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Nagy I., Szendrő K., Garreau H.

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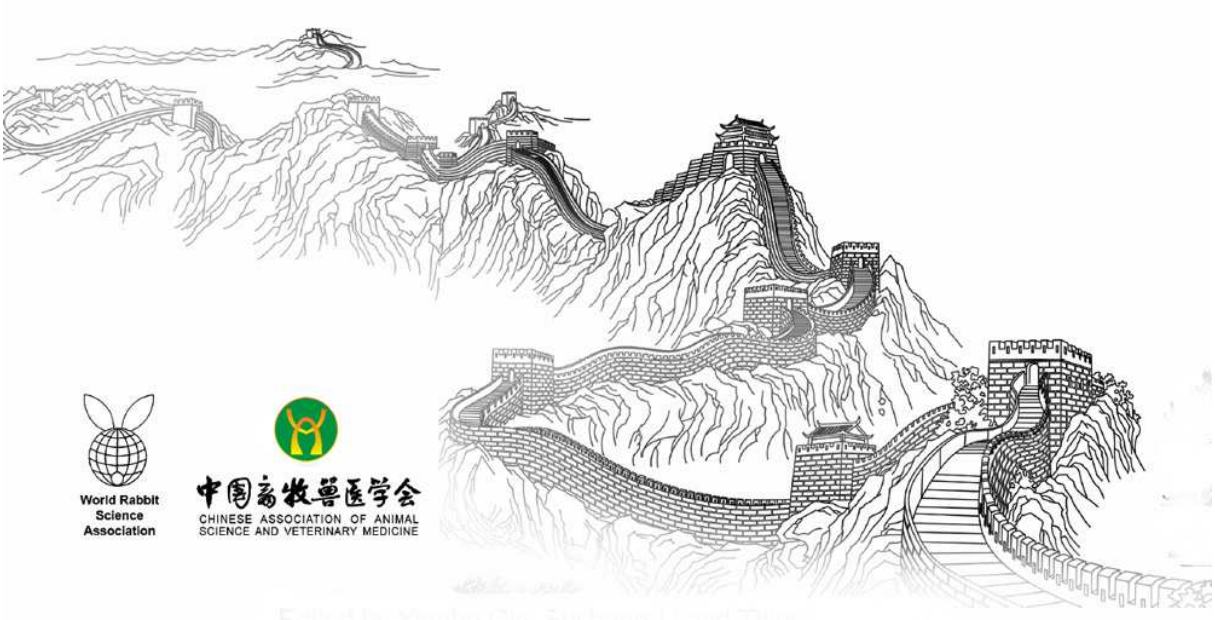

DEVELOPING SELECTION INDICES FOR PANNON LARGE RABBITS SELECTED FOR AVERAGE DAILY GAIN AND THIGH MUSCLE VOLUME

Nagy I.[1*], Szendrő, K.[2], Garreau, H.[3]

[1]Kaposvár University, Faculty of Agricultural and Environmental Sciences, H-7400, Kaposvár, Guba Sándor Str. 40,
[2]Kaposvár University, Faculty of Economic Science, H-7400, Kaposvár, Guba Sándor Str. 40, Hungary
[3] INRA Station d'Amelioration Genetique des Animaux, 24 Chemin de Bordé Rouge, Castanet Tolosan, France
*Corresponding author: nagy.istvan@ke.hu (I. Nagy)

ABSTRACT

After the preliminary step of database handling (filtering for outliers and false data entries), the multigeneration records (2005-2014) on average daily gain (ADG, n = 31366), thigh muscle volume (TMV, n = 4967) (measured by Computer Tomography) and litter weight at day 21 (LW21, n = 34722) of the Pannon sire line rabbits were analyzed using two (ADG and TMV) and three (ADG, TMV and LW21) trait animal models. The applied softwares were VCE and ASREM, respectively. Both programs were used to estimate genetic parameters for these traits because they apply different algorithms. Then using these parameters selection indices (BLUP index) were developed using the software SELACTION. Based on the obtained weighing factors the selection responses were calculated for all traits based on the structure of the Pannon sire line rabbit population. It could be concluded that the applied softwares estimated slightly different genetic parameters for the same traits. Heritability estimates for ADG, TMV and LW21 ranged between 0.15-0.17, 0.23-0.25 and 0.15-0.16, respectively depending on the type of the model and the applied software. Similarly the random litter effects for ADG, TMV and LW21 ranged between 0.15-0.17, 0.23-0.25 and 0.15-0.16, respectively. Interestingly LW21 showed positive genetic correlation both with ADG (0.47-0.50) and with TMV (0.10-0.21). On the contrary an unfavourable negative genetic correlation was found between ADG and TMV (-0.20- -0.31). When only ADG and TMV were used in the models the weighing factors were set to get 23% and 67% contribution of AGD and TMV, respectively. In this case using VCE the obtained responses estimated by the sofware SELECTION were 0.176 (g/day) and 5.184 (cm3) for ADG and TMV, respectively. The estimates were slightly different 0.506 (g/day) and 4.677 (cm3) if the genetic parameters were estimated with ASREML. When all three traits were included in the index (contributions of ADG, TMV and LW21 were 22%, 50% and 28%, respectively) using the VCE's genetic parameters the estimated responses were 1.36 (g/day), 2.508 (cm3) and -0.004 (kg) for ADG, TMV and LW21, respectively. However using ASREML's genetic parameters all estimated responses were positive 0.75 (g/day), 4.279 (cm^3) and 0.064 (kg).

