dry matter content in the age groups of 10, 14 and 16 weeks.

Sex had a significant effect only at 12 weeks of age (Table 3) when the females surpassed the males. However, no similar tendencies could be detected either in younger or in older rabbits.

Change in dry matter content is determined mainly by crude fat content. During fattening water is replaced by fat. Table 8 provides evidence of this relationship between fat and water content. When the fat content of the empty body increases by 1%, the water content decreases by 1.1-1.2%. The authors found correlations from -0.86 to -0.98 between the fat and water content of the empty body, which correspond to the close and negative correlation reported by FRAGA *et al.* (1978).

Crude fat

Between the ages of 6 and 16 weeks fat content of the empty body almost doubled (from 5.35% to 10.05%, Table 3), both age and body weight being responsible for this. The regression functions describing the relationship between age and fat content of the empty body are listed in Table 4. The reciprocal equation was less adequate for describing the relationship than the linear or the exponential model. Fat content of the empty body increased by 0.42% per week in the PP genotype and by 0.52% per week in the DP genotype.

The relationship between body weight and fat content (Table 5) appears very similar to the effect of age. Here, the linear and exponential models also describe the relationship more accurately. The R^2 value was higher in the DP and also, according to the b value, the regression curves were steeper for the crossbred rabbits. When body weight increased by 100 g, fat content of the empty body increased by 0.2% (PP) or 0.25 (DP). These values are similar to those reported by FRAGA *et al.* (1983), but FERREIRA *et al.* (1996) detected more marked changes working in Brazil.

It is difficult to make a distinction between the effect of age and weight, since body weight increases with age. According to the linear regressions of body weight on fat content at various ages, there are slight or intermediate correlations between these two characteristics (Table 6). R^2 was also found by DE BLAS *et al.* (1977) to be low. Although the b values

Table 6 : Linear regressions of weight (kg) on chemical composition of the empty body between 6 and 16 weeks of age (y = a+bx)

	Genotype					
Age weeks	PP			DP		
	a	b	r	a	b	r
			Dry matter (%)			
6	23.0	0.4	0.34	19.7	7.2	0.60
8	21.0	4.9	0.44	17.4	7.0	0.39
10	20.7	4.5	0.38	26.3	2.5	0.26
12	23.5	3.3	0.27	22.5	3.6	0.46
14	13.2	6.3	0.60	16.2	5.8	0.42
16	13.4	6.3	0.53	23.2	3.6	0.35
			Crude fat (%)			
6	1.59	3.3	0.38	-1.86	6.6	0.60
8	0.76	4.0	0.45	-1.35	4.5	0.33
10	0.29	3.2	0.34	3.51	2.2	0.23
12	-2.64	4.0	0.32	-3.97	4.7	0.48
14	-14.5	7.5	0.64	-11.1	6.8	0.47
16	-12.1	6.6	0.54	-6.23	5.2	0.44

were higher (Table 6) than those determined for the whole population (Table 5), the rate of fat deposition was lower between subsequent age groups than the effect of different body weights within the same age group (Figure 2). The experiment reported by FRAGA *et al.* (1983) supports this conclusion. By analysing body composition between 2.0 and 2.5 kg of weight, these authors found that liveweight at slaughter accounted for the greatest part of variation in the proportion of fat. In the present study in every age group the HW rabbits contained more fat (by 0.6-2.1%) than the LW rabbits, and the differences were significant (Table 3). Heavier rabbits of the same age are biologically more mature (being closer to mature weight), and therefore the growth of the adipose tissue is more intensive. In an experiment performed by FRAGA *et al.* (1983) an increase in rate of weight gain resulted in an increase in the fat content of the body. The linear multiple regressions (Table 7) show a similar tendency; the effect of weight was highly significant in any cases but the significant level of age effect was lower.

The allometric coefficient of fat tissue increases considerably in the weight range 950 to 2100 g (OUHAYOUN, 1983). On the contrary, the fat content of meat (*M. longissimus dorsi* and hind leg) is low and increases slowly with age or with weight gain (PARIGI-BINI *et al.*, 1992; MAERTENS AND DE GROOTE, 1992; SZENDRŐ *et al.*, 1996). These findings show that the amount of fat depots in different body parts is more responsible for the higher fat content of the empty body in older rabbits than the intramuscular fat.

