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THE PERFORMANCE OF ANGORA RABBIT DOES AND THEIR PROGENY DEPENDING ON THE SEMEN USED FOR ARTIFICIAL INSEMINATION

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ABSTRACT: German Angora does were artificially inseminated with either Pannon White (N) or heterospermic (N+A) or Angora (A) rabbit semen to compare the reproduction and growth traits of 54 N x A, 53 (N+A) x A and 65 A x A matings. The kindling rate was 59.3, 58.5 and 47.7%, resp., the value of total born per litter averaged 7.09, 6.36 and 6.19, litter size at 21 days of age 5.73, 5.97 and 4.89, and litter weight at 21 days 1739, 1700 and 1446 g. In the (N+A) x A group the ratio of NA and AA offspring at 21 days of age was 70.1% and 29.9%, which differed from the expected 1:1 distribution (P<0.05). Rabbits were weaned at 42 days of age. For 91 NA from N x A, 74 NA and 30 AA from (N+A) x A, and 94 AA offspring from A x A mating combinations, the body weight averaged 317, 287, 288 and 303 g at 21 days and 1054, 993, 869 and 908 g at 42 days, and 2004, 1891, 1610 and 1594 g at 70 days, and the daily weight gain between 3 and 6 weeks of age was 35.0, 33.6, 27.7 and 28.8 g and between 6 and 10 weeks of age 33.4, 32.1, 25.4 and 24.7 g, respectively. It seemed that the Angora sperm disadvantageously influenced the fertility and litter size. The larger birth litter size, better gain and lower mortality of NA and their higher ratio in the heterospermic group indicated their better viability compared to AA rabbits. The body weight of NA born in the heterospermic group differed more and more with advancing age from their AA littermates, which supports the hypothesis of the negative pleiotropic effect of the Angora gene and/or the remaining part of the genome on growth.

RESUME: Les performances de la lapine angora et de sa progéniture dépendent du type de semence utilisé pour l'insémination artificielle.
Des lapines Angora de souche allemande ont été artificiellement inséminée avec de la semence de lapin à pelage commun de souche Pannon Blanc (N), à pelage Angora (A) ou d'un mélange hétérospermique (N+A) afin de comparer les performances de reproduction et de croissance de 54 N x A, 53 (N+A) x A et 65 A x A accouplements. Les taux de mises bas ont été de 59,3, 58,5 et 47,7%, le nombre total de lapereaux nés de 7,09, 6,36 et 6,19, la taille de portée à 21 jours 5,73, 5,97 et 4,89, et le poids de portée à 21 jours 1739, 1700 et 1446 g respectivement. Dans le groupe (N+A) x A, la proportion d'individus NA et AA à 21 jours a été respectivement de 70.1% et 29.9% ce qui est significativement différent du ratio 1:1 attendu a priori (P<0,05). Les lapereaux ont été sevrés à l'âge de 42 jours. Chez les 91 animaux NA issus des inséminations N x A, les 74 NA et 30 AA issus de (N+A) x A, et 94 AA issus de A x A, le poids vif moyen a été respectivement de 317, 287, 288 et 303 g à 21 jours, 1054, 993, 869 et 908 g à 42 jours, et 2004, 1891, 1610 et 1594 g à 70 jours, avec un gain moyen quotidien de 35,0, 33,6, 27,7 et 28,8 g entre 3 et 6 semaines d'âge et de 33,4, 32,1, 25,4 et 24,7 g entre 6 et 10 semaines d'âge. En conclusion, il apparaît que la semence de lapin angora a une influence négative sur la fertilité et la taille de portée. Comparativement aux animaux AA, les résultats ont montré qu'en raison d'une plus grande taille de portée à la naissance, une plus faible mortalité, un meilleur gain de poids et une plus forte proportion dans le groupe hétérospermique, les lapereaux NA ont une meilleure viabilité. Dans le groupe hétérospermique, la différence de poids entre les animaux NA et AA s'est accru avec l'âge en faveur des lapereaux NA, ce qui soutient l'hypothèse d'un effet pléïotropique négatif du gène angora et/ou de la partie résiduelle du génome angora sur la croissance.

