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STUDY ON GROWTH AND CARCASS CHARACTERISTICS IN NORMAL-HAIRED AND ANGORA RABBITS OF DIFFERENT GENETIC BACKGROUND

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ABSTRACT

The authors examined the growth and slaughter traits of rabbits born from various matings (NxN, F1xN, NxF1, F1xF1, AxF1 and AxA) of purebred normal-haired (N), angora (A) and their single-crossed (F1) rabbits. The normal-haired and angora progeny each carried in their genetic background different proportions of the genes of the other type: normal-haired (0, 25, 33 or 50% A) and angora (50, 25 or 0% N). It was established that weight gain in the angora rabbits was lower than in the normal-haired ones. Body weight and weight gain during growth in the normal-haired rabbits carrying genes originating from angoras in ratios of 0, 25, 33 and 50% were found to diminish with this increase in A background; conversely, the same parameters in the angoras carrying the genes of the other type in ratios of 0, 25 and 50% increased with higher proportion of N background. Slaughter yield in the normal-haired crossbred rabbits proved equal to, or more favorable than that of purebred normal-haired ones, but a higher proportion of perirenal fat was found in the crossbred rabbits.

INTRODUCTION

A previous paper published by the authors (EIBEN *et al*., 2000) examined how pregnancy rate, litter size at birth and at 21 days and litter weight vary depending on maternal and paternal genotype in various matings (NxN, AxA, F1xN, NxF1, F1xF1 and AxF1) of purebred normal-haired (N), angora (A) and their single-crossed (F1) rabbits.

The objective of this study was to examine growth and slaughter traits in progeny born from the above matings, of both normal-haired and angora phenotype, which also carried in their genetic background different proportions of the genes of the other type.

MATERIAL AND METHODS

The studies were performed at the experimental site of the University of Kaposvár involving 2329 offspring born from 437 various matings of 51 purebred normal-haired Pannon White (N), 31 German angora (A) and their 65 single-crossed (F1) rabbit does (Table 1). The procedure used for mating and the reproduction performance results obtained are reported in a paper previously published by the authors (EIBEN *et al*., 2000).

The breeding does were kept individually in flat-deck wire mesh cages (80x50x40 cm) in a closed building with artificial lighting (16L:8D). In winter the building was heated by blowing in warm air (15-16°C), while in summer, in the absence of air conditioning, the temperature at times exceeded 25°C. After parturition newborn were fostered from the larger litters (N or F1 does: >10; A does: > 6) to smaller ones within the groups. The does were allowed to nurse the suckling rabbits freely. The progeny were sexed at the age of 21 days, when they were also individually weighed and tattooed. At weaning age of six weeks the doe was transferred into another cage, after which the littermates were reared in groups (5 or 6 rabbits per cage) up to 12 weeks of age. The baby wool was shorn from the angoras when they were 60 days old.

Table 1: Mating combinations, phenotype and genotype of the progeny

Matings sire x dam	**No. of litters**	**Offspring** day 21 n	Pheno-type	Genotype, % NN	AN/NA	AA	**Litter genetic background %** N	: A
NxN	60	330	normal	100			100	0
F1xN	55	291	normal	50	50		75	25
NxF1	52	277	normal	50	50		75	25
F1xF1	58	207	normal	33	67		50	50
		64	angora			100	50	50
AxF1	55	160	normal		100		25	75
		107	angora			100	25	75
AxA	45	87	angora			100	0	100

The breeding does and the progeny were fed *ad libitum* with the same commercially available rabbit diet (86% dry matter, 16.5% crude protein, 2.7% crude fat, 15.5% crude fibre, 0.70% lysine, 0.32% methionine, 0.60% Met+Cys, 10.3 MJ/kg digestible energy; pellet ∅ 3 mm). Drinking water was freely available from nipple drinkers. No hay supplementation was given.