The effect of genotype was significant at the ages of 6, 10, 14 and 16 weeks. In evaluation of the two largest

Figure 2 : Linear regressions of body weight on the fat content of the empty body in the rabbits at 6, 8, 10, 12, 14 and 16 weeks (PP ——— DP ——)

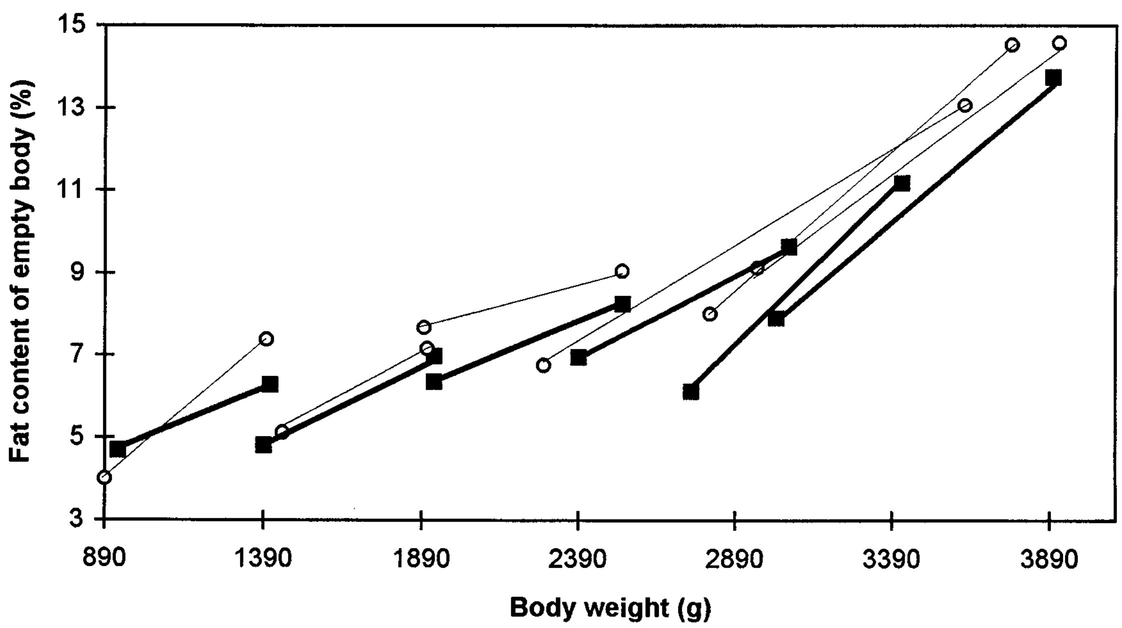

Table 7 : Linear multiple regressions of weight (W = kg) and age (A = weeks) on the chemical composition of the empty body

	Variable used in the equation			Effect of		
Genotype	a	b_W	b_A	W	A	R^2
			Dry matter			
PP	25.2	4.14	-0.295	***	*	0.59
DP	25.4	3.98	-0.145	***	NS	0.66
			Crude fat			
PP	3.54	3.73	-0.386	***	***	0.49
DP	3.18	4.33	-0.404	***	**	0.55

*** P < 0.001, ** P < 0.01, * P < 0.05, NS = non significant

genotype groups the authors measured higher fat content in the crossbred rabbits on each occasion (Table 3), due to the genetically more fatty body of the DD breed. In our previous experiment it was found that Danish White rabbits were more prone than PP rabbits to become overweight if fed *ad libitum* (SZENDRŐ *et al*., 1996).

The difference found between the 2 sexes was significant only at 12 weeks of age. With the exception of the age group of 16 weeks, the females contained more fat than the males (Table 3). FRAGA *et al.* (1983) and FEKETE AND BROWN (1992) also published data on the more elevated fat content of growing female rabbits.

Crude protein

The protein content of the empty body increased by 2.5% between 6 and 16 weeks of age (Table 3). All three (linear, exponential and reciprocal) models were equally accurate in describing the relationship between age and protein content. The regression coefficient indicates that the weekly increase in the protein content of the empty body was 0.21-0.22% on average (Table 4), but was higher at earlier age (between 6 and 10 weeks). Although the protein content of the meat is independent of weight and age (PARAGI-BINI *et al.*, 1992; MAERTENS AND DE GROOTE, 1992; SZENDRŐ *et al.*, 1996), the muscle and other protein sources (skin, liver and gastointestinal tract) do not increase in protein content as intensively in older animals as in younger ones, and therefore change in the protein content of the empty body is smaller at more advanced age than in younger rabbits.

