STUDY ON THE PERFORMANCE OF NORMAL HAIR, ANGORA AND THEIR RECIPROCAL CROSSBRED RABBITS : 1. COMPONENTS OF LITTER SIZE

EIBEN C.[1], SZENDRO ZS.[1], ALLAIN D.[2], THEBAULT R.G.[3], RADNAI I.[1], BIRONE NEMETH E.[1], LANSZKI J.[1]

1 Faculty of Anim. Sci., Pannon Agric. University, P.O.Box 16, Kaposvàr, H-7401, Hungary
2 INRA, SAGA, B.P. 27, 31326 Castanet-Tolosan Cedex, France
3 INRA, U.E. Génétique Phanères, Le Magneraud, 17700 St. Pierre d'Amilly, France

Abstract - Ovulation rate and embryonic development were investigated in a comparison of normal hair Pannon White meat (N) and Angora (A) rabbits after AI with semen of N or A genotype (sire x dam: NxN, AxN, NxA AxA; n: 18, 24, 15, 12). Multiparous does were slaughtered at 12th day after AI. in November, 1994. The evaluated traits: rate of ovulation and total embryo resorption, ovary size, number of corpora lutea (CL), number of live (NS) and dead embryos (ND), number of implantation sites (NI), implantation rate (IR), mortality before implantation (NDB), survival rate until placentation (SRP), and between implantation-placentation (SRIP). Compared to N rabbits a quarter of A does did not ovulate (2.1 and 25.0 %). In both N and A does a relative high rate of total embryo resorption was noticed (37.8 and 20.0 %). N does significantly surpassed A females in CL (11.0 and 7.49) and NS (8.06 and 3.52). Regarding ND (1.62 and 2.10) and NDB (1.37 and 1.87) there were not significant differences between N and A does. Compared to purebred groups of NxN and AxA while in crossing of AxN the performance impaired (CL, NI, NS, ND, IR, SRP, SRIP), it improved in NxA (CL, NI, NS, IR). It was concluded that in Angora rabbits for the observed weaker performances determining litter size both dam and sire breed are responsible.

INTRODUCTION

Compared to rabbits for meat production, Angora rabbits have a much weaker reproductive ability, which is due to a heat stress caused by the long wool (BROCKHAUSEN *et al.*, 1979; SCHLOLAUT, 1994), the pleiotropic effect of Angora gene or both of these factors (ROCHAMBEAU, 1988).

Litter size at birth directly depends on the ovulation rate, fertilization rate and prenatal survival (BLASCO *et al.*, 1993; CIFRE *et al.*, 1994). Furthermore, there are breed variation in ovulation rate and prenatal survival (HULOT *et al.*, 1981, 1988) and this latter may also depend on the uterine capacity of rabbit doe (BLASCO *et al.*, 1993). However, uterine capacity may be related both to uterine length and nutrient supply (secretion activity) of uterus. In addition, ovulation rate could be also connected with the general condition of doe (GARCÍA-XIMÉNEZ *et al.*, 1984; CIFRE *et al.*, 1994).

In different Angora strains GARCÍA *et al.* (1984) mentioned smaller litter size at birth (3.92 to 5.68) as compared to the values generally found in meat rabbits. However, in a trial with normal hair NZW and German Angora rabbits (SHENG, 1992) the crossbreeding group was superior to purebred Angora does for litter size at birth and number of offsprings born alive (8.33 and 7.67 of crossbred and 7.61 and 7.17 of purebred Angora rabbits). In previous studies the noticed smaller litter size at birth in Angora females was explained by the higher rate of prenatal mortality (BROCKHAUSEN *et al.*, 1979).

The purpose of present report was to examine the biological components of litter size in normal hair and Angora rabbits.

MATERIAL AND METHODS

Normal hair Pannon White meat (N) and German Angora (A) does were artificially inseminated (AI) with semen of bucks with N and A genotype (sire x dam: NxN, AxN NxA and AxA; n= 18, 24, 15 and 12), so in the four experimental groups the parents were straightbred N or A rabbits while in groups of AxN and NxA the embryos were crossbreds (F1). 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. For the observations the multiparous does after a half year production were slaughtered at 12th day of pregnancy in November, 1994. Angora rabbits were sheared about one week before AI.