At the age of 12 to 14 weeks trial slaughter was performed on some of the progeny (normal-haired NN, F1N, NF1, F1F1 and AF1: n=17, 16, 19, 19 and 17; angora F1F1, AF1 and AA: n=4, 9 and 8) at live weight between 2.50 and 2.85 kg, which corresponds to the Hungarian market weight. The NN, the crossbred normal-haired and angora rabbits were slaughtered at reaching 60%, 65% and 76% of their adult weight, respectively. The method of BLASCO *et al.* (1993) was used in both the slaughter of the rabbits and the dividing of the carcasses. Prior to slaughter the animals were fasted for 24 hours but had free access to drinking water.

Statistical evaluation of the data was performed according to the GLM (General Linear Models) procedure, by means of SAS version 6.09 software. The tables give the least square means (LSM) and the residual standard deviation (RSD). The chi-square test was used for the purpose of examining the significance of frequency distributions (FREQ examination, SAS version 6.09). The factors affecting the respective traits (individual body weight, weight gain and slaughter traits) were tested by means of analysis of variance, on the basis of the individual data recorded, with account taken of the fixed effects (parity and season), by means of the following model (interpreted according to the given trait):

$Y_{ijklm} = \mu + G_i + P_j + Pa_k + S_l + e_{ijklm}$

where Y_{ijklm} performance of the individual animal examined, μ overall mean

G_i genotype of progeny (i=NN, F1N, NF1, F1F1, AF1, AA)

P_j phenotype of progeny (j=normal-haired, angora)

Pa_k effect of parity (k=1, 2, 3, 4, 5)

S_l effect of season (l=spring, summer, autumn, winter)

e_{ijklm} random error

RESULTS AND DISCUSSION

Growth and weight gain

Individual body weight at the age of three weeks was found to be influenced primarily by maternal genotype, as the progeny of the N, F1 and A does differed significantly from each other in their weight at 21 days (Table 2). The effect on weight of genotype of the mother was verified by the fact that at three weeks of age the suckling rabbits born from the NxN and F1xN matings corresponded in weight, as did those from the NxF1 and F1xF1 groups, however, significant difference was ascertained between the F1xN and the NxF1 matings, in which the progeny were of identical genotype. The influencing role of the dam's genotype is corroborated by the authors' previous study (EIBEN *et al*., 2000), in which it was found that milk production (based on 21-day litter weight) was statistically different among N, F1 and A does.

The effect of the genotype of the individual offspring could also be detected in the data obtained for 21-day body weight: angoras derived from the same mating (F1xF1 or AxF1) proved smaller than their normal-haired siblings (Table 2). The weight of the angora progeny rose significantly with increase in the proportion of the N gene (0, 25 or 50%), while among the normal-haired offspring weight was found to decline with increase in the A genetic background (0, 25, 33 or 50%). The above findings were primarily attributable to the different rearing ability of the N, F1 and A mothers, but the genotype of the individual progeny was also held partly responsible.

Table 2: Body weight and daily weight gain of normal-haired or angora offspring derived from different mating combinations

Group	Offspring phenotype	Offspring genome part	Individual weight, g wk 3	wk 6	wk 10	wk 12	Daily weight gain, g/day wk 3-6	wk 6-10	wk 10-12
NxN	normal	0% A	415[a]	1297[a]	2229[a]	2695[a]	41.8[a]	33.4[a]	31.9[a]
F1xN	normal	25% A	420[a]	1237[b]	2118[b]	2528[b]	38.6[c]	31.4[b]	28.4[cd]
NxF1	normal	25% A	392[b]	1239[b]	2114[b]	2581[b]	40.0[b]	32.3[ab]	31.8[ab]
F1xF1	normal	33% A	392[b]	1154[c]	2003[c]	2441[c]	35.8[d]	29.8[cd]	29.7[bc]
AxF1	normal	50% A	364[cd]	1120[c]	1931[d]	2324[d]	35.0[d]	28.7[cd]	26.1[d]
F1xF1	angora	50% N	381[bc]	1112[c]	1966[cd]	2367[cd]	34.6[de]	30.7[bc]	27.7[cd]
AxF1	angora	25% N	347[e]	1047[d]	1819[e]	2213[e]	33.2[e]	27.1[d]	28.3[cd]
AxA	angora	0% N	290[f]	833[f]	1620[f]	1941[f]	25.6[g]	27.4[d]	24.3[de]
P			***	***	***	***	***	***	***
Parity			**	***	**	**	***	***	**
Season			***	***	***	***	*	***	**
RSD			72.2	176	278	300	6.44	6.72	10.6

