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Kaposvári Egyetem, Állattudományi Kar, Kaposvár
University of Kaposvár, Faculty of Animal Science, Kaposvár

Genetic parameters of production traits in Pannon White rabbit

I. Nagy, Sz. Metzger, Z. Princz, I. Radnai, E. Bíróné Németh, Zs. Szendrő

University of Kaposvár, Faculty of Animal Science, Kaposvár, H-7400 Guba S. u. 40.

ABSTRACT

Genetic parameters for body weight at 5 (BW5) and 10 (BW10) weeks of age and average daily gain (ADG) from 5 to 10 weeks of age were estimated using univariate and bivariate animal models in Pannon White rabbits from 2001–2005. Of the influencing factors, age (BW5, BW10), sex (BW5, BW10, ADG) and year season (BW5, BW10, ADG) affected the examined traits. Heritabilities of BW5, BW10 and ADG were 0.21 (0.01), 0.26 (0.01) and 0.27 (0.01), respectively. Common litter effect of BW5, BW10 and ADG were 0.47 (0.01), 0.29 (0.01) and 0.20 (0.01), respectively. Genetic correlation between the body weight measured at different ages was 0.54 (0.05). Genetic correlation between ADG and BW5 and ADG and BW10 were -0.19 (0.06) and 0.76 (0.03), respectively.
(Keywords: genetic parameters, production traits, rabbits)

INTRODUCTION

Pannon White rabbit breed was developed at the University of Kaposvár. The selection programme consisted of several steps. Initially the dressing out percentage of the original New Zealand White population of the University was improved through progeny tests. Then Californian rabbits were used to cross the local New Zealand population to create a new synthetic line. Using the best crossing combinations the basis of the new line was created. The performance of this line did not exceed substantially the level of previous performance but the increased variance could be utilized in further selection. The synthetic line has been selected as a closed population since 1992. This line is recognised as the Pannon White rabbit breed. The population consists of cca 250 does and 60 bucks. The selection objective of the breed is to improve the average daily gain (between the 5–10th weeks of age) and dressing out percentage (which is indirectly estimated by means of Computerized Tomography). Detailed description of the breed's establishment and its selection programme is given by *Szendrő et al.* (1997). Evaluation of CT-based selection was published by *Szendrő et al*. (2004) and *Nagy et al.* (2006). The objective of the present study is to estimate genetic parameters of production traits of the Pannon White breed.

MATERIALS AND METHODS

The present analysis was based on data from 40 487 Pannon White rabbits born between 2001–2005. The evaluated animals were reared in 6 739 litters and the total number in the pedigree file was 42 578. The number of base animals was 269. Growing rabbits were housed in a closed rabbitry, in fattening cages (25×40×30 mm; 30×50×30 mm) (2–3 rabbits per cage, i.e. 20 rabbits per m^2). After weaning (35-d) they were fed a commercial pellet (16.3% crude protein, 15.2% crude fibre, and 10.6 MJ DE/kg). In winter the rabbit house was heated to a minimum temperature of 15–16 °C, while – in the absence of air conditioning – in the summer the temperature occasionally reached levels as high as 28 °C. Although in this study only the production traits were analysed the most important recorded traits are provided in *Table 1*. The number of measurements, means and standard deviations of the traits evaluated in this study can be seen in *Table 2*.

Table 1

Measured traits of the Pannon White rabbit breed

Reproduction traits	Production traits	Slaughter traits
- gestation length (day) - number of kits born total - number of kits born alive	- body weight measured at 5 weeks of age (kg) - body weight measured at 10 weeks of age (kg) - average daily gain measured between 5–10 weeks of age (g)	- slaughter weight (kg) - dressing out percentage (%) - cross sectional area of *m. longissimus dorsi* (cm^2) - weight of *m. longissimus dorsi* (g) - thigh muscle weight (g) - predicted (CT) thigh muscle weight (g) - perirenal fat weight (g)

Table 2

Number of measurements, mean and standard deviation of the evaluated traits

Traits	Number of records	Mean	Standard deviation
Body weight measured at 5 weeks of age (kg)	40487	0.89	0.18
Body weight measured at 10 weeks of age (kg)	40487	2.33	0.29
Average daily gain measured between 5–10 weeks of age	40487	41.19	6.93

The statistical analysis consisted of two consecutive steps. The first step was testing for the significance of fixed effects conducting least squares analyses using the GLM procedure of SAS (*SAS* Inc., 2005) leaving only significant factors in the model (*Table 3*.)

Table 3

Significance of the influencing factors of the examined traits

Factor	Type	BW5	BW10	ADG
Age (day)	C	*	*	-
Sex	F	*	*	*
Year-season	F	*	*	*

^{BW5}body weight measured at 5 weeks of age (kg); ^{BW10}body weight measured at 10 weeks of age (kg); ^{ADG}average daily gain measured between 5–10 weeks of age; ^{C}covariate; ^{F}fixed effect; $^{*}p<0.05$.