INTRODUCTION

Heat stress caused by the fleece (BROCKHAUSEN *et al.*,1979; SCHLOLAUT, 1987), the pleiotropic effect of the Angora gene (DAMME *et al.*, 1985; GUPTA *et al.*, 1995; BOLET *et al.*, 1996) and/or the remaining part of the genome (ROCHAMBEAU, 1988), the targeted selection for wool production (SCHLOLAUT, 1988) and the effect of close inbreeding (SCHLOLAUT, 1974; GUPTA *et al.*, 1995) can be the reason(s) for the poorer performance of Angora rabbits. Prolificacy improves by crossbreeding the Angora herds (GARCÍA *et al.*,1984; SHEN *et al.*, 1992; WANG and JIANG, 1992; WANG and ZHENG, 1993). SHEN *et al.* (1992) described an improvement in the maternal traits by crossing normal hair and Angora rabbits. OLÁH (1958) observed an intermediate growth of the F1 progeny by doing a reciprocal mating of the two breeds. In the experiment by DAMME *et al.* (1985) backcrossing the F1 does with Angora bucks, the 90-day weight of the heterozygous and the Angora littermate progeny differed by 6%, which allowed the authors to conclude the negative pleiotropic effect the Angora gene has on growth.

In our research Angora does were artificially inseminated with normal hair Pannon White (N), Angora (A) and heterospermic (N+A) semen to compare the maternal traits. In the heterospermic group we compared the real genotypic ratio of the progeny to the expected 1-to-1 distribution. We tried to find out if there was any difference in the growth between the littermate NA and AA progeny and the matingly different but genetically identical heterozygous (NA) and Angora (AA) rabbits.

MATERIAL AND METHODS

Animals

Multiparous German Angora (A) does (n=77) were artificially inseminated (AI) in five mating periods between May and September on the Experimental Rabbits Farm of the Pannon Agricultural University. The breeding does were kept in flat-deck wire cages (80 x 50 x 40 cm) individually, in a room fitted with windows. Supplementary neon lights were also applied (16 h per day). The room was heated with blown-in warm air (15 to 16(C) in winter. In summer the temperature became more elevated and reached 25(C temporarily. Nest boxes were hung on the outside of the cages 3 days before littering. These boxes were removed at 21 days of age of the young. The doe was taken out of the cage at weaning (42 days of age). The offspring stayed in the cage together (5 to 6 rabbits/cage) for another 6 weeks.

Diet

The does and their progeny were fed the same pelleted, commercial diet ad libitum (86% dry matter, 16.5% crude protein, 2.70% crude fat, 15.5% crude fibre, 0.70% lysine, 0.32% methionine, 0.60% methionine+cystine, 10.3 MJ/kg DE, 3 mm pellet diameter). The rabbits had free access to the valved self-drinker. No supplementary hay was provided.

Breeding

The does were inseminated on the 25th to 30th day post partum. Those that remained not pregnant (checked by palpation 10 to 14 days after insemination) were re-inseminated 28 to 30 days after the previous AI. Every doe was expected to deliver three times. The quality of the semen was checked macroscopically and microscopically (for density and motility) and scored from 0 to 5 (5 was the best). The fresh semen was diluted in a ratio of 1:5-8. The heterospermic inseminations were carried out with a mixture of semen (1:1) of similar quality of the N (n=10) and A bucks (n=10). At AI, a dose of 1.5 μg of GnRH analogue hormone (Ovurelin, manufactured by Reanal, Hungary) was administered to induce ovulation. Litter size at birth were standardized to 6 by using fostering within a group. The does were allowed to nurse any time. The 21-day-old rabbits were sexed, weighed and tattooed individually. They were weaned at 42 days of age. The does, which remained not pregnant three times, and those which were culled or died before they produced a litter were excluded from the experiment, and their data were eliminated from the evaluation (n=10).