Different superscripts within columns denote significant difference.
(NS: P>0.05 a,b,c,d,e,f,g and *P<0.05 **P<0.01 ***P<0.001)

It is evident from the data given in table 2 that at every age the NN rabbits gained weight the most readily and the AA ones the most slowly; from the age of six weeks there developed clear-cut differences in weight between these two genotypes and the other groups. The quite distinct tendency was a deterioration in body weight at 6, 10 and 12 weeks, and particularly in weight gain between the ages of 3 and 10 weeks, with increase in the proportion of the A gene in the normal-haired rabbits; on the other hand, among the angora progeny these parameters were found to improve with increase in the proportion of the N gene.

Although weight gain in the genetically identical F1xN and NxF1 progeny differed at times, their weight corresponded between the ages of 6 and 12 weeks; thus, it can be inferred that the offspring of F1 does succeeded in compensating for their weight disadvantage recorded at the age of three weeks.

Significant difference between the weight gain of the normal-haired progeny born from the F1xF1 and AxF1 matings and that of the angora progeny of these groups was ascertained only in certain instances, but the body weight in both phenotypes differed at statistically verifiably levels at the ages of 10 and 12 weeks.

The body weight and weight gain of the normal-haired offspring of the AxF1 group (50% A) was found to correspond statistically with that of the angora progeny of the F1xF1 mating (50 %N). This provides a basis to infer that where genetic background is similar there is no substantial difference in live weight or growth between rabbits of normal-haired and angora phenotype.

This finding is illustrated by the fact that, where there was a greater degree of difference in genetic background, more substantial differences were observed between the groups. The N genetic background of the normal-haired and angora rabbits born from the F1xF1 mating was 67 and 50% respectively, that of those born from the AxF1 pairing 50 and 25% respectively (Table 2). So, greater differences were recorded where there was greater deviation in the genetic background.

Difference was observed between the weight of the AN and AA littermates born from the AxF1 mating (Table 2). In a previous study performed by the authors (EIBEN *et al*., 1999), when angora does were inseminated with mixed (N+A) semen, the NA offspring were also heavier than their AA siblings. In an experiment by DAMME *et al*. (1985), when angora x NZW does were back-crossed with purebred angora bucks, the weight of the AA progeny proved 140 g significantly lower than that of their AN counterparts (2240 g vs. 2380 g), from which it was concluded that the angora gene exerts a pronounced pleiotropic effect on growth. In this study the growth of the AA rabbits lagged behind that of the other two angora groups significantly throughout the investigation period, to a more substantial degree than would be determined by genetic background. This finding and the observation that the weight of the normal-haired F1xF1 offspring was lower than anticipated, together with the differences ascertained between AxF1 littermate AN and AA progeny, all serve to corroborate the hypothesis regarding the pleiotropic effect of the gene for the angora characteristic (ROCHAMBEAU, 1988).

Mortality between weaning and the age of ten weeks was 5 to 6% in the NxN, F1xN and NxF1 groups (normal-haired progeny), 7 to 9% in the F1xF1 and AxF1 groups (normal-haired and angora offspring), but significantly the highest (10%) in the AxA group. After ten weeks of age the mortality rates were similar among the groups (2%).

Slaughter traits

The authors attempted to ensure that rabbits of different genotypes were slaughtered at the same market weight, but despite this intention slaughter weight did differ significantly between the groups in some instances (Table 3). Therefore the weight of the individual body parts could not be compared directly; thus, the authors examined changes with respect to each group in the proportions of the individual body parts in relation to live weight or reference carcass weight.

