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PEDIGREE ANALYSIS IN THE SIKA RABBITS IN SLOVENIA

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ABSTRACT

The aim of the study was to determine the current level of inbreeding of SIKA rabbits in Slovenia. The pedigree of 27.110 rabbits was analysed. There were 13.521 males and 13.589 females. Without known parents were 146 animals. Altogether, there were 1490 dams and 391 sires. For a reference population we used animals born in years 2010 and 2011. The average relationship coefficient is 7.8 %, meaning that in a completely random mating scheme the inbreeding in the next generation would be at this level. Average inbreeding coefficient in the population was 6.5 %. The effective number of ancestors was only 24, which is in contrast with the large number of known ancestors. Effective number of ancestors contributing 50 % of genes to the gene pool of the population was 9. A single animal contributes 7.3 % in males and in females 7.2 % of genes in the population gene pool.

Key words: rabbits / breeds / SIKA / pedigree / inbreeding coefficient / generation interval / relationship coefficient

1 INTRODUCTION

Inbreeding is a result of mating between relatives (Falconer and Mackay, 1996). An increased rate of inbreeding means an increased risk to a breeding programme in terms of the variance of genetic gain, and a reduciton of the additive genetic variance (Meuwissen, 1991).

Slovenian rabbit SIKA C line (sire line) was developed by crossings of New Zealand White and Californian rabbit breeds, as well as Pannon White rabbit at the Rabbit Centre of Department of Animal Science (Kermauner *et al.*, 2008). The breeding goals of SIKA C line are good fattening and slaughter traits.

The population of SIKA C line is practically closed since 1995. Closed populations are exposed to inbreeding accumulation. Increasing is even faster if population is small. Inbreeding reduces the mean of fitness traits, such as survival and reproduction and consequently worsens general vigour and fertility (i.e. inbreeding depression).

Chai (1969) and Moura *et al.* (2000) noted a consistent reduction in litter size at birth and at weaning as a consequence of inbreeding. There were also some reports of a decline in weight at 21 days of age and at weaning.

The objective of this study was to assess genetic structure of SIKA C line rabbits based on pedigree information.

2 MATERIAL AND METHODS

Pedigree data on Slovenian SIKA sire line (C line) was received from the Rabbit Centre of Biotechnical Faculty. The pedigrees of 27.110 rabbits were analysed. Single record of animal consisted of identification, sire, dam, gender, and birth date. Because culling date was not recorded, animals born in years 2010 and 2011 were considered as reference population.

The two groups of parameters are usually used for population description: demographic and genetic parameters. Demographic analysis serves for numerical status and changes in a population, while genetic analysis

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Table 1: *Demographic description of entire and reference population*

Item	Entire population	Reference population
No. of animals	27110	3001
No. of males	13521	1483
No. of females	13589	1518
No. of sires	391	60
No. of dams	1490	167
Ratio dams : sires	3.81	2.78
No of founders	146	0
Proportion of founders (%)	0.53	0.00

shows evolution and dynamics of gene pool of a population. The pedigree completeness, effective number of founders, effective numbers of ancestors, individual inbreeding coefficient and the average relatedness coefficient were analysed (Lacy, 1989; Maignel *et. al.*1996; Boichard *et al*., 1997). Parameters were computed using the PEDIG programme (Boichard., 2002).

3 RESULTS AND DISCUSSION

The pedigrees of 27.110 rabbits, 13.521 males and 13.589 females, were analysed (Table 1), There were 391 sires and 11490 dams in entire population. The ratio between dams and sires was 3.81. Animals with both parents unknown were considered as founders. There were 146 founders, which represented 0.53 % for the entire population. As a reference population, animals born in years 2010 and 2011 were included. Animals (3001) in the reference population had 60 sires and 167 dams with ratio between them 2.78. All animals in the reference population had known parents.

Generation interval was calculated for the entire population, first for all offspring, and then for those offspring who had its own offspring (Table 2). Four combinations are shown: father (sire) – son, father – daughter, mother (dam) – son, and mother – daughter. Generation intervals differed between sires and dams. Dams have offspring from 180 to more than 300 days earlier than sires. Sires had offspring at an average age about 540 days, while the dams were on average 335 days old. Generation interval in males and females did not differ, neither considering all not only offspring with its own offspring.