The next traits were evaluated:

- rate of ovulated does,
- total embryo resorption (when at least one CL but not any NS or ND was observed),
- ovary size,
- number of corpora lutea (CL),
- number of live (NS) and dead embryos (ND),
- number of implantation sites (NI=NS+ND),
- mortality before implantation (NDB=CL-NI),
- implantation rate (IR=NI/CL*100),
- survival rate until placentation at 12th day of age (SRP=NS/CL*100),
- survival rate between implantation-placentation (SRIP=NS/NI*100).

Data of five does (2 N and 3 A) showing purulent uteritis and of three rabbits (1 N and 2 A) with symptoms of swelling like changes were removed from the evaluation.

Values were statistically analysed using variance analysis and Chi-square test.

RESULTS AND DISCUSSION

The average live weight of does at the day of AI and at slaughter were 4827 ± 75 and 4891 ± 79 g (N) and 3505 ± 95 and 3610 ± 100 g (A), respectively. The live weight of breeding animals corresponded to that of standard weight for German Angora (BROCKHAUSEN *et al.*, 1979; ROCHAMBEAU, 1988; GARCÍA *et al.*, 1993) and Pannon White meat rabbits (SZENDRÖ *et al.*, 1996).

Abnormalities in the maternal reproductive tract

Although theoretically there is no transuterine blastocyst migration in the rabbit uterus duplex (ZÖLDAG, 1990; ARGENTE *et al.*, 1992; BLASCO *et al.*, 1993), similarly to other authors (BLASCO, 1994) in three cases 1 to 1 embryo migration was found.
In agreement with the findings of ABO *et al.* (1986) who observed numerous bilateral paraovarian cysts in infertile does, in 12 N and 7 A does 1 to 6 cysts on the oviduct per doe were detected. In one N female the left uterus was absent but there were 7 live and 3 dead embryos in the right uterus horn. In another cases the compensatory ovarian hypertrophy were also mentioned by unilaterally ovariectomized does (ARGENTE *et al.*, 1992; BLASCO, 1994).
More infertile does showed fatty, inactive uterus.

Rate of ovulated does

In agreement with other reports in normal hair rabbits (BECHSTEDT *et al.*, 1986; HULOT *et al.*, 1976, 1988), 97.9 % of N does ovulated. However, compared to N females a quarter of A does did not ovulate (2.1 and 25.0 %, $P<0.005$, Table 1). Unexpectedly, the highest rate of no-ovulation was observed in group NxA (33.3 %). Group differences were mainly due to dam breed effect.

Total embryo resorption

Regarding this trait in contrast to the 7-8 % of total embryonic loss observed in 7-day-pregnant normal hair rabbits (MEUNIER *et al.*, 1983), independently from sire breed both in N and A does considerably higher rates were noticed (37.8 and 20.0 %, $P>0.05$). In addition, compared to purebred groups insignificantly greater values were found in crossing combinations of AxN and NxA (47.8 and 30.0 %).

Ovary size

N rabbits had larger ovaries but the difference was not significant. However, the size of ovary may be connected with the live weight of does, too. Nevertheless, in both N and A does the right ovary was insignificantly bigger.

Table 1 : Biological components of litter size of normal hair (N) and Angora (A) rabbits