Table 3: Slaughter performance of normal-haired and angora rabbits derived from different matings

Mating (sire x dam)		NxN	F1xN	NxF1	F1xF1	AxF1	F1xF1	AxF1	AxA
Phenotype of progeny		NORMAL-HAIRED					ANGORA		
Genotype of progeny		NN	NN/AN	NN/AN	NN/AN/NA	AN	AA	AA	AA
Standard live weight	g	2790^{a}	2712^{b}	2613^{cd}	2660^{bc}	2673^{bc}	2688^{bc}	2626^{cd}	2575^{d}
Live weight after fasting	g	2659^{a}	2578^{b}	2478^{c}	2513^{c}	2531^{bc}	2530^{c}	2473^{c}	2368^{d}
Reference carcass weight	g	1386^{a}	1343^{b}	1284^{c}	1340^{b}	1307^{bc}	1238^{c}	1284^{c}	1170^{d}
Hot carcass weight	g	1672^{a}	1623^{b}	1553^{c}	1609^{b}	1579^{bc}	1516^{c}	1537^{c}	1433^{d}
Carcass yield	**%**	**62.8^{b}**	**62.9^{b}**	**62.7^{b}**	**64.1^{a}**	**62.4^{bc}**	**59.9^{d}**	**62.2^{c}**	**60.6^{d}**
Commercial skin	%1	15.6^{b}	15.1^{ab}	14.6^{a}	15.2^{ab}	15.5^{b}	18.3^{d}	16.5^{c}	18.9^{d}
Full gastrointestinal tract	%1	14.3^{c}	14.1^{bc}	14.5^{c}	13.3^{b}	13.9^{bc}	14.3^{c}	12.9^{ab}	11.6^{a}
Head	%1	5.2	5.3	5.3	5.2	5.2	5.0	5.1	5.2
Liver	%2	5.3	5.3	5.6	4.9	5.3	6.1	4.9	5.8
Perirenal fat	%2	2.1^{ab}	2.3^{abc}	1.7^{a}	2.4^{bc}	2.4^{bc}	2.6^{c}	1.8^{a}	2.7^{c}

Different superscripts within rows denote significant difference ($P<0.05$).

%1 as a percentage of live weight
%2 as a percentage of reference carcass weight

The slaughter yield of the angora rabbits lagged behind that of the normal-haired ones. This is due to differences in the weight of the pelt and its proportionate ratio, as the difference between the angora and the normal-haired rabbits with respect to the ratio of the skin was equal to the difference in their carcass yield (Table 3). The relative proportion of the weight of the digestive tract proved lower, but that of the perirenal fat higher, in the angora rabbits than in the normal-haired ones; however, these findings seem rather subject to chance. The outstandingly high dressing percentage (64%) of the normal-haired progeny of the F1xF1 group can be due to the relatively larger carcass weight with a reduction in the ratios of the skin, the digestive tract and the legs, and a higher ratio of the perirenal fat. The slaughter yield of the normal-haired and angora offspring of the AxF1 group was similar, but, in agreement with findings reported by DAMME *et al*. (1985), among the normal-haired progeny the ratio of the skin was lower, while live weight and carcass weight were higher; thus, they showed no significant improvement in carcass yield. In the angora and the crossbred rabbits, in a manner similar to our previous report (EIBEN *et al*., 1996), an increase in the relative proportion of the perirenal fat was observed. Especially for angoras, it can be explained by their higher maturity rate.

CONCLUSIONS

On the basis of the findings of this study it can be established that up to the age of 21 days the weight of young rabbits is determined primarily by the genotype of the mother, but there also prevails an influence exerted by the genotype of the individual offspring.

From the age of three weeks the genetic background of the progeny is the determinant factor: in the normal-haired rabbits it was observed that increase in the proportion of the angora gene was accompanied by a similar decrease in body weight and weight gain; on the other hand, in the angora offspring body weight increased and weight gain improved in proportion with increase in the ratio of genes originating from normal-haired rabbits.

The body weight and weight gain of the normal-haired and angora littermates born from the same mating deviated where their genetic background also differed substantially. Thus, not their phenotype but their genotype was responsible for the differences observed in the parameters examined.

The slaughter yield of the angora rabbits proved poorer than that of the normal-haired ones: dressing percentage decreased to the same relative degree as the weight of the pelt increased. The less slaughter yield of the angora in comparison with the normal-haired rabbits was therefore a consequence of the higher proportion of the pelt in relation to live weight. Although dressing percentage proved the most in the normal-haired offspring of the F1xF1 group, the influence of genetic background could not be detected unambiguously in the slaughter parameters.

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