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GENETIC PARAMETERS FOR AVERAGE DAILY GAIN AND THIGH MUSCLE VOLUME MEASURED BY COMPUTER TOMOGRAPHY IN PANNON TERMINAL LINE RABBITS

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ABSTRACT

In rabbit breeding, Computer Tomography aided selection is exclusively applied worldwide at Kaposvár (Hungary) for the Pannon White rabbit and for the Pannon terminal line rabbit population improving their slaughter performance. The terminal line is created with purpose of increasing the average daily gain (g/d) and thigh muscle volume (cm^3) of the progenies. Since 2006 selection has been for average daily gain and thigh muscle volume (applying computer tomography, CT) in a closed population. Objective of the present study was therefore to estimate the efficiency of the CT-aided selection of the Pannon terminal line rabbits for average daily gain and thigh muscle volume. Present analysis was based on data from 22098 Pannon terminal rabbits born between 2006 to 2011 at the rabbit farm of Kaposvár University. The evaluated animals were reared in 3396 litters and the total number of the pedigree file was 27869. The number of the base animals was 151. The data on daily gain between the age of 5-10 weeks and CT-based thigh muscle volume were analyzed using REML and BLUP procedures in order to estimate genetic parameters and breeding values. Estimated heritabilities were moderate for average daily gain (0.23±0.02) and for thigh muscle volume (0.25±0.03). Litter effects were low for both traits (0.16±0.00; 0.09±0.01, respectively). Genetic correlation coefficient estimate between average daily gain and thigh muscle volume was low (0.01±0.08).

Keywords: Pannon White rabbits, genetic parameters, computer tomography, average daily gain, thigh muscle volume.

INTRODUCTION

An efficient breeding programme of any population requires the constant monitoring the performance for selection criteria traits. The breeding objectives in domesticated animals generally target the improvement of reproduction performance in maternal lines, growth and/or slaughter value in paternal lines. The development of the Pannon white rabbit population was initiated at Kaposvár University in the late 1980s. The base of the synthetic Pannon White rabbit breed were New Zealand White and Californian rabbits. Detailed description of population foundation is given by Nagy *et al.* (2006). Using conventional methods, performance of breeding candidates for slaughter traits can only be evaluated by sib or progeny test. Because progeny test lengthens the generation interval, generally it is not applied in rabbit breeding (for exception see Varewyck *et al.*, 1986). With the aid of Computer Tomography (CT) procedure the body composition of an animal can be predicted in vivo. In rabbit breeding CT-aided selection is exclusively applied at Kaposvár University, Hungary and so far cca 10000 rabbits have been scanned in vivo. Application possibilities of CT system in rabbit research are summarised by Romvári (2005). CT-aided selection is practised continuously at the Kaposvár University since 2001 to improve the slaughter value of Pannon White rabbits. Estimated genetic

parameters for the average cross-sectional area of the muscle Longissimus dorsi and dressing out percentage were reported by Nagy *et al.* (2006). From 2004 selection criteria changed to thigh muscle volume (TMV) (summing the surface of 11-12 CT scans) and data evaluation with BLUP methodology was also introduced. The Pannon White rabbit population at Kaposvár is selected for average daily gain (ADG) for cca 15 generations.

In large scale rabbit farm, the competitiveness of any purebred rabbit breed is lower compared to hybrids therefore some years ago maternal and terminal/sire lines were formed by the Kaposvár University. Besides the Pannon White breed the other used genotypes forming the maternal and terminal lines had high reproductive performance and weight gain, respectively. The development of the maternal line started in 1999. Since 2005 the selection has been for teat number and number of kids born alive in a closed population. The development of the maternal line aimed to utilize maternal heterosis. Formation of the sire line started with the repeated (2004, 2005 and 2006) semen imports of genotypes showing high average daily gain. The semen from five Hungarian and foreign genotypes (larger sized) was used in inseminating Pannon White does showing high weight gain. From the born progeny of these inseminations 99, 67 and 5 female; 33, 28 and 5 male breeding animals were selected forming the base of the terminal line. The terminal line is created with the purpose of increasing the average daily gain and thigh muscle volume of the progenies. Since 2006 the genotype selection has been for average daily gain and thigh muscle volume (applying computer tomography)in a closed population.

Although the efficiency of the breeding in Pannon White rabbit programme was evaluated several times (e.g. Garreau *et al*., 2000; Szendrő *et al*., 2004; Gyovai *et al.,* 2008; Szendrő *et al.,* 2010), so far the genetic parameters have not been examined in the Pannon terminal line.
The objective of the present study was therefore to estimate the efficiency of the CT-aided selection for ADG and TMV in the Pannon terminal line rabbits.