Keywords: Breeding programme, Rabbit, Selection indices, Computer tomography

INTRODUCTION

The CT-aided selection of the Kaposvár University applied in the course of the Pannon rabbit breeding programme is unique World wide. The efficiency of this breeding programme was demonstrated several times (Szendrő et al., 2010; Szendrő et al., 2012 and Nagy et al., 2013). However, for the Pannon White rabbits Gyovai et al (2012) estimated an unfavourable genetic correlation between the thigh muscle volume (TMV) (selection criterion) and litter weight at day 21 (LW21). This result suggests that on the long term CT-aided selection may decrease reproductive performance of this breed. Until 2012 the selection procedure was accomplished in two consecutive steps. In the first step the 10 week old rabbits were pre-selected for their average daily gain (ADG) between the ages of 5 and 10 weeks. Only rabbits showing higher ADG than their kindling batch were taken to CT scan where TMV is determined by CT analysis then the second selection step was performed based in the BLUP breeding values of the rabbits (Nagy et al., 2006). However, after Gyovai et al. (2012) noted their concern about a possible side effect of the selection procedure, the breeding program of the Pannon White rabbit breed was changed, ADG was replaced by LW21 as the selection criterion trait of the first step and TVM remained the selected trait of the second step.

CT aided selection is also applied for the Pannon Terminal line where so far no deterioration was found for the maternal performance. However, as the selection procedure has the same structure as described for the Pannon White rabbits (ADG and TMV) (Nagy et al., 2006), it was decided to examine if the breeding programme of the Pannon Large breed can be extended by LW21 without dropping ADG from the selection criteria traits. Thus the objective of this study was to develop a BLUP index combining the selection criteria traits, making also possible to consider all traits in the first step of the selection procedure.

MATERIALS AND METHODS

Growth and reproductive performance records of the Pannon Large rabbit breed (sire line) were collected between 2005 and 2014 at the experimental rabbit farm of the Kaposvár University. The analyzed traits were ADG (g), TMV (cm^3), and LW21 (kg). Live body weight of rabbits at CT scans (BW, kg) and the number of reared kits in the litter (LS21) and the age of the kits at the weighing of the litter (AGE21, day) were also registered. Descriptive statistics of these traits are provided in table 1.

Table 1: Descriptive statistics of the analyzed traits

Trait	N. records	Minimum	Maximum	Mean	Standard deviation
ADG	31366	151	70	48,8	7.68
TMV	4967	230	569	374	41.9
LW21	3356	0,24	4.41	2,74	0.64
BW	4967	2,15	3.54	2,97	0.23
LS21	3356	1	11	7.37	1.38
AGE21	3356	12	23	20.8	0.72

ADG, average daily gain between the ages of 5 and 10 weeks; TMV, thigh muscle volume; LW21, litter weight at day 21; BW, live body weight of rabbits at CT scans; LS21, number of reared kits in the litter; AGE21, age of the kits at the weighing of the litter

Altogether the pedigree of the analyzed rabbits contained 31567 individuals. The registered traits were evaluated either with two-trait (ADG, TMV), or with three-trait (ADG, TMV, LW21) animal models based on the REML method using ASREML (Gilmour et al., 2009) software. The general structure of these models was:

$$\mathbf{y = Xb + Zp + Wa + e}$$

where y=vector of phenotypic observations, b=vector of fixed effects, p= vector of individual permanent environmental effects, a=vector of additive genetic effects, e= vector of residuals, X, Z, W incidence matrices linking phenotypic records to parameters. The characteristics of the considered environmental factors are given in table 2. Animal effects were included for all traits, random litter effects and permanent environmental effects were considered for ADG, TMV and for LW21, respectively. Based on the population structure and on the estimated genetic parameters, selection indices for ADG, LW21 and TMV and expected genetic trends were calculated using the Selection software (Rutten and Bijma, 2001).

