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EFFECTS OF SELECTION AND INBREEDING ON GROWTH AND CARCASS TRAITS OF PANNON TERMINAL LINE RABBITS

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ABSTRACT

Effects of selection and inbreeding on average daily gain (between the age of 5-10 weeks) (ADG) and thigh muscle volume (TMV) (measured *in vivo* with computerized tomography) were estimated in a group of 22098 Pannon terminal line rabbits born between 2006 and 2011 and reared in 3396 litters. The data sets were analyzed with bivariate animal models taking pedigree completeness (complete generation equivalent) into account. By 2011 all rabbits were inbred and their average inbreeding coefficient and complete generation equivalent of the population were 7.69% and 11.89, respectively. Significant inbreeding depression (per 10% inbreeding) was only detected for ADG (0.57 g/d). The estimated annual selection response was substantial both for ADG and TMV (1.49 g/d and 5.84 cm^3, respectively) proving the efficiency of the breeding programme.

Key words: Pannon rabbit, genetic trend, inbree ding depression, average daily gain, thigh muscle volume.

INTRODUTION

For the genetic evaluation of the domesticated animals BLUP procedure is widely used mainly because of its favorable mathematical properties. At the Experimental rabbit farm of the Kaposvár University all rabbit genotypes are selected according to their BLUP breeding values estimated for the traits defined in their breeding programme. However, when the population has a closed structure application of the BLUP selection may cause 3-4 times higher inbreeding rate compared to phenotypic selection (Kristensen and Sorensen, 2005). One of the unfavorable consequences of inbreeding is the reduction of the population mean for traits exhibit directional dominance (inbreeding depression). Inbreeding depression was observed in several domesticated (Miglior *et al*., 1995; Sewalem *et al*., 1999) and experimental (labor) species (Fikse *et al.*, 1997; Fowler and Whitlock, 1999; Holt *et al*., 2005a). Inbreeding depression is mainly apparent in fitness traits (Falconer and Mackay, 1996). In rabbits, Moura *et al*. (2000) observed the reduction of litter size by 0.805 and 0.589 pup per 10% dam and litter inbreeding, respectively. Traits more distantly related to fitness are not all changed by inbreeding. However, random drift can reduce additive genetic variance within the population proportionally to the average level of inbreeding (Falconer and Mackay, 1996). The Pannon terminal line rabbit population at Kaposvár is selected for average daily gain (ADG) and thigh muscle volume (TMV) for several generations but so far the efficiency of selection and effects of inbreeding were not taken into account. Objectives of the present study were 1) to estimate the inbreeding depression for ADG and TMV; 2) to estimate the efficiency of the computerized tomography (CT)-aided selection of the Pannon White rabbits for ADG and TMV taking the effects of inbreeding into account.

MATERIALS AND METHODS

Population management and traits recorded were the same as described by Gyovai *et al.* (2012). Descriptive statistics are presented in Table 1.

Mating system

At the initiation of the base population (in 2004), rabbits were sorted into four groups. After the mating, all progeny receive the group number of the bucks. The male progenies remain in the group but the female progenies are moved and mated with the bucks of the adjacent group (where the group number is one less). Thus descendents of any buck will be placed back to its group after four generations

Pedigree analyses

Inbreeding coefficients and complete generation equivalents of the rabbits were determined with ENDOG 4.8 software (Gutiérrez *et al.*, 2010).

Statistical models

The effects of selection (selection response) and inbreeding on ADG and TMV were analyzed with bivariate animal model using PEST (Groeneveld, 1990) and VCE (Groeneveld, *et al.*, 2008) softwares. The model was the same as described by Gyovai *et al.* (2012).

The BLUE estimate for the inbreeding coefficient was used to describe inbreeding depression (per 10% increase of the coefficient). Significance of inbreeding depression was evaluated using the Hypothesis section of PEST. Average of breeding values of animals born in the same year calculated for ADG and TMV (measured between 2006 and 2011). These values were then linearly regressed on the consecutive year-seasons (using SAS 9.1 software package) to calculate genetic trends. Genetic trend estimation was restricted for animals having records for the evaluated traits.

