STUDY ON THE PERFORMANCE OF NORMAL HAIR, ANGORA AND THEIR RECIPROCAL CROSSBRED RABBITS : 2. REPRODUCTION TRAITS

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Abstract - A crossbreeding experiment was carried out from May to Sept. in 1994 with 63 normal hair Pannon White meat (N) and 67 German Angora (A) does. During investigations because of illness or death 17.5 and 34.3 % of N and A females were removed. The live weight of A and N does at AI and at parturition were 3444 ± 34, 4409 ± 33 and 3426 ± 41, 4317 ± 34 g, resp. Reproduction traits of A females, including CR (%), kindling interval (days) and number of AI per litter were weaker (P<0.05) compared to N rabbits (46.9, 85.2, 2.16 *vs.* 75.0, 72.1, 1.56). Litter size at birth, at 21 day and at weaning (9.54, 8.00, 7.73 *vs.* 6.43, 5.25, 4.83) and litter weight at 21 day (2510 *vs.* 1448 g) were larger in NxN group than that of AxA (P<0.05). However, comparing purebred A and N youngs a higher rate of total litter loss (23.5 *vs.* 1.1 %, P<0.05) and suckling mortality (17.9 *vs.* 14.2 %) were observed in A rabbits. Nevertheless, in all traits examined compared to purebred groups of NxN and AxA respectively, in crossbreeding of AxN a decrease while in NxA an increase was found. Concerning litter size and live weight of young rabbits the individual heterosis was 0.5-9.5 and 2.7-5.4 %, resp.

INTRODUCTION

Rabbits with a special coat (i.e. Angora or Rex) are generally described as having poorer reproductive ability, growing performance, resistance and viability compared to normal hair meat ones. In the case of Angora the reason of these phenomena are explained by the Angora gene and also by the remaining genome of the rabbit (ROCHAMBEAU, 1988) or/and by the heat stress caused by the long wool (BROCKHAUSEN, 1979; FINZI *et al.,* 1992; SCHLOLAUT, 1994). For the weaker performance of Rex rabbits ROCHAMBEAU *et al.* (1984, 1986) presumed a pleiotropic effect of the Rex mutation which was also supposed in the case of Angora gene in a crossing experiment with normal hair NZW and Angora rabbits (DAMME *et al.,* 1985).
The aim of present study was to investigate some reproductive traits in rabbits owing the Angora gene (heterozygous, homozygous) or not. The results reported here, about the conception rate, litter traits and mortality are part of a larger experiment with crossbreeding groups of normal hair meat and Angora rabbits.

MATERIAL AND METHODS

The investigations were carried out on the Research Station on the Fac. of Animal Sci., Pannon Agric. University. In five series of artificial inseminations (AI) from May to September in 1994 the production of 63 normal hair Pannon White meat (N) and 67 German Angora (A) does from 184 and 172 matings were evaluated.

Experimental groups

10 bucks of normal hair meat rabbit and 10 Angora were used which were completed when a male was removed or died (Table 1).

Table 1 : Mating combinations and number of does, litters and young rabbits in the 5 experimental groups

Group	Mating* combinations	No. of does	Litter genotype	No. of litters born	No. of litters weaned	No. of rabbits born alive	No. of rabbits weaned
1.	NxN	31	NN	65	62	572	494
2.	AxN	22	AN	65	61	562	444
3.	NxA	32	NA	31	22	213	126
4.**	NxA	21	-	31	23	178	127
5.	AXA	24	AA	30	24	162	115
Total	-	*130*	-	*222*	*192*	*1687*	*1306*

N= Normal hair Pannon White meat rabbit ; A=German Angora rabbit
* Sire breed listed first ; ** 4. group: Heterospermic semen (mixed 1:1 from bucks of N and A genotype).

Housing

Rabbits were housed in an isolated building with windows and artificial lighting. In winter it was heated (15 16°C) with warm air of an over-under pressure ventilation system, but in summer the temperature could reach sometimes 25-30 °C. Does and bucks were reared in individual flat-deck wire cages (80x50x40 cm). 3 days before parturition a nest box with shavings was supplied outside the cage which was removed when kids were 21-day-old. At weaning does were transferred and the litter stayed in place (5-6 fryers per cage).

