

Efficiency Analysis of the Coarse-wool Hybrid Rabbits

Sheng you-zhang

Institute of Animal Husbandry and Veterinary Science,
Jiangsu Academy of Agricultural Sciences, Nanjing 210014, China.

ABSTRACT

In order to improve the quantity and quality of the coarse wool in the rabbit fibre of German breed, the character of the France Angora and the meat rabbits whose coarse wool rate in fleece is relatively high are utilized in linecrossing or breed crossing. After two years, the rabbits of two way cross and three way cross have reproduced 2-3 generations. The coarse wool rate including heterotypical fibers has increased 17.55% on an average and the highest is 22%, which is 38% higher than France Angora and 1.9 times of German Angora. The total wool production averages 771g, which is higher than that of France Angora and little less than that of German Angora. Both the reproduction and the wool quality of the hybrid offsprings have been improved significantly.

Experimental methods

I. Hybrid-parents choosing and detection of its main property

1. Choose the German Angora whose annual wool yield is over 800g, adult weight over 4 kg and the rate of coarse wool about 50%. (G for short)
2. Choose the France Angora whose annual wool yield is over 600g, adult weight over 3.5kg and the rate of coarse wool over 12%. (F for short)
3. Choose the New Zealand meat rabbits whose adult weight is over 3.5kg and the rate of coarse wool over 22%.
4. ①Choose SAB whose adult weight is over 5.5kg and the rate of coarse

①SAB means German meat rabbits

wool about 27%.

II. Cross combinations of various breeds

1. Interbreeding

A. Cross the New Zealand meat rabbits as the male parent with the German Angora as the female and then upgrade the first generation of the hybrid as male parent with German Angora or cross the hybrid with France Angora in three way rotation. (C for F_1 CC for F_2 and AC for the cross in three-way rotation)

B. Cross the SAB as the male parent with German Angora as the female and then upgrade the first generation with German Angora or France Angora in three-way rotation. (R for F_1 RR for F_2 and AR for the three-way rotation cross)

2. Linecrossing

Cross the France Angora as the male parent with German Angora, whose first generation is selfcrossed or upgraded with German and France Angora. (FG for F_1 , FGG for the self-crossed or upgraded.)

III. Test items

1. The reproductive performance of each generation.

2. Growth and development.

3. Genetic properties of fleece.

4. Chemical and physical properties of wool fibers.

5. Combining ability and some heritability of various cross combinations, such as the wool yield and the rate of coarse wool, etc..

Results

I. Reproductive performance

Both New Zealand meat rabbits and SAB are of good fertility, so the litter size has increased obviously after crossing. For instance. The F_1 of combination C is 9.5% higher than G; FG is 5.1% and 33.33% higher than G and F resp.; CC is 7.8% higher than G; AC is 34.03% and 70% higher than G and F resp.; RR is 20.89% higher than G; AR is 16.67% higher than F. As for milking capacity, R is the highest, which produced 5,000 g in 21 days. The second highest is CC, which produced 3,490g. The grading F_2 of German Angora, either of

CC or RR have good milking capacity, which is conducive to bringing up strong offsprings. For the number of 42-day-old rabbits at weaning, RR, AC and CC are the highest, where there are 8.4, 7.8 and 7.6 heads resp., which are 47.31%, 36.84% and 33.33% higher than German Angora resp. Through linecrossing and interbreeding, the reproductive performance, such as litter size, milking capacity, weaning litter weight and the survival rate at weaning is better improved than German Angora ($P < 0.01$). See Table 1 for details.

II. The growth and development of the interbred and linecrossed F_1 and F_2

As shown in Tables 2 and 3, the growing rabbits grow vigorously in the 21 days after birth. The relative growth weight redouble number of time of the 21-day-old rabbits in combinations C, R, FG CC, RR and FGG is 2.91%, 2.82%, 2.83%, 2.95%, 2.82% and 2.81% resp. The daily gain reaches highest at the 42 days of age, 31.2g, 32.2g, 24.67g, 31.71g, 30g and 25.40g for C. R. FG. CC. RR and FGG resp. The absolute growth rate gradually slows down with age. The weaning weight at 42 days of age is of considerable influence on the weight at 6 mth of age and there is significant correlation between the combinations. For instance. The correlation coefficient for C is 0.58 ($P < 0.01$), for R 0.54 ($P < 0.01$), FG 0.45 ($P < 0.05$), CC 0.47 ($P < 0.05$), RR 0.52 ($P < 0.01$) and FGG 0.44 ($P < 0.05$). The weight at 42 days of age has positive correlation with that at 6 mth of age. Therefore to enhance feeding management at nursery stage and put on the individual weight at weaning have an important effect on increasing the weight and buliding up the health of breeding rabbits.