The experimental group

Sire x Dam	Symbol of mating	n	Genotype of progeny	n
Pannon White x German Angora	N x A	28	NA	91
Heterospem x German Angora	(NA+A) x A	29	NA/AA	74/30
German Angora x German Angora	A x A	29	AA	94

The three groups of Angora does were inseminated with N, A or heterospermic (N+A) semen in a sequence. In this way, the same doe could act in every group. With this design our intention was to reduce the standard error caused by grouping small numbers of females. The does which returned were re-inseminated with the type of semen used previously. The genotype of the offspring in the (N+A) x A group was determined based on the fur at 3 weeks of age. Altogether individual data of 289 offspring deriving from 86 litters was evaluated.

Statistical procedure:

The statistical evaluation was carried out according to the GLM procedure using the program package of SAS ver. 6.09. The factors affecting the single traits were tested by analysis of variance based on the individual data, taking the fixed effects into account (i.e. paternal genotype, parity, sex, number of doe teats, season) by using the following model:

$$Y_{ijklmno} = \mu + Gp_i + P_j + G_{ok} + S_l + T_m + Se_n + e_{ijklmno}$$

in which

$Y_{ijklmno}$ = the performance
μ = overall mean
Gp_i = effect of paternal genotype (i = 1,2,3)
P_j = parity effect (j = 1,2,3,4,5)
G_{ok} = genotype effect of the offspring (k = 1,2)
S_l = sex effect (l = 1,2)
T_m = effect of the doe's number of teats (m = 1,2,3)
Se_n = season effect (n = 1,2,3)
$e_{ijklmno}$ = standard error

The analysis of significance of the distributions was performed by Chi-square Test (FREQ-Test, SAS ver. 6.09).

Table 1 : Comparison of kindling rate, litter size and 21 d litter weight of German Angora rabbit does inseminated with N, A or heterospermic (N+A) semen

Trait	Kindling rate %	Litter size										21 d litter weight, g	
		Total		Alive		Nursed		21 days		At weaning			
		LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM
Overall mean	54.7	6.55	-	6.08	-	6.20	-	5.53	-	5.22	-	1628	-
Group[1]													
NxA	59.3	7.09	2.17	6.76	1.92	6.61	1.93	5.73	1.49	5.44	1.42	1739	416
(N+A)xA	58.5	6.36	2.85	5.90	2.87	6.08	2.18	5.97	2.00	5.66	2.09	1700	606
AxA	47.7	6.19	3.11	5.59	2.77	5.92	2.21	4.89	2.15	4.55	2.17	1446	515
Group effect	NS	NS		NS		-		NS		NS		NS	
Parity effect	*	NS		NS		-		NS		NS		*	
Season effect	*	NS		NS		-		*		*		*	

[1] group: sire x dam
Means within a column with different superscripts are significantly different ; (NS: P>0.05 *P<0.05 **P<0.01 ***P<0.001)

RESULTS AND DISCUSSION

The N bucks produced better quality semen then the Angoras (2.03 and 2.57, P<0.001). This finding is in accordance with the observations by HU *et al.* (1988), RADNAI *et al.* (1988) and THEAU-CLÉMENT *et al.* (1991). Season did not affect the semen quality (P>0.05).

In each group the Angora does weighed the same, i.e. 3437(32 g at insemination and 3400(44 g after littering. At AI the does were 4.5% smaller in spring and by 6.4% in summer than in autumn (P<0.01). The non pregnant does were 3.5% lighter at insemination than those that delivered later (3377 g and 3497 g, P<0.05), which means that poorer body condition resulted in lesser fertility.

Conception rate was highest in the group of does inseminated with N semen. Performance of the (N+A) x A group was lower but closely similar to N x A group. Kindling rate was lowest in the A x A mating (Table 1). These differences were not significant, although it seems that the semen of Angora bucks reduced the kindling rate because of its poorer quality and lower fertility. Our results coincide with those reported by SINKOVICS *et al.* (1983) and BROCKHAUSEN *et al.* (1979) concerning the conception characteristics of German Angora rabbits (45% and 46%).