Feeding

All of rabbits were fed with a commercial pelleted diet (86% DM, 16.5% CP, 2.70% EE, 15.5% CF, 0.70% lysine, 0.32% methionine, 0.60% met+cys, 10.3 MJ/kg DE; ∅ 3 mm) and watered by automatic nipple system, *ad libitum.*

Breeding

At the beginning of experiment the age of multiparous does were 11 and 15 months on average in N and A genotypes. The primiparous or multiparous does were inseminated 25-45 days after delivery, and does open (palpation on the 10-14th day) were re-inseminated 28-30 days after the previous AI. At the time of AI 1.5 µg GnRH analogue per doe (D-Phe6-GnRH; Ovurelin inj. ad us. vet., Reanal) was injected into the femoral muscle to induce ovulation. Before dilution (1:5-8) the semen quality was evaluated macroscopically and microscopically (density, motility). After each parturition does of N genotype (group NxN and AxN) were artificially inseminated alternately once with sperm of N or A genotype thus the same doe belonged to group 1 or 2, by turns. Similarly, in group NxA, (N+A)xA and AxA after kindling, Angora does were inseminated once with semen of A, N or N+A genotype. Empty does were inseminated with sperm of genotype used before. With this method -in spite of little doe numbers- the random error deriving from group formation could be decreased. Does which had not at least one litter before their illness or death or in case of 3 unsuccessful AI were eliminated (culled) from the evaluation. After parturition, if it was possible, the kids were fostered from large litters (over 10 and 6 in meat and angora does, respectively). Youngs were marked with an individual ear tattoo number at 21 days of age. Weaning was achieved at six weeks of age (does were transferred). Angora rabbits having long wool were sheared about one week before each AI.

Recordings

Live weight of does at AI and at parturition; live weight of bucks at AI.; conception rate (CR); gestation period; kindling interval (days between two consecutive litterings); number of AI per litter; litter size total (LST), alive (LSA), nursed (litter size after fostering, LSN), at 21 days (LS21) and at weaning (LSW); litter weight at 21 days (LW21); total litter loss (when all kids died before 21 days, MT); suckling mortality (when there was at least one young alive at 21 days, MS).

Statistical analysis

Data were subjected to analysis of variance or judged by using the Chi square test.

RESULTS AND DISCUSSION

Mortality and eliminating of the does

The per cent of does closed from the evaluation were similar in N and A genotype (11.1 *vs.* 14.9 %) though inside this the occurrence of 3 unsuccessful AI was more frequent in A does (4.8 *vs.* 10.4 %) but the differences were not significant. In addition, the per cent of females which were removed because of illness or death was higher in A genotype (17.5 *vs.* 34.3 %, P<0.05) and this confirms the weaker resistance of Angora does.

Live weight of does and of bucks

The average weight of A and N does were 3444 ± 34 and 4409 ± 33 g at AI and 3426 ± 41 and 4317 ± 34 g at parturition. It is important to note that compared to does open the later pregnant females were about 4.0 % heavier at AI in A genotype (3370 ± 50 and 3509 ± 46 g, P<0.05). Thus, the weaker reproductive performance of Angora does may be related to the poorer condition, as well.

The weight of A and N bucks at AI were 3193 ± 43 and 4609 ± 37 g, respectively (P<0.05).
The live weight of breeding animals corresponded to that of standard weight for German Angora (ROCHAMBEAU, 1988; GARCÍA-XIMÉNEZ *et al.*, 1993) and Pannon White meat rabbits (SZENDRÖ *et al.*, 1996).