Traits	Overall Mean Values	Mating combinations* NxN Mean	s.e.	AxN Mean	s.e.	NxA Mean	s.e.	AxA Mean	s.e.	Difference Dam N-A	Sire N-A
n	69	18		24		15		12			
No-ovulation (%)	13.6	0.0^{A}	-	4.2^{AB}	-	33.3^{C}	-	16.7^{BC}	-	-22.9	+6.3
Total embryo res.	28.9	27.8^{ab}	-	47.8^{a}	-	30.0^{ab}	-	10.0^{bc}	-	+17.8	0
n	41	13		12		7		9			
Ovary size**											
left side	154	172	12	160	12	154	15	131	14	-	-
right side	167	177	10	178	11	166	14	148	12	-	-
Corpora lutea (CL)											
total	9.27	11.2^{A}	0.7	10.9^{A}	0.7	8.43^{B}	0.95	6.56^{B}	0.84	+3.56	+1.09
left side	4.54	5.54^{a}	0.53	4.42^{ab}	0.55	4.86^{ab}	0.72	3.33b	0.63	+0.88	+1.32
right side	4.73	5.62^{A}	0.51	6.50^{A}	0.53	3.57^{B}	0.69	3.22^{B}	0.61	+2.66	-0.17
Live embryos (NS)											
total	5.79	8.69^{A}	0.81	7.42^{A}	0.85	3.71^{B}	1.11	3.33^{B}	0.98	+4.54	+0.82
left side	2.74	4.15^{a}	0.54	3.25^{ab}	0.56	2.00^{b}	0.73	1.56^{b}	0.64	+1.92	+0.67
right side	3.05	4.54^{A}	0.48	4.17^{A}	0.50	1.71^{B}	0.66	1.78^{B}	0.58	+2.62	+0.15
Dead embryos (ND)											
total	1.86	1.31	0.56	1.92	0.58	2.86	0.76	1.33	0.67	-0.49	+0.46
left side	0.97	0.85	0.42	0.83	0.43	1.29	0.57	0.89	0.50	-0.25	+0.20
right side	0.89	0.46^{a}	0.28	1.08^{ab}	0.29	1.57^{b}	0.38	0.44^{a}	0.34	-0.24	+0.26
Implantation sites	7.64	10.0^{A}	0.8	9.33^{A}	0.79	6.57^{B}	1.04	4.67^{B}	0.92	+4.04	+1.28
Mort. before imp.[1]	1.62	1.15	-	1.58	-	1.86	-	1.89	-	-0.50	+0.22
Imp. rate[2] (%)	81.0	89.7^{a}	-	85.6^{ab}	-	77.9^{ab}	-	71.2^{b}	-	+13.0	+5.4
Survival rate (%)											
until placentation[3]	60.2	77.9	-	68.1	-	44.0	-	50.8	-	+25.6	+1.6
between imp.-plac.[4]	73.6	86.9	-	79.5	-	56.5	-	71.3	-	+19.2	-3.7

* sire breed listed first; ** average length x high, in mm^2

Values in the same row with different superscripts are statistically different (a, b, c: P<0.05; A, B, C: P<0.005)

1: NDB=CL-NI, 2: IR=NI/CL*100, 3: SRP=NS/CL*100, 4: SRIP=NS/NI*100

Number of corpora lutea (CL)

The CL of N rabbits was consistent with values previously noted by GARCÍA-XIMÉNEZ *et al.* (1984), BOLET *et al.* (1988) and HULOT *et al.* (1988) but it was lower than means reported by ARGENTE *et al.* (1992), BLASCO *et al.* (1992) and CIFRE *et al.* (1994). However, compared to N rabbits A does shed about 3.5 less corpora lutea independently of sire breed (N: 11.0 and A: 7.49 P<0.005). This contradicts the result of THEAU-CLEMENT *et al.* (1991) who reported 8.9 to 11.3 ova in a French strain of Angora rabbits what was similar to that of generally found in meat rabbits. According to some German experiments (BROCKHAUSEN *et al.*, 1979) the number of ova shed was also higher (9-10) in German Angora does. The individual heterosis for CL was 8.8 %.

Left and right ovaries were individually considered. In N does the CL was slightly larger in the right ovary and it was adversely somewhat greater in the left side in A rabbits, though in agreement with the findings of BLASCO *et al.* (1992) and GOSALVEZ *et al.* (1994) the differences were not significant between ovaries.

Live (NS) and dead embryos (ND)

The average size (CR=cranial-rump) of the 12 day old embryos was 10-11 mm.