Table 1. The reproductive performance of cross combinations

Unit: Head, g

Combinations	Litter size	Survival number born	Weight at birth	Weight at 21 days	Weaning number	Litter weight at weaning
N × G C	8.33 ± 1.53	7.67 ± 0.58	516.67 ± 3.9	2850 ± 505	6.33 ± 1.53	6565
F × G FG	8.00 ± 3.96	6.80 ± 4.87	386 ± 260	1940 ± 705	5.75 ± 3.86	5325
NG × G CC	8.20 ± 1.48	8.20 ± 1.46	425 ± 63	3490 ± 1075	7.6 ± 1.82	8340
NG × F AC	10.20 ± 1.40	10.20 ± 2.00	510 ± 106	1840 ± 405	7.8 ± 2.89	7370
SAB × G R	7.25 ± 1.5	7.25 ± 1.5	380 ± 73.53	5000 ± 1410	7.0 ± 1.16	7530
SABG × G RR	9.2 ± 3.9	9.2 ± 3.9	605 ± 263	2175 ± 280	8.4 ± 3.21	9315
SABG × F AR	7.00 ± 4.0	6.4 ± 4.7	375 ± 283	1670 ± 63	6.25 ± 4.79	6865
G G	7.61 ± 1.56	7.17 ± 1.20	417 ± 127	2084 ± 5.99	5.7 ± 1.86	4999
F F	6.0 ± 2.7	6.0 ± 2.8	316 ± 133	1510 ± 540	5.2 ± 3.03	5330

Table 2. Weight increase of the F₁

Unit: g, g / daily,

Combinations	Computed items	n	Weight at birth	Weight at 21 days	Weight at 42 days	Weight at 3 mth	Weight at 4 mth	Weight at 5 mth	Weight at 6 mth
C	Total	21	58.14 ± 4.17	436.39 ± 36.37	1090.0 ± 140.0	2330.0 ± 380	2800.0 ± 250.0	3230.0 ± 120.0	3570.0 ± 100.0
	Absolute			18.01	31.12	25.83	15.67	14.33	11.33
	Relative			2.91	1.32	1.10	0.27	0.21	0.14
R	Total	18	62.67 ± 6.86	443.8 ± 73.25	1120 ± 120	2150.0 ± 36.0	2870.0 ± 360	3510.0 ± 33.0	4070 ± 430
	Absolute			18.15	32.20	21.46	24.00	21.33	18.67
	Relative			2.82	1.34	0.94	0.42	0.29	0.21
FG	Total	21	56.66 ± 8.11	402.00 ± 44.78	920.0 ± 130	2030.0 ± 320	2570 ± 260	3110.0 ± 270	3450 ± 250
	Absolute			16.45	24.67	23.13	18.00	18.00	11.33
	Relative			2.83	1.19	1.14	0.34	0.28	0.15

Table 3. Weight increase of the F₂

Unit: g, g / daily,

Combinations	Computed items	n	Weight at birth	Weight at 21 days	Weight at 42 days	Weight at 3 mth	Weight at 4 mth	Weight at 5 mth	Weight at 6 mth
CC	Total	25	54.78 ± 2.71	424.14 ± 78.8	1090 ± 1800	2240 ± 230	2690 ± 360	3050 ± 290	3440 ± 380
	Absolute			19.59	31.7	23.96	15	12	13
	Relative			2.96	1.36	1.04	0.26	0.18	0.17
RR	Total	25	62.50 ± 1.0	1040 ± 110	1040 ± 110	2100 ± 510	2900 ± 610	3390 ± 680	3870 ± 650
	Absolute			17.39	30.00	22.08	26.67	16.33	16.0
	Relative			2.82	1.24	1.01	0.47	0.23	0.19
FGG	Total	24	55.03 ± 4.80	920 ± 150	920 ± 150	1950 ± 210	2540 ± 260	3010 ± 220	3320 ± 290
	Absolute			15.79	25.40	21.46	19.67	15.67	10.33
	Relative			2.81	1.25	1.08	0.38	0.25	0.14