Litter size at birth proved, by 0.82, larger in the N x A crossing as compared to the other two types of mating. The number of offspring born alive was by 0.3 larger in the (N+A) x A group than in the A x A. These differences were not significant among the groups (Table 1). This phenomenon however could indicate the better fertility of N semen, and also, the probably improved prenatal viability of the crossbred NA rabbits. In our previous study (EIBEN *et al.*, 1996) the implantation rate was (namely by 6.7%) higher in N x A as compared to A x A group. In terms of the number of progeny (total and born alive) of German Angora rabbits, SCHLOLAUT (1987) reported similar (6.18 and 5.43), GARCÍA *et al.* (1984) smaller (3.92 and 3.33), while SHEN (1992) larger values (7.61 and 7.17) than ours. Litter size at 3 and 6 weeks of age was smaller by 1 in the A x A group than the average in the N x A and (N+A) x A matings. These differences are non-significant, but support the opinion that crossbred litters are more populous (BLASCO *et al.*, 1993). Evaluating New Zealand White x Angora litters as compared to purebred Angoras SHEN (1992) found larger litters (the difference was almost 1 rabbit) in favour of the crossbreds (7.61 vs. 8.33 at birth and 5.70 and 6.33 at weaning), too. In spite of the better growth rate and heavier weight of the NA progeny, the Angora does could not raise more rabbits in the N x A litters than in the (N x A)+A group (Tables 1 and 2). Thus our findings support the opinion that Angora does are unable to raise litters larger than 6 rabbits (ROUGEOT and THÉBAULT, 1989; HULLÁR and SZABÓ, 1991).

Ratio of the NA and AA progeny in the (N x A)+A group was found to be 70.1% and 29.9%, respectively (P<0.001), i.e. the number of Angora offspring was significantly fewer than it was expectable theoretically (50% to 50%). This result is probably due to a lower fertility of the Angora

Table 2 : Comparison of the body weight and daily weight gain of normal hair (NA) offspring born from N x A or (N+A) x A matings and Angora progeny (AA) deriving from groups of (N+A) x A or A x A

Trait		Individual weight, g								Daily weight gain, g/day					
Age		3 weeks		6 weeks		10 weeks		12 weeks		3-6. wk		6-10. wk		10-12. wk	
		LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM	LSM	SEM
Overall mean		299	-	956	-	1775	-	2158	-	31.3	-	28.9	-	28.8	-
Group[1]	Pro-geny														
NxA	NA	317[a]	82	1054[a]	193	2004[a]	280	2393[a]	305	35.0[a]	6.2	33.4[a]	7.3	31.7[a]	10
(N+A)xA	NA	287[b]	45	993[b]	137	1891[b]	263	2347[a]	273	33.6[a]	5.3	32.1[a]	7.0	32.4[a]	8.8
(N+A)xA	AA	288[b]	52	869[c]	114	1610[c]	266	1941[b]	328	27.7[b]	4.9	25.4[b]	7.8	25.1[b]	12
AxA	AA	303[ab]	71	908[c]	152	1594[c]	253	1950[b]	310	28.8[b]	5.0	24.7[b]	5.8	25.9[b]	8.1
Group effect		*		***		***		***		***		***		***	
Parity effect		***		***		***		***		***		***		NS	
Sex effect		NS		NS		NS		NS		NS		NS		NS	
Doe`s teat		NS		*		-		-		NS		-		-	
Season effect		***		***		***		***		*		***		NS	

[1] group: sire x dam
Means within a column with different superscripts are significantly different ; (NS: P>0.05 *P<0.05 **P<0.01 ***P<0.001)

semen, and suggests that the NA offspring could have a better prenatal vitality than the AA offspring.

Total litter losses until 21 days of age (20.7%, 20.7% and 14.3%) and mortality of the suckling rabbits (17.6%, 9.04% and 16.7%) were similar in the N x A, (N+A) x A and A x A groups, respectively (P<0.05). There was no difference in the rate of mortality even in the period between 3 and 6 weeks of age (6.4%, 4.0% and 5.8%). GUPTA *et al.* (1995) could wean 3.62 out of 5.68 rabbits born in Russian Angora rabbits. Similarly to our results, they detected higher mortality during the first few weeks of life.