There were 4.5 more live embryos in N rabbits compared to A does (8.06 and 3.52, P<0.005). The NS of N rabbits was in accordance with that found by BOLET *et al.* (1988) while concerning this trait ARGENTE *et al.* (1992) and BLASCO *et al.* (1992) observed higher values in synthetic lines. In addition, in AxN group the NS moderately decreased while in crossing group of NxA it insignificantly increased. For the obtained differences the dam breed was primary responsible. The individual heterosis for NS was -7.4 %.

In A rabbits more dead embryos (ND) were detected but the difference was not significant (N: 1.62 and A: 2.10).

Although the effect of sire breed was insignificant, the decreasing and improving tendency in group AxN and NxA regarding NS and ND compared to purebred strains could be also related to a poorer semen quality of A rabbits (ZÖLDAG *et al.*, 1988; BODNAR *et al.*, 1995).

Number of implantation sites (NI=NS+ND)

The NI of N and A does were similar to that of reported by BOLET *et al.* (1988) and BROCKHAUSEN *et al.* (1979), resp. Due to a difference in NS, the N rabbits surpassed A does by about 4 embryos on average in terms of NI (9.67 and 5.62 $P<0.005$). In a comparison with straightbred rabbits, in crossing groups the observed tendency in NI was consistent with that of NS, i.e. it was smaller in AxN and larger in NxA. In addition, an individual heterosis of 8.4 % for NI was found.

Mortality before implantation (NDB=CL-NI)

There was not significant difference in NDB between A (1.87) and N (1.37) does. The observed heterosis was 13.2 %.

Implantation rate (IR=NI/CL*100)

In N rabbits 13.1 % more embryos implanted as compared to A does (87.7 and 74.6 %, $P<0.05$). The IR of N and A does were consistent with that of noted by BOLET *et al.* (1988), ARGENTE *et al.* (1992) for meat-, and BROCKHAUSEN *et al.* (1979) for Angora rabbits. In group of AxN the IR was 4.1 % lower and adversely, in crossing of NxA it was 6.7 % higher compared to purebred groups of NxN and AxA, respectively ($P<0.05$).

Survival rate until placentation (SRP=NS/CL*100)

In contrast to N does, the SRP was 25.6 % lower in A rabbits (73.0 and 47.4 %). These findings are in agreement with the earlier results about SRP in meat (BOLET *et al.*, 1988; ARGENTE *et al.*, 1992) and Angora (BROCKHAUSEN *et al.*, 1979) rabbits. However, comparing to purebred strains in both crossing groups of AxN and NxA the SRP were slightly smaller (9.8 and 6.8 %).

Survival rate between implantation-placentation (SRIP=NS/NI*100)

N rabbits surpassed A does by 19.3 % in SRIP (83.2 and 63.9 %). This means that embryo death were 16.8 % and twice so great of 36.1 % during this period in N and A does, respectively. Newertheless, these mortality rates were consistent with that of mentioned in meat- (HULOT *et al.*, 1979; 1981) and Angora rabbits (BROCKHAUSEN *et al.*, 1979, SCHLOLAUT, 1987). Despite generally expected better viability of heterozygous embryos, as in the case of SRP lower rates of SRIP were found in crosses of AxN and NxA compared to straigthbred groups.
SRP and SRIP were also primary affected by dam breed genotype.

CONCLUSION

On the basis of the results the next could be stated:
Exept total embryo resorption group NxN was superior to AxA for all of the traits examined which partly explains the generally weaker reproductive performance of Angora rabbits. However, while in crossing group of AxN the performance impaired (CL, NI, NS, ND, IR, SRP, SRIP), it improved in NxA (CL, NI, NS, IR) which also could be related to the poorer quality of Angora semen. In summary, the examined biological components of litter size were particularly affected by dam breed genotype.
To get more information, it would be useful to examine some other effects (live weight, hormone levels, size of blastocysts etc.) in different genotypes of normal hair and Angora rabbits.

Acknowledgements - This research project was supplied by the Hungarian grant of OTKA (T-016168).

REFERENCES

ABO ELEZZ Z.R., RADWAN A.A., HASSIEB M.M., BADAWY A.M., KOSBA M.A., 1986. Studies on the female genital systems of infertile rabbits which did not clinically respond to certain hormonal treatments. *3rd Int. Coll. Rostock*, 125-131.