The second step was the estimation of the heritabilities of the individual traits and their genetic correlations. The method used to obtain the variance components was the animal model using the program PEST 3.1 (*Groeneveld*, 1990) (for data coding) and VCE 5 (*Kovac* and *Groeneveld*, 2003).

In case of BW5, BW10 and ADG the linear model was:

$$y = Xb + Za + Wc + e$$

where (according to *Mrode*, 2005): y= vector of observations, b= vector of fixed effects, f= vector of random effects, c= vector of common environmental effects (of the dam), X, Z, W incidence matrices relating records to fixed and random animal and random common environmental effects, respectively. Expected values of a, c, and e were E(a)= E(c) = E(e) = 0. The variance-covariance structure was assumed to be $V(a)= A\sigma^2_a$, $V(c) = I\sigma^2_c$, $V(e) = I\sigma^2_e$, and cov(a,e) = cov(e,a) =0, where A is the numerator relationship matrix. Also $cov(y,a) = ZAI\sigma^2_a$.

Regarding the model distribution of y was assumed normal, the traits were determined by many additive genes of infinitesimal effects at infinitely many unlinked loci. Due to the size of the data and the relatively low computing capacity heritabilities of the traits and genetic correlations between the traits were estimated using univariate and bivariate models, respectively.

RESULTS AND DISCUSSION

Heritability estimates of the analysed traits and the relative importance of the common environmental effects can be seen in *Table 4*.

Table 4

Relative importance of the additive genetic (h^2) and common environmental (c^2) effects (standard errors of estimates are given in brackets)

Traits	h^2 (SE)	c^2
Body weight measured at 5 weeks of age (kg)	0.21 (0.01)	0.47 (0.01)
Body weight measured at 10 weeks of age (kg)	0.26 (0.01)	0.29 (0.01)
Average daily gain measured between 5–10 weeks of age	0.27 (0.01)	0.20 (0.01)

Heritability of body weight measured at 5 week old rabbits was low. The heritability of body weight increased with the increasing age. Opposite tendency was received for common environmental effects that were decreased with the increasing age. Similar estimates were found by other authors (*Estany et al*., 1992; *Ferraz et al*., 1992; *Lukefahr et al*., 1996) justifying that the importance of maternal effects (i.e. mainly the milk production of the does) gradually diminish after weaning. *Szendrő et al.* (1988) also observed the decreasing heritability of body weight measured at ages of 6 and 10 weeks, however based on paternal half sibs they found much higher heritabilities (0.88±0.10; 0.66±0.10) than others. Heritability and common litter effects of average daily gain between 5 and 10 weeks of age were similar to that of the body weight measured at 10 weeks of age. Several authors received similar estimates for average daily gain (*Estany et al*., 1992; *Garreau et al*., 2000; *Krogmeier et al*., 1994) although *Moura et al.* (1997) reported higher heritability (0.48) and lower litter effects (0.11) than found in this study. The estimated genetic correlation coefficients among the examined traits are presented in *Table 5.*

Table 5

Genetic correlation estimates between the examined traits (standard errors of estimates are given in brackets)

Traits	r_g (SE)
BW5-BW10	0.54 (0.05)
BW5-ADG	-0.19 (0.06)
BW10-ADG	0.76 (0.03)

^{BW5}body weight measured at 5 weeks of age (kg); ^{BW10}body weight measured at 10 weeks of age (kg); ^{ADG}average daily gain measured between 5-10 weeks of age.

The estimated genetic correlation between the body weights measured at 5 and 10 weeks of age was only moderately high. Similar results were found by (*Lukefahr et al.*, 1996). Average daily gain showed high genetic correlation with the body weight of the latter age but the correlation was negligible with the body weight measured at the younger age. Similar conclusions can be drawn as in the preceding section. The body weight of the 5 week old rabbits was primarily determined by maternal effects and only secondarily by additive genetic effects. As the maternal influence gradually decrease after weaning the body weight of the 10 week old rabbits was mainly determined by additive genetic effects. Therefore the average daily gain between these ages was mainly independent of the 5 week old weight as it was primarily the performance of the doe rather than the growing rabbit. The latter body weight was however mainly determined by the rabbits' additive genetic effects and consequently it showed high genetic correlation with average daily gain. Previous genetic correlation estimate for this population was very similar (0.74) to the value received in this study (*Garreau et al.*, 2000).

CONCLUSIONS

Average daily gain between the ages of 5 and 10 weeks can be used as a selection objective. From the evaluated traits it had the highest heritability and lowest common environmental effect. Because of the high genetic correlation with the body weight measured at 10 weeks of age it can be expected that selection on average daily gain may reduce the maturity of the rabbits at slaughter if the slaughter weight is fixed. The maternal effects though decreasing with the increasing age they are still present at the age of 10 weeks. Therefore application of BLUP method in the selection can be recommended as it offers a better litter effect adjustment than other conventional methods.

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Corresponding author:

Nagy István
University of Kaposvár, Faculty of Animal Science
H-7400 Kaposvár, Guba S. u. 40.
Tel.: 36-82-314-155
e-mail: nagy@mail.atk.u-kaposvar.hu