Although the difference was non-significant, 21-day litter weight was smaller in the A x A group than in the N x A and (N+A) x A matings, which can be explained by smaller litter size (Table 1).

In the most populous litters of the (N+A) x A group the individual weight of the 21-day-old littermate NA and AA offspring did not differ at all (Table 2), which indicates that the doe(s milk production determines the growth of the progeny during the lactation period. Thereafter the NA rabbits grew significantly faster (P<0.05) than their AA littermates. Moreover, at 12 weeks of age they made up for their lag behind the NA rabbits born from N x A mating. Body weight of the crossbred NA progeny of the same doe proved heavier than that of their AA littermates by 14.3%, 17.5% and 20.1% at 6, 10 and 12 weeks of age, respectively (P<0.001). This finding supports the statements by other authors concerning the disadvantageous pleiotropic effect of the Angora gene (DAMME *et al.*, 1985; GUPTA *et al.*, 1995) and/or the negative effect of the remaining part of the genome of the Angora rabbits (ROCHAMBEAU, 1988) on growth. SHEN *et al.* (1992) reported 15.6% difference in body weight at 6 weeks of age in favour of New Zealand White x Angora crossbreds as compared to the purebred Angoras, which is very similar to our difference of 14.1% observed between the N x A and A x A progeny.

Mortality loss was greater in the progeny of the A x A group than in that of the N x A group during the interval from weaning to 10 weeks of age (8.1% vs. 2.0%, P<0.05, resp.). This value fell between the previous extremes in the (N+A) x A group (4.0%). Within this group the NA and AA littermates showed the same rates of mortality. Mortality differences among the experimental groups were not any more significant between the ages of 10 to 12 weeks (1.5%, 2.3% and 4.0%), nevertheless, the greatest loss was again detected in the A x A group.

Conception rate was poorer in summer (44.4%, P<0.05) than in spring (57.5%) or autumn (74.1%), and litter size at birth seemed also smaller by 0.63 (P>0.05). Reduced litter size in summer (SIMPLICIO *et al.*, 1988) is caused by the higher occurrence of semen abnormalities (HU *et al.*, 1988; THEAU-CLÉMENT *et* *al.*, 1991) and the higher rate of embryonic mortality (ASHOUR *et al.*, 1995) at that time of the year. In our investigation the litter sizes at 3 and 6 weeks of age were the same in spring and in autumn but they were smaller in summer (-8.4% and -17%, P<0.05). Body weight and weight gain of the progeny were greatest in winter, medium in autumn but remarkably reduced in summer (by 8.2-10.7% and by 5.1-15.7%, resp., P<0.001). These seasonal changes correspond with those reported by WANG and ZHENG (1993) and GUPTA *et al.* (1995). Heat stress, namely, influences the feed intake (AYYAT and MARAI, 1996) and weight gain (LUKEFAHR *et al.*, 1996) of the rabbits in a negative way. In hot weather the does lose weight and produce less milk (PAPP, 1997). Because of the heat shock caused by the long wool cover, these adverse effects may be more expressed in the case of the Angora rabbits.

CONCLUSIONS

The poorer quality of the semen of Angora bucks seemed to reduce the conception rate and litter size. We detected 70% of NA and 30% of AA genotype in the 3-week-old progeny born from the (N+A) x A matings. This finding was different from the theoretically expectable 1:1 ratio and could be explained by the poorer quality of Angora sperm, although the possibility of a better intrauterine survival rate of the crossbred progeny can not be discarded.

The litter mates of NA and AA genotype born from heterospermic inseminations weighed the same at 3 weeks of age. Thus the growth of the kits was determined by the doe(s milk production during suckling. At 6, 10 and 12 weeks of age, the weight of NA rabbits were by 14,3%, 17,5% and 20,1% greater than their AA littermates, which gives evidence of the negative pleiotropic effect of the Angora gene and/or the unfavourable effect of the remaining part of the genome on growth.

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