Conception rate (CR), kindling interval, number of AI per litter, gestation length

Our result confirms the weaker fertility of A does since it was the lowest in group AxA and highest in group NxN (46.9 and 75.0 %, P<0.05, Table 2). This is in agreement with SINKOVICS *et al.* (1983) who observed a CR of 45 *vs.* 75 % in a comparison of Angora and meat rabbits. The A does showed a better fertility of about 13 % in case of AI with heterospermic (N+A) or N genotype semen while it was about 7 % poorer in group of N does inseminated with sperm of A bucks. These findings partly could be explained by the lower quality of Angora sperm deriving from the higher semen abnormality rate observed by HU *et al.* (1988), RADNAI *et al.* (1988), THEAU-CLÉMENT *et al.* (1991) and BODNAR *et al.* (1995). Another reason for the lower CR of A does could be the high percent (25.9 %) of no-ovulating females (EIBEN *et al.*, 1996). It seems that the dam breed effect is more pronounced in fertility because comparing the difference in CR of A (group 3+5) and N does (group 1+2) apart from buck genotype it is 18.6 % whereas apart from doe genotype (sire breed effect, between group 1+3 and 2+5) it is only 9.6 %.
Kindling interval and number of AI per litter also indicate the poorer fecundity of A does. The period between two consecutive kindlings were 85.2 ± 3.1 and 72.1 ± 2.2 days in favour of N rabbits (P<0.05). The number of AI per delivery were 2.16 ± 0.12 and 1.56 ± 0.11 in A and N rabbits, resp. (P<0.05). This latter data are partly in agreement with SCHLOLAUT (1987) who reported a value of 1.66 and 1.53 in Angora and NZW rabbits. The gestation length in groups varied between 31.6 to 31.8 days, on average.

Litter size (LS)

The differences in LS between genotypes are very largely determined by the dam, not by the embryo (BLASCO *et al.*, 1993). LST, LSA, LS21 and LSW were highest in group NxN and lowest in AxA (Table 2). Comparing our results regarding LST and LSA in purebred German Angora does GARCÍA-XIMÉNEZ *et al.* (1984) reported smaller (3.92 and 3.33) and SHENG (1992) larger (7.61 and 7.17) values, but they were consistent with those (6.18 and 5.43) noted by SCHLOLAUT (1987). In contrast to NxN in crossbreeding group of AxN a decrease and comparing to AxA in groups of NxA and (N+A)xA an increase in litter size performances was observed but the tendency was not significant. In his study DAMME *et al.* (1985) did not find any significant difference in LST, LSA and LSW between purebred NZW and Angora x NZW rabbits (9.4, 8.3, 5.3 *vs.* 9.7, 8.7, 5.1). Comparing purebred Angora does SHENG (1992) also reported a similar better result in crossing group of NZW x Angora concerning LST and LSA (7.61, 7.17 *vs.* 8.33, 7.67).
Litter size was primarily determined by dam breed because independently from sire breed the difference in LST, LSA, LS21 and LSW between N (group 1+2) and A (group 3+5) does were 2.38, 2.40, 2.38 and 2.58, resp. (dam breed effect).
LS directly depends on the ovulation rate, fertilization rate and prenatal survival (BLASCO *et al.*, 1993 and CIFRE *et al.*, 1994). The lower LS of A does is connected with the number of corpora lutea and prenatal mortality. In our investigation (EIBEN *et al.*, 1996) in contrast to other reports (THEAU-CLÉMENT *et al.*, 1991) a significant greater value in the number of corpora lutea was found in favour of N rabbits (11.0 *vs.* 7.49) while the survival rate after implantation was in 12 days pregnant N does about 23 % higher compared to A females. This latter confirmed the high rate of embryonic mortality previously found in Angora rabbits (BROCKHAUSEN *et al.*, 1979).
However, an insignificant effect of sire breed independently from that of does was also noticed, litter size from N bucks was 0.32-0.74 larger than that of A males. The reason of this was probably the higher quantity and better quality of semen from buck of N genotype. In contrast to the expected frequency of 1:1 in young rabbits of N and A genotype born in group (N+A)xA, it was 2.3:1 in favour of N offsprings that confirms the better fertilization ability of semen deriving from N bucks, too.
There is, however, a small benefit in LS from heterosis in the embryo (BLASCO *et al.*, 1993). Similarly to the published heterosis values in crossing of CAL and NZW lines (BRUN *et al.*, 1992), an individual heterosis for LS between 0.5-9.5 % was found. In favour of crossings LST, LSA, LS21 and LSW were in order 0.18, 0.69, 0.03 and 0.17 higher compared to purebred groups.

