Impact of selection for scrapie resistance on genetic diversity of the Sambucana sheep breed (Piedmont, Italy)


MATERIALS AND METHODS

In Italy, as in other European countries, since 2005 a program of selection for scrapie resistance in sheep, based on the PRNP polymorphism, has been implemented with the aim of increasing ARR 'resistant' allele and eliminating VRQ 'susceptible' allele. In a small breed, the ARR-carriers may be more related to each other than randomly chosen individuals, as a consequence for an equal number of reproducing the effective size may be smaller than expected in a pure genetic drift condition (1). In the Sambucana sheep breed (reared in Piemont region, north-west Italy) the ARR allele frequency was higher than in other breeds, like Balfour for example, before the selection plan started (2). On the other hand, due to the reduced number of animals (3500), this breed is considered at risk of extinction (3). The selection does not affect neutral loci as far as allelic richness and neutral markers located on the same chromosome. The average number of alleles was 8.637 and 9.010 before and after 2005, respectively. INRA5, MAF214 and INRA23 showed a significant decrease of heterozygosity both before and after 2005 (data not shown). Based on the estimate performed with the Micro-Checker software, they could be affected by presence of null alleles, so they were discarded.

RESULTS AND DISCUSSION

Seven individual samples and the SP5313 marker were discarded due to consistent failure of amplifying. Error rate per multilocus genotype and average error rate per allele were 0.55% and 0.41% respectively (6). Genetic variation was evaluated the impact of scrapie resistance selection on genetic variation of the Sambucana.

Table 1
No linkage disequilibrium was assessed for the markers located on the same chromosome. The average number of alleles was 8.637 and 9.010 before and after 2005, respectively. INRA5, MAF214 and INRA23 showed a significant decrease of heterozygosity both before and after 2005 (data not shown). Based on the estimate performed with the Micro-Checker software, they could be affected by presence of null alleles, so they were discarded.

Table 2
The selection does not affect neutral loci as far as allelic richness and gene diversity is concerned whereas observed heterozygosity significantly decreases after 2005. According to (1), some within flock founder effect could explain this evolutive picture even though some rams were used in a rotational mating scheme from 2004 to 2009.

Table 3
PRNP allele frequencies are reported in Table 3 (n.s.=not significant; ***P<0.001; **P<0.01; *P<0.05; \( \Delta \) difference).

Table 4
PRNP allele frequencies are reported in Table 4 (n.s.=not significant; ***P<0.001; **P<0.01; *P<0.05; \( \Delta \) difference).

Table 5
Effects of removal of VRQ-carrier rams on allelic richness, gene diversity and heterozygosity at neutral markers (n=3500) are reported in Table 7 (average values (standard error). n.s. = not significant; ***P<0.001; **P<0.01; *P<0.05; \( \Delta \) difference). Rs based on a minimum sample size of 63 animals.

Table 6
Neutral marker freq. before and after selection.

Table 7
If all the VRQ-carrier rams are removed the allelic richness increases and the gene diversity is almost unchanged. The carriers of undesirable PRNP genotypes would not be essential to maintain the overall diversity in the Sambucana breed.

CONCLUSIONS

In a small breed the ARR carriers may be more related to each other than randomly chosen individuals. A medium-term conservation strategy should provide for the sire rotational mating scheme to be increased.

REFERENCES