ARGENTE M.J., SANTACREU M.A., BLASCO A., 1992. Uterine capacity in rabbits. First results. *J. Appl. Rabbit Res.* **15**, 473-479.

BECHSTEDT U., HARTWIG W., TSCHAUSCHEV P., 1986. Untersuchungen zum Einsatz von GnRH vet. "Berlin-Chemie" und erste Ergebnisse der klinischen. Prüfung des GnRH-Analogons zur Ovulationsauslösung beim Kaninchen. *3. Int. Coll. Rostock*, 106-110.

BLASCO A., SANTACREU M. A., ARGENTE M. J., 1992. Genetic parameters of ovulation rate, embryo and fetal survival in rabbits. *J. Appl. Rabbit Res.* **15**. 247-254.

BLASCO A., BIDANEL J. P., BOLET G., HALEY C. S., SANTACREU M. A., 1993. The genetics of prenatal survival of pigs and rabbits: a review. *Livestock Prod. Science*, **37**. 1-21.

BLASCO A., 1994. Divergent selection for uterine efficiency in rabbits. *Proc. 6. Hungarian Conf. on Rabbit Production*, PATE Kaposvár, 106-113.

BODNAR K., EIBEN CS., RADNAI I., 1995. Effect of summer heat on the sperm quality of Pannon White and Angora rabbit (in Hungarian). Proc. *7. Hungarian Conf. on Rabbit Prodduction*, PATE Kaposvár, 26-30.

BOLET G., BRUN J.M., HULOT F., 1988. Relationships between ovulation rate and embryonic survival in various strains of rabbits. *4. World Rabbit Congress, Budapest*, **Vol. 2.**, 149-157.

BROCKHAUSEN P., PAUFLER S., MICHELMANN H.W., SCHLOLAUT W., 1979. Untersuchung des Einflusses der Wollänge und der Schurfrequenz auf Fruchtsbarkeitskriterien beim veiblichen Angorakaninchen. *Züchtungskunde*, **51(4)**, 315-325.

CIFRE J., VICENTE J.S., BASELGA M., GARCÍA-XIMÉNEZ F., 1994. Ovulation rate in lines of rabbits selected on different criteria. *Ist Intern. Conf. on Rabbit Prod. in Hot Climates, Cairo (Egypt)*, Proc. 247-251.

GARCÍA-XIMÉNEZ F., BASELGA M., PLÁ M., DELTORO J., 1984. Ovulation rate in meat rabbit. *3. World Rabbit Congress, Roma*, **Vol. 2.**, 426-429.

GARCÍA F. X., MAGOFKE S. J. C., CARO T. W., GARCÍA P., 1984. Reciprocal crosses between two lines of Angora rabbit *Avances Prod. Anim.* **9(1-2)**, 183-187.

GARCÍA F. X., MAGOFKE S. J. C., ARINOVICHE M. N., 1993. Descriptive analysis of the effect of age on high production Angora rabbits. *Avances en Prod. Anim.* **18**, 1-2, 109-120.

GOSALVEZ L. F., ALVARIÑO J. M. R., DIAZ P., TOR M., 1994. Influence of age, stimulation by PMSG or flushing on the ovarian response to LH-RHa in young rabbit females. *World Rabbit Science* 2.2. 41-45.

HULOT F., POUJARDIEU B., 1976. Induction artificielle de l'ovulation et fertilité chez la Lapine (Oryctolagus cuniculus) allaitante ou non. *Ann. Biol. anim. Bioch. Biophys.*, 16(5), 635-643.

HULOT F., MATHERON G., 1981. Effets du génotype, de l'âge et de la saison sur les composantes de la reproduction chez la Lapine. *Ann. Génét. Sél. Anim.*, **13.2**, 131-150.

HULOT F., MARIANA J.C., CATTIAU G., 1988. HCG-Induced ovulation in two rabbit breeds: Effect of dose, season and sexual behaviour. *Livestock Prod. Science*, **20**, 257-267.