Table 2 : The performance of does in the five crossbreeding group

Group / Mating combinations[1]	Overall[2] Mean	1. NxN		2. AxN		3. NxA		4.[3] (N+A)xA	
Traits	**Value**	**Mean**	**s.e.**	**Mean**	**s.e.**	**Mean**	**s.e.**	**Mean**	**s.**
CR[5] (%)	62.4	75.0^{a}	-	68.4^{ab}	-	59.3^{bc}	-	59.6^{abc}	-
		N doe (1+2 group)				A doe (3+4+5 gr			
Kindling interval (day)	78.7	72.1 ± 2.2^{a}				85.2 ± 3.1^{b}			
no. of AI/litter	1.86	1.56 ± 0.11^{a}				2.16 ± 0.12^{b}			
Litter size									
total(LST)	8.08	9.54^{a}	0.36	8.98^{a}	0.36	7.35^{b}	0.52	6.39^{b}	0.
alive(LSA)	7.60	8.80^{a}	0.36	8.78^{a}	0.36	7.10^{b}	0.53	6.14^{b}	0.
nursed(LSN)	-	9.11^{a}	0.28	8.71^{a}	0.28	7.03^{b}	0.42	6.10^{b}	0.
day 21(LS21)	6.64	8.00^{a}	0.26	7.66^{a}	0.26	5.65^{b}	0.43	5.70^{b}	0.
at weaning(LSW)	6.36	7.73^{a}	0.26	7.57^{a}	0.26	5.32^{b}	0.44	5.39^{b}	0.
Litter weight (g)									
at 21 d. (LW21)	2006	2510^{a}	71	2410^{a}	72	1655^{b}	120	1627^{b}	11
Mortality (%)									
total (MT)	9.7	1.1^{a}	-	2.9^{b}	-	11.3^{c}	-	10.7^{c}	-
suckling (MS)	15.5	14.2^{ab}	-	13.0^{ab}	-	16.9^{a}	-	9.0^{b}	-

Means within a line with different superscripts are significantly different ($P<0.05$).

[1] Sire breed listed first; N=normal hair Pannon White meat rabbit, A=German Angora rabbit

[2] Group 1+2+3+5

[3] 4. group: Heterospermic semen (mixed 1:1 from bucks of N and A genotype).

[4]. Individual heterosis

[5] CR=Conception rate

Litter weight

Concerning LW21 it was the highest in NxN and lowest in AxA ($P<0.05$, Table 2). In the crossbreeding group of AN a decrease and in NA or (N+A)xA an increase was obtained but compared to purebred groups the differences were not significant. The effect of dam breed was considerably higher (908 g) than that of sire's (154 g) in this respect. The observed heterosis was 2.7 % (Table 2). Since there is a positive correlation between LST and litter weight (SZENDRÖ *et al.,* 1988), LW21 is connected with both LST and nursing (milking) ability of does. Data about individual weight at 3 and 6 weeks of age are reported in the third part of companion paper (EIBEN *et al.,* 1996).

Individual weight

As there was not any significant difference between sexes, data were pooled. Youngs born from N does had significantly larger IW21 than offsprings from A females ($P<0.05$) however, the differences between groups of same doe genotype were statistically not proven. The 37 g heavier IW21 of NN offsprings compared to AA rabbits was mainly due to the dam breed (28.8 g) but it was also influenced by breed of sire (8.1 g). The heterosis was 3.8 %.

The obviously higher dam breed effect in LW21 and IW21 may be related to the superiority of N does in teat number (9.11 *vs* 8.68, $P<0.05$) that consequently reflects the better nursing ability of N females. Nevertheless, because of shearing a risk of wounded teats in A females could be also taken into consideration.