Table 1: Descriptive statistics for the analysed traits

Trait	Birth year	Mean	S.D.	Minimum - Maximum
ADG (n=22098)		48.58	7.41	20.29-81.14
TMV (n=3724)		373.4	42.15	233.4-569.5
F / CGE	2006	4.68 / 7.01	3.91 / 0.89	0-27.78 / 3.08-10.08
F / CGE	2007	5.25 / 7.57	3.69 / 1.12	0-29.82 / 2.66-11.42
F / CGE	2008	5.94 / 8.73	2.94 / 0.73	0.86-31.22 / 5.91-10.53
F / CGE	2009	6.88 / 9.81	2.97 / 0.56	2.49-33.05 / 7.58-11.36
F / CGE	2010	6.79 / 10.47	3.42 / 1.36	0-33.05 / 5.19-12.30
F / CGE	2011	7.69 / 11.89	2.61 / 0.67	3.62-29.63 / 9.97-13.70

ADG: Average daily gain (g/d); TMV: Thigh muscle volume (cm^3); F: Inbreeding coefficient (%); CGE: Complete generation equivalent

RESULTS AND DISCUSSION

Inbreeding coefficients (F) for all animals in the pedigree ranged between 0% and 33.05%. By 2011 all rabbits were inbred. Average F continuously increased with years (Table 1), but the inbreeding level of the population is still relatively low compared to other rabbit populations (e.g. Kerdiles and Rochambeau, 2002). Gulisija *et al.* (2006) noted that the inbreeding coefficient has a limited interpretation as an absolute measure of autozygosity, since its value depend on the depth of a pedigree. Lutaaya *et al.* (1999) found that missing pedigree information can cause severely underestimated inbreeding trend. Groen *et al.* (1995) suggested estimating inbreeding coefficient only for animals with more than 7 ancestral generations and to compare animals with equal number of

ancestral generations in their pedigrees. Average complete generation equivalent continuously increased in the subsequent years and reached the value of 7 in 2006 (Table 1) consequently the risk of underestimating the inbreeding coefficients was low. The complete generation equivalent reported by this study exceeded that of several other studies (Baumung and Sölkner, 2002; Goyache *et al*., 2003; Koenig and Simianer, 2006; Sorensen et al., 2005; Janssens et al., 2005) analysing the pedigrees of other species with longer generation interval (for exceptions see Zechner *et al*., 2002).
Estimated total inbreeding depression (per 10% inbreeding) was 0.57g for ADG (p=0.02) and it had no effect for TMV. Chai *et al.* (1969) and Ferraz *et al.* (1992) reported substantial inbreeding depression in rabbits for body weight measured at ten weeks of age. It has to be noted that Chai *et al.* (1969) practiced full-sib matings (fast inbreeding) for 20 generations thus the average inbreeding coefficient of their rabbit population was above 0.8. Fast inbreeding is more harmful than slow inbreeding as natural selection has more time to act and slow inbreeding should result in less inbreeding depression (Holt *et al*., 2005b). On the contrary Ferraz *et al*. (1992) studied a rabbit population where the level of average inbreeding was about the same as in our case. Using the Lipizzan data of Zechner *et al*. (2002) no inbreeding depression was observed for morphological traits (Curik *et al*., 2003), similarly Holt *et al*. (2004) reported that inbreeding did not affect body weight of inbred strain of mice.

Selection responses for ADG and TMV are presented in Table 2. Between 1992 and 1997 Garreau *et al*. (2000) found substantially smaller annual selection response (0.6 g/d) for ADG in the Pannon White rabbit population. Other authors (Estany *et al*., 1992; Moura *et al*., 1997; Piles and Blasco, 2003) also found lower selection (0.45-1.23 g/d) responses for ADG than reported here. The reason of the difference can be that the body weight of the Pannon terminal line was larger than that of the other reported breeds.

Table 2: Annual selection responses for average daily gain and for thigh muscle volume.

Trait	b	p
ADG	1.49	0.0001
TMV	5.84	0.0001

ADG: Average daily gain (g/d); TMV: Thigh muscle volume (cm^3);

CONCLUSIONS

Despite its closed structure the inbreeding level for the Pannon terminal line rabbit population was relatively low. Nevertheless, application of methods to control the inbreeding level of the population can be advocated. Genetic trends of the investigated traits were substantial.

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