MATERIALS AND METHODS

The present analysis was based on data from 22098 Pannon terminal rabbits born between 2006 and 2011 at the rabbit farm of Kaposvár University, Hungary. The evaluated animals were reared in 3396 litters and the total number of the pedigree file was 27869. The number of the based animals was 151. Descriptive statistics are presented in Table 1.

Table 1: Descriptive statistics for the traits.

Trait	No. of records	Mean	S.D.	Minimum	Maximum
Average daily gain (g/d)	22098	48.58	7.42	20.29	81.14
Thigh muscle volume (cm^3)	3724	373.4	42.15	233.4	569.5

Growing rabbits after weaning at 35 days of age were kept in a closed rabbit house, in fattening cages (2-3 rabbits per cage). In the winter the rabbit house was heated to 12-18 °C, during summer the temperature occasionally reached levels as high as 28 °C. Growing rabbits were fed a commercial pelleted diet *ad libitum* and water was available *ad libitum* from nipple drinker.
The selection of growing rabbits was performed in two-step procedure. The first was the daily weight gain between 5 and 10 weeks of age, and the next one was the thigh muscle volume obtained from the CT scanning.
The animals were weighed at 5 and 10 weeks of age, to calculate the daily weight gain. Rabbits showing the highest weight gain (30-40%) were subjected to CT examination at 10.5 weeks of age.
Rabbits, three at a time, were fixed in stretch position, lying flat on a specially designed "container" during examination, without aesthesia and after eight hours of feed deprivation. The CT scanning was performed by means of a Siemens Somatom Plus 40 and Siemens Somatom Emotion 6 spiral scanner of the Institute of Diagnostic Imaging and Radiation Oncology, Kaposvár University. The CT scans

(pictures) were adjusted to take 10 mm thick imaginary slices, from the thigh muscle with total overlapping (slice: 10 mm, feed: 10 mm) providing direct volumetric information.
The daily gain between the age of 5-10 weeks and CT-based thigh muscle volume were analyzed with the REML and BLUP procedures in order to estimate genetic parameters and breeding values. The softwares of PEST (Groeneveld *et al*., 1990) and VCE 5 (Kovac and Groeneveld 2003) were applied. The applied linear model was:

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

The various factors included in the model are shown in Table 2.

Table 2: The considered factors for the examined traits

Factor	Level	Type of factor	Traits	
			ADG (g/d)	TMV (cm^3)
CT scan year-month	55	F	x	–
Animal	27869	A	x	x
Litter	3396	R	x	x
Year-month	45	F	–	x
Sex	2	F	x	x
Body weight at CT-scan	1	C	–	x
Pixel	3	F	–	x
Inbreeding coefficient	1	C	x	x
Complete generation equivalent	1	C	x	x

F: fixed effects; A: additive genetic effects; R: random effect; C: covariant;

RESULTS AND DISCUSSION

The heritability estimates and random litter effects are shown in Tables 3 and 4.

Table 3: Estimate of heritability (diagonals) and genetic correlation (off-diagonals). Standard errors of estimates are given in brackets.

Trait	Average daily gain (g/d)	Thigh muscle volume (cm^3)
Average daily gain (g/d)	0.23 (0.02)	0.02 (0.08)
Thigh muscle volume (cm^3)		0.25 (0.03)

Table 4: Estimate of random litter effects (diagonals) and correlation (off-diagonals). Standard errors of estimates are given in brackets.

Trait	Average daily gain (g/d)	Thigh muscle volume (cm^3)
Average daily gain (g/d)	0.16 (0.00)	-0.24 (0.07)
Thigh muscle volume (cm^3)		0.09 (0.01)

Heritability estimates for ADG and for TMV were moderate. Present heritability estimate for ADG was very similar with the value (0.24) reported by Nagy *et al*. (2006) but slightly lower than estimate of 0.27 reported by Gyovai *et al*. (2008) in Pannon White breed. Moura *et al*. (1997), Gómez *et al*. (1998) and Larzul *et al*. (2005) reported higher values of 0.48, 0.29, 0.34 respectively in different kind

of rabbit population. Differences in heritability estimates for ADG can probably be explained on the basis that ADG was measured at the different age intervals in the various studies and to the different populations of rabbits.

The estimated heritability for TMV was higher values (0.26) than those estimates of 0.21 several times in Pannon White rabbits by Gyovai *et al*. (2008, 2010 and 2012). Hermesch *et al*. (2000) estimated similar value (0.22) in total weight of the left back leg in Large White and Landrace breeds.
Random litter effect is an environmental effect primarily manifested through the milk production of the doe. Generally the importance of the random litter effect is decreasing with the increasing age of the growing rabbits. The magnitude of this effect was low for both traits.

The genetic correlation between ADG and TMV was very low (0.02) which might be explained by the decreased range of ADG of the CT scanned animals.

CONCLUSIONS

The results show that the selection based on Computer-Tomography-scan can effectively improves thigh muscle volume in Pannon terminal rabbit population.

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