As expected, number of offspring, considering those only who had its own offspring, is lower (Table 2). At the same time we can see that many males and females are no longer represented after two generations. Number of animals that occur as parents is significantly smaller.

Average inbreeding coefficient of inbreed animals was 6.52 % and maximum was at 33.12 %. There were 15.4 % or 4.163 animals which were inbred more than 10 % (Table 3). The rest of the population had inbreeding coefficient below 10 % and 32.7 % animals had inbreeding coefficient above 0 and less than 5 %. As reported by Nagy *et al.* (2011), the average inbreeding level of the Pannon White rabbit was 6.3 %, which is similar to our results.

Inbreeding coefficient tells us how much an individual animal is inbred, but it does not show how much an animal is related with other animals. However, the relatedness coefficient between potential parents is good predictor for inbreeding coefficients of progeny in the next generation. Relatedness coefficients in the population of SIKA C line are shown in Table 4. Among males and among females, as well as between males and females, the average relationship was 7.8 %. Standard deviations of coefficients ranged between 5.7 and 6.1 %.

Calculation of inbreeding and relatedness coefficients is sensitive to the pedigree completeness level (Boichard *et al.*, 1997). Due to quite complete pedigrees (the equivalent of complete generations for the reference population was 11, Table 5), the estimates of inbreeding and relatedness coefficients were not biased.

For the reference population, the number of founders was 100 for both males and females (Table 5). The entire population had 146 founders (Table 1). All these founders can not be traced back through the pedigree of animals of the reference population. Consequently, their genes were lost during evolution of the SIKA breed. The effective number of founders was 36.3 in males and 36.7 in females of the reference population.

Table 2: *Generation interval by gender of parents and offspring*

	No. parents	No. offspring	GI (days)	No. parents*	No. offspring*	GI (days)*
Father – son	328	12409	524.8	161	277	553.4
Father – daughter	331	12434	528.2	273	1270	545.8
Mother – son	1360	13082	336.0	240	305	318.2
Mother – daughter	1406	13131	334.3	642	1374	348.1

GI – generation interval; * – offspring, who have its own offspring

Table 3: *Inbreeding coefficients of the SIKA rabbits*

Inbreeding coefficient	Number of animals	Percent of animals (%)
0.00–0.05	8869	32.71
0.05–0.10	9105	33.59
0.10–0.15	3409	12.57
0.15–0.20	521	1.92
0.20–0.25	46	0.17
0.25–0.30	154	0.57
0.30–0.35	33	0.12

The effective number of ancestors for SIKA C line population was smaller than the effective number of founders, 24.2 in males and, 24.5 in females. The effective number of founders is expected to be higher than effective number of ancestors (Boichard *et al.*, 1997), because ancestors with many progenies have higher probability of contribution of their genes to gene pool of population. The number of ancestors contributing the most of 50 % genes to gene pool of population was 9 in males as well as in females. The largest contribution to gene pool from a single ancestor was 7.3 % of genes in males and 7.2 % in females.

4 CONCLUSION

The population of SIKA line C rabbits has a fairly complete pedigree. The average inbreeding coefficient in the population was 6.5 %. Because the population is closed for more than 20 years, high inbreeding coefficients are expected. Average relationship coefficient was 7.8 %. It means that under completely random mating scheme the inbreeding in the population in the next generation would be 7.8%. Because of avoiding of mating close relatives, the average inbreeding is actually lower. The effective number of founders and ancestors was only 36 and 24, respectively, which is contrast with much larger number of founders. This only shows that genetic variability of population has decreased, because small number founders and ancestors contributed their genes to the gene pool of today's population. It is necessary to keep existing genetic variability if we want to keep population of SIKA C line for the future.

Table 4: *Relatedness coefficients in the reference population*

	Number of pairs	Mean	Standard deviation
Among males	440391	0.078	0.057
Among females	486591	0.078	0.059
Males × females	926793	0.078	0.061

Table 5: *Probabilities of gene origin for the reference population*

	Males	Females
Equivalent of complete generations	10.99	11.00
Number of founders	100	100
Effective number of founders (f_e)	36.3	36.7
Effective number of ancestors (f_0)	24.2	24.5
N_{50}	9	9
C_{max}(%)	7.3	7.2

N50 – number of ancestors contributing the most for a cumulated expected contribution of 50 % genes to the gene pool of the population; Cmax – expecting contribution of ancestor contributing the most

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