III. Analysis on the heredity of the F₁'s and F₂'s fleece

As shown in Table 4, when short-wool rabbits are crossed with long-wool rabbits, their F₁s are of entirely short fleece. There emerges long fleece only in F₂. As in the F₂ of combination CC, the proportion of the long and short is 17:21 and the emergence rate of long fleece is 44.74%. In AC, the proportion of the

long and short is 14:25 and the emergence rate of long fleece is 35.90%. Considering the fleece heritability, short-wool rabbits are better than long-wool ones. As in the F_2 of RR, the proportion of the long and short is 30:20; in AR, the proportion is 29:26, the emergence rate of long fleece is 57.69% and 52.72% resp. SAB is the hybrid, which, in crossbreeding, was introduced the blood of Angora rabbits, so the emergence rate of long fleece is higher than that of short fleece in the two combinations' F_2 .

Table 4. Characters of the hybrids' fleece Unit: Head, %

Combinations	Proportions of long and short fleece	Emergence rate of long fleece
C	0:17	0
FG	23:0	100
CC	17:21	44:74
AC	14:25	35:90
R	0:29	0
RR	30:22	57:69
AR	29:26	52:73
G	32:0	100
F	32:0	100

IV. Test of the wool quality and yield of the hybrid.

1. The change of different types of wool

In various cross combinations, the change of coarse wool, fluff and heterotypical fibers is obvious. In FG, the coarse wool and heterotypical fibers average 15.95%, which is 25.69% higher than France Angora and 1.63 times of German Angora. In CC, the amount of coarse wool and heterotypical fibers is 15.1%, which is 19.63% higher than France Angora and 1.5 times of German Angora. Of the hybrids of three-way rotation cross in AC, the amount of coarse wool and heterotypical fibers is markedly increased to 17.12%, which is 34.91% higher than France Angora and 2.8 times of German Angora. In RR, the amount of coarse wool and heterotypical fibers is 22.96%. In AR, the amount of coarse wool and heterotypical fibers is 16.61%, which is higher than both France and German Angora, and the difference is significant ($P < 0.01$). In hybridization, there emerge a lot of excellent individuals. For instance. In FG, the coarse wool on the back and shoulders of No. 84-314 doe at 8 mth of age is

18.40% and 17.30% resp. and heterotypical fibers is 12.04% and 12.03% resp. The coarse wool coefficient averages 29.8%, which is 3.9 times of German Angora and 1.35 times of France Angora. Furthermore, its fluff is clear and loose and the colour is white and bright, However there still remain some defects in hybridization. For instance. In AR and RR, though the amount of coarse wool is comparatively high, the fluff is still rather twined, especially on the belly and breech. This can only be improved by further hybridization.

2.The fineness of wool fibers

The fineness of hybrids' wool fibers is relavent to their parents. In CC, the fineness of coarse wool is 49.42μ , which is 20μ thinner than that of New Zealand rabbits, but 11.2μ thicker than that of German Angora. In AC, the fineness of coarse wool is 46.43μ , which is 4.03μ thinner than that of France Angora and 14.34μ thinner than New Zealand rabbits. In AR, the fineness of coarse wool is 47.29μ , which is 3.60μ and 13.69μ thinner than that of France Angora and SAB resp., but 10.6μ thicker than that of German Angora. Generally ,the fineness of coarse wool filers of all the hybrids is below 50μ , which is up to the needs of wool textile. As for the fineness of fluff fibers, FG, CC, AC, RR and AR are 13.66μ , 12.00μ , 13.18μ , 13.66μ and 12.83μ resp., which are a little bit thicker than that of France and German Argora. The difference is not significant.

3.Wool yield.

As shown in Table 5, the annually average wool yield of the long-haired hybrids is as follows: FG is 769.60g, CC 815.56g, AC 714.28g, RR 777.76g, AR 778 g; purebred German Angora 820g; purebred France Angora 625.71g. The wool yield of all the hybrids is higer than France Angora but lower than German Angora. It is possible that the wool yield may reach and even surpass that of German Angora rabbits through purified breeding of the hybrids.

4.Analysis of trace elements and amount of amino acids in wool

The trace elements and amino acids in the coarse wool and fluff were detected. As stated in the testing data, the amount of many trace elements in the coarse wool is much higher than that in the fluff, such as Na in coarse wool is 3.39 times of that in fluff, Ca is 2.23 times, K 2.21. times, Mg 3.48 times, Mn 1.45 times, Fe 1.45 times, Cu 1.47 times, Al 1.27 times, etc. The amount of amino acids in the fluff and in the coarse wool is almost the same. All these data

have provided a scientific basis for compounding full maintenance feed so as to step up the increase of the coarse wool amount.