The correlation between body weight and protein content of the empty body is rather ambiguous. The accuracy of estimation is the same for all three models used for calculation (Table 5). However, the R^2 value was much lower for the DP rabbits. Further uncertainties arise from the regression coefficient, which was positive for the PP and negative for the DP cross. Protein content was higher in HW rabbits at earlier age and in LW rabbits at more more advanced age (Table 3). However, the difference detected between the HW and LW groups were significant only at 10 and 16 weeks of age. FRAGA *et al.* (1983) observed that an increase in rate of weight gain resulted in a decrease in percentage in N. These authors also detected a slight increase in N content between 2.0 and 2.5 kg liveweight. The positive effect of body weight and the negative effect of weight gain may be responsible for the contradictory results obtained.

The protein content of the PP genotype tended to be higher between 12 and 16 weeks of age than before this period, although the difference was not significant (Table 3).

Crude protein content was similar when the two sexes were compared (Table 3), but it was only at 16 weeks of age that the male rabbits contained significantly more protein than the females. FEKETE AND BROWN (1992) detected marked, but non-significant difference in the protein content of alfalfa-fed rabbits in favour of the males, but the effect of sex was negligible in an oat-fed group. Data published by FRAGA *et al.* (1983) contradict the data obtained in the present study; these authors ascertained a significant sex effect, males showing higher nitrogen content than females.

Ash

Ash content of the empty body decreased by 0.53% between 6 and 16 weeks of age (Table 3). The regressions between age and ash content of the empty body also show this tendency (Table 4). The equations obtained for the PP and DP genotypes are very similar in spite of the low R^2 values. The linear regression coefficient shows that ash content decreased by 0.036-0.041% per week.

There was a weak correlation between body weight and ash content of the empty body (Table 5). The b value, which determines the slope of the regression curve, was positive for DP genotype and negative for PP (Table 5). The data published by FRAGA *et al.* (1983) are also contradictory. As a consequence,

Table 8 : Linear regressions of fat on the water content of the empty body (y = a + bx)

Genotype	a	b	R^2
PP	77.0	-1.07	73.4
DP	77.5	-1.10	90.6
PD	78.2	-1.22	87.8
DD	78.6	-1.22	95.7

estimation based on body weight is not reliable.

Ash content was non-significantly higher in LW rabbits than in HW rabbits (Table 14) except at 6 weeks. Since ash is situated mainly in the bones, the difference between the younger and older rabbits and between the LW and HW groups may be related to the ratio of bone in the body. The skeleton develops most intensively in the young (its allometric coefficient being 1.91 up to 1 kg liveweight and 1.55 later on; OUHAYOUN, 1982). In younger and in lighter rabbits the ratio of bone in the body is higher.

Ash content tended to be higher (by approx. 0.1%) in the DP rabbits than in the PP rabbits (Table 3).

The males contained more ash than the females during the first 4 weeks, the tendency being later reversed (Table 3). FRAGA *et al.* (1983) and FEKETE AND BROWN (1992) did not find any significant effect of sex.

CONCLUSIONS

There exists a close relation (R^2 = 73% to 96%) between the dry matter and the fat content of the empty body, 1% fat deposition being accompanied by a 1.1% to 1.2% decrease in water content. Content of these both components is dependent on age (increasing from 27.6% to 34.2% and from 5.4% to 10.1% respectively between the ages of 6 to 16 weeks) and on body weight. The effect of live weight is more substantial. The changes occurring with change in age and weight can be explained primarily by increase in the quantity of depot fats. The effect of genotype is also significant, DD genotype young rabbits depositing fat more rapidly than those of PP genotype, which correlates with the faster growth and earlier fat deposition of the DD genotype. Sex exerts only a slight effect, significant difference in favour of the females having been observed only at the age of 12 weeks in this study.

The protein and ash content of the empty body was found to be influenced significantly by age: between the ages of 6 and 16 weeks protein content rose from 18.4% to 20.9%, while ash content fell from 3.5% to 3%. These changes can be explained by increased ratio of meat and decreased ratio of bone within the whole body. Genotype, live weight and sex were each observed to exert a significant effect only at one point on the age scale; approximately corresponding values were generally obtained.

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