At weaning NN youngs were 219 and 48 g heavier than that of AA and AN rabbits ($P<0.05$) while the difference between NA and AA offsprings was 152 g in favour of NA genotype. In terms of IWW to the difference between NN and AA groups both dam (119 g) and sire (100 g) breed effects contributed. The heterosis was 5.4 % (Table 2 and 3). In group of (N+A)xA both NA and AA youngs had insignificantly lighter IW21 and IWW than those born from crossing NXA and AXA, resp, which could be related to the higher LS21 in group (N+A)xA.

Despite of the smallest litter size in AA rabbits, the IW21 and IWW were 11.7 and 20.2 % lower compared to NN youngs and for this both the poorer growing performance of lighter youngs and the weaker milking ability of A females could be responsible.

Suckling mortality

Suckling mortality was divided into two parts. Total litter loss (MT) means that up to 21 days all youngs died mainly because of the mother's fault (kindling outside the nest, lack of milk etc.). In the case of suckling mortality (MS) one or more kids can die but at 21 day there is at least one young alive. This latter is primary due to the weaker survival ability of suckling (SZENDRÖ *et al.*, 1984).

The MT was 23.5 % in AxA and only 1.1 % in NxN groups ($P<0.05$) whereas comparing to purebred rabbits it was higher in AxN (2.9 %) and lower in NxA (11.3 %) crossbreeding groups ($P<0.05$). The particularly high value in AxA was primary due to dam breed effect (15.4 %).

With respect to MS, apart from (N+A)xA there were no significant differences among the other 4 groups (13.0-17.9 %). However, the observed higher rate in AA was probably due to a poorer viability of sucklings (presumed smaller individual weight at birth and lower milking ability of A does).

CONCLUSION

The comparison between normal hair meat and Angora rabbits showed that Angora does are less resistant partly because of their weaker condition. The weaker reproductive performance of Angora rabbits depends first of all on the dam breed effect which was significant in the case of CR, LS, LW21 and MT. In connection with the lower amount and poorer quality of Angora semen, the sire breed effect was significant only in CR and LST. Concerning litter size and live weight an individual heterosis between 0.5-9.5 % was found.

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Etude des performances de lapins à pelage commun, de lapins Angora, et de leurs croisements réciproques : 2. Caractères de reproduction - Une expérience de croisements entre souches de lapins a été réalisée de mai à septembre 1994, à partir de 63 femelles White Pannon, à pelage commun (N) et 67 femelles Angora Allemand, à pelage long (A). Au cours de l'expérimentation 17,5 % des femelles N et 34,3 % des femelles A ont été éliminées pour des raisons sanitaires ou décès. Les poids vifs des femelles A et N, au moment de l'IA et de la mise bas, étaient respectivement de 3444 ± 34 g, 4409 ± 33 et 3426 ± 41, 4317 ± 34 g. Les performances des femelles Angora (A): taux de fertilité, intervalle entre mise bas (ours) et le nombre d'AI/portée ont été significativement plus faibles (P<0,05) que celles des femelles White Pannon (N)(46.9, 72.1, 1.56 contre 75, 85.2, 2.16). La taille de la portée à la naissance, à 21 jours et au sevrage (42 j),(9.54, 8.00 et 7.73 contre 6.43, 5.25 et 4.83), le poids de la portée à 21 jours (2510 contre 1448 g) et le poids individuel à 21 j et au sevrage (315 et 1082 g contre 278 et 863 g) étaient significativement plus élevés dans le groupe NxN que dans le groupe AxA (P<0,05). Les taux de disparition totale de la portée (23.5 contre 1.1 %, P<0.05), de pertes entre naissance et 21 jours (17,9 contre 14,2 %) et de pertes entre 21 jours et sevrage (8,3 contre 3,3 %, P<0,05) ont été toujours plus élevés dans la souche A, comparée à la souche N. Par ailleurs, pour toutes les performances étudiées, on a trouvé une augmentation pour le croisement AxN et une diminution pour le croisement NxA. Concernant la taille de portée et le poids vif des lapereaux, l'effet hétérosis a été respectivement de 0.5 à 9.5 et de 2.7 à 5.4.