MEUNIER M., HULOT F., POIRIER J.C., TORRES S., 1983. A comparison of ovulatory gonadotropic surge in two rabbit strains: no evidence for a relationship between LH or FSH surge and factors of prolificacy. *Reprod. Nutr. Dévelop.* **23(4)**, 709-715.

ROCHAMBEAU H. DE, 1988. Genetics of the rabbit for wool and meat production. *4. World Rabbit Congress, Budapest*, **Vol. 2.**, 1-68.

SCHLOLAUT W., 1987. Angora rabbit housing and management. *J. Appl. Rabbit Res.* **10**, 164-169.

SCHLOLAUT W., 1994. Investigations on adaption to high temperatures by Angora rabbits. *Ist Intern. Conf. on Rabbit Prod. in Hot Climates, Cairo (Egypt)*, Proc. 453-460.

SHENG Y.Z., 1992. Efficiency analysis of the coarse-wool hybrid rabbit. *J. Appl. Rabbit Res.* **15**, 1680-1688.

SZENDRÖ ZS., BIRONE NEMETH E., RADNAI I., JENSEN N. E., KENESSEY Á., 1996. Comparison of production of Danish White and Pannon White purebred and crossbred rabbits. *Archiv Tierzüchter* (in press).

THEAU-CLÉMENT M., THÉBAULT R. G., BOLET G., ROCHAMBEAU H. DE, 1991. Reproduction of a French strain of Angora rabbits: ovulation rate of females and semen production of males. *Reprod. Nutr. Dévelop.* **31(6)**, 667-673.

ZÖLDÁG L., GÁBOR GY., SINKOVICS GY., 1988. A rapid semen evaluation method and efficacy of artificial insemination in Angora breeding stocks (in Hungarian). *Magyar Állatorvosok Lapja*, **43(9)**, 517-519.

ZÖLDÁG L.,1990. Reproductive biology of domestic rabbit (in Hungarian). In *Házinyúl-egészségtan*, Editor: Vetési F. Mezôgazdasági Kiadó, Budapest, 62-78.

Etude des performances de lapins à pelage commun, de lapins angora, et de leurs croisements réciproques : 1. Composantes de la taille de portée - Nous avons comparé le taux d'ovulation et le développement embryonnaire chez des lapines Pannon White (N), à pelage commun, élevées pour leur viande, et des lapines Angora, à poil long (A), après IA de semence provenant des mâles des deux génotypes (N et A) (mâle x femelle: NxN, AxN, NxA, AxA ; n: 18, 24, 15, 12). Les femelles multipares ont été sacrifiées 12 jours après l'insémination, en novembre 1994. Nous avons observé : le taux d'ovulation et la résorption totale des embryons, la taille de l'ovaire, le nombre de corps jaune (NO), le nombre d'embryons vivants (NS) et morts (ND), le nombre de sites d'implantation (NI), le taux d'implantation (IR), la mortalité avant implantation (NDB), le taux de survie avant (SRB) et après (SRA) implantation, le taux de mortalité avant (DRB) et après (DRA) implantation. Concernant le taux d'ovulation, 25.0 % des femelles A n'ont pas ovulé, contre 2.1 % des femelles N. Nous avons observé, sur les deux souches (N et A) un taux élevé de résorption totale des embryons (37.8 et 20.0 %). Les femelles N ont un nombre de corps jaune (NO) et un nombre d'embryons vivants (NS) significativement plus élevé que les femelles A (11.00 *vs* 7.49, et 8.06 *vs* 3.52). Par contre il n'y a pas de différence significative entre le nombre d'embryons morts (ND) (1.62 *vs* 2.10) et la mortalité avant implantation (NDB) (1.37 *vs* 1.87). Tandis que le croisement NXA réduit les performances NO, NI, NS, IR, SRB, SRA, DM, DRA, le croisement AXN améliore NO, NI, NS et IR. On peut en conclure que chez le lapin angora, le mâle et la femelle sont tous les deux responsables des performances médiocres observées sur les composantes de la taille de portée.