Table 5. Analysis of wool fiber quality and wool yield of the hybridized combinations Unit: cm, %, μ , g

Combinations	Absolute length Amount					Fineness		Strength	Stretch	Yield
	coarse	fine	coarse	fine	hetero- typical	coarse	fine			
C	3.43	2.97	17.00	78.23	5.03	67.24	13.03	/	/	/
FG	9.76	6.22	9.57	83.44	6.38	49.42	13.66	3.23	40.07	769.6
CC	9.35	5.98	10.05	84.82	5.13	49.44	12.40	2.37	42.12	815.56
AC	7.92	5.35	10.81	85.25	6.31	46.43	13.18	4.25	44.94	714.28
R	8.35	5.07	19.92	72.98	7.19	72.65	12.51	/	/	/
RR	11.93	8.36	18.55	77.06	4.41	49.91	13.66	1.59	37.37	777.76
AR	11.28	7.22	11.28	82.85	5.33	47.28	12.83	2.71	41.08	778
Z	3.35	2.45	17.02	77.73	5.23	69.42	15.67	/	/	/
G	8.35	5.07	3.02	93.9	3.04	37.22	10.88	/	/	820
F	9.39	6.46	9.24	87.28	3.45	50.46	11.86	/	/	625.71
SAB	3.57	2.67	16.91	78.19	5.04	60.97	12.51	/	/	/

5. Detection of the combining ability and heritability of some characters in different hybridized combinations

As shown in Table 6, the reproductive performance of the hybridized combinations, including litter livability, birth litter weight, weaning litter weight, weaning survival rate, weight at 6 mth of age and the coefficient of coarse wool at 8 mth of age is of significant superiority. Take weaning survival rate for example. CC is 16.31%, RR 16.20%, FG 11.73%, AC 12.53%, AR 10.39%. The difference is significant ($P < 0.05$).

For the coefficient of coarse wool at 8 mth of age, the interbred hybrids are of the highest superiority: CC is 33.76%, RR 26.14%, AC 22.10%, AR 16.66%, the F1 of C 24.06% and R 28.89%. There is a significant difference between the hybrids and the parental German Angora ($P < 0.01$).

Table 6. Heterosis of the hybridized combinations

Unit: %

Combina- tion	Reproductive performance				Weight at 6 mth	rate of coarse wool at 8 mth
	Survival number born	Litter weight at brith	weight at weaning	survival rate at weaning		
C	4.59	1.52	2.64	5.00	1.33	24.06
R	2.83	2.51	6.26	4.89	/	24.89
FG	/	3.04	5.56	11.73	0.80	7.41
CC	6.56	9.20	12.43	16.31	2.49	33.76
RR	5.07	6.54	3.52	16.20	4.13	26.14
AC	1.20	5.71	7.88	12.53	0.01	22.10
AR	7.54	4.97	4.19	10.39	1.80	16.66

For the combining ability of the coefficient of coarse wool of the linecrossed hybrids, FG is 7.41%. The genetic parameter of the coarse wool coefficient is 0.3155 and that of wool yield is 0.3299. Wool yield is in the positive correlation with the coarse wool coefficient and the correlation coefficient is 0.3017.

Conclusion

1.The reproductive performance of the hybrids of various combinations are improved and their number born, number weaned and milking capacity are higher than German and France Angora. The weaning survival rate of the F2 of the interbred and linecrossed is of heterosis, between 10.39–16.31%.

2.The hybrids of various combinations grow vigorously in 21 days after birth and the growth rate at this time makes up 50% of that in the six mth from birth. The hybrids grow faster in the first 3 mth than in the later 3 mth after birth ($P < 0.01$). Therefore to enhance feeding management of the growing rabbits is very important. The weaning weight at 42 days of age is in the positive correlation with the weight at 6 mth of age ($P < 0.05$). This indicates that it is necessary to enhance the feeding management of the does in milk and increase the weaning weight of the growing rabbits so as to raise good breed of rabbits.

3.Considering the hybrid combining ability of coarse wool at 8 mth of age, the interbred is 2.41 times of the linecrossed. The coarse wool heritability of the

linecrossed is 0.3155 and the wool yield heritability is 0.3299. The coefficient of coarse wool is in the positive correlation with the wool yield, the coefficient is 0.3017. Therefore in hybrid breeding of coarse-wool rabbits, the coefficient of coarse wool may be taken as an index in selecting individuals.