Table 2: Structure of the used models

Factor	Type	Levels
animal effect	random	31567
sex	fixed	2
random litter effect	random	4894
body weight (at CT-scan)	covariate	1
year-month (of CT-scan)	fixed	62
ct pixel	fixed	5
reared litter size	covariate	1
age at litter weighing	covariate	1
year-month (of litter weighing)	fixed	70
permanent environmental effect	random	3166

RESULTS AND DISCUSSION

The estimated heritabilities and relative importance of random litter and permanent environmental effects are provided in table 3.

Table 3: Genetic parameters of the analyzed traits

Genetic parameter	ADG	TMV	LW21
h^2_ASREML_2_ trait	0.16±0,01	0.23±0.03	-
h^2_ASREML_3_ trait	0.17±0.02	0.24±0.03	0.16±0.04
c^2_ASREML_2_ trait g	0.16±0.01	0.09±0.01	-
c^2_ASREML_3_ trait	0.17±0.01	0.09±0.02	-
pe_ASREML_2_ trait	-	-	-
pe_ASREML_3_ trait	-	-	0.17±0.03

Among the analyzed traits, the highest heritability and the lowest relative importance of random litter effects was observed for TMV. For ADG and LW21 the permanent environmental and random litter effects exceeded that of the heritability estimates. These findings were not concordant with the results of Nagy et al. (2013) where for the same rabbit breed ADG showed moderate heritability (0.23) and somewhat lower random litter effect (0.16). Similar heritability estimates (0.20) were reported for different Spanish rabbit lines by Mínguez et al. (2015). The genetic correlation coefficients can be seen in table 4.

Table 4: Estimated genetic correlation coefficients among the analyzed traits

Software_trait	ADG-TMV	ADG-LW21	TMV-LW21
ASREML_2_trait	-0.22±0.07	-	-
ASREML_3_trait	-0.20±0.08	0.50±0,10	0.22±0.12

ADG, average daily gain between the ages of 5 and 10 weeks; TMV, thigh muscle volume; LW21, litter weight at day 21

Based on table 4 the estimated genetic correlation coefficients between ADG and TMV are not favourable confirming the similar results of Nagy et al. (2013). However, contrary to the results of Gyovai et al. (2012) no negative correlation was found between LW21 and TMV. The contributions of the various traits to the selection indices were 33.3% (ADG) and 66.7% (TMV) and 22% (ADG), 50% (TMV) and 28% (LW21) for the 2 and 3 trait models, respectively. Based on the economic weights the indices and the expected selection responses are indicated in tables 5 and 6.. The expected selected responses were positive for all traits except for LW21 using the 3 trait model and VCE software where LW21 practically remained the same. The obtained values are favourable because contrary to the unfavourable genetic correlation between ADG and TMV no trait showed negative expected selection response. The expected selection response based on the two trait model was very similar to the estimated genetic trend of the Pannon Large breed for TMV (Nagy et al., 2013), but it was substantially lower the estimated annual genetic trend for ADG (1.49 g) (Nagy et al., 2013).

Table 5: Calculated selection indices for the examined traits

Software_trait	ADG	TMV	LS21
ASREML_2_trait	0.8	0.42	-
ASREML_3_trait	0.6	0.34	10

ADG, average daily gain between the ages of 5 and 10 weeks; TMV, thigh muscle volume; LW21, litter weight at day 21

Table 6: Expected selection responses for the analyzed traits

Software_trait	ADG	TMV	LS21
ASREML_2_trait	0.51	4.70	-
ASREML_3_trait	0.75	4.28	0.06

ADG, average daily gain between the ages of 5 and 10 weeks; TMV, thigh muscle volume; LW21, litter weight at day 21

CONCLUSIONS

In the breeding programme of the Pannon Large rabbit breed, the use of the genetic parameters estimated with ASREML (3 trait model) and the connected selection indices can be advocated as all estimated responses were positive. Although the main interest of the slaughterhouse is to process rabbits with high TMV from the breeders' perspective it cannot coincide with deteriorating rearing performance of the rabbit does.

ACKNOWLEDGEMENTS

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[1]Kaposvár University, Faculty of Agricultural and Environmental Sciences, Hungary
[2]Kaposvár University, Faculty of Economic Science, Hungary
[3]INRA Station d'Amelioration Genetique des Animaux, France

E-mail: nagy.istvan@ke.hu

AIM

The objective of this study was to develop a BLUP index combining the selection criteria traits, making also possible to consider all traits in the first step of the selection procedure.

MATERIAL AND METHODS

Growth and reproductive performance records of the Pannon Large rabbit breed (sire line) were collected between 2005 and 2014 (N= 31567). The analyzed traits were ADG (g), TMV (cm^3), and LW21 (kg). Live body weight of rabbits at CT scans (BW, kg) and the number of reared kits in the litter (LS21) and the age of the kits at the weighing of the litter (AGE21, day) were also registered. Traits were evaluated either with two-trait (ADG, TMV), or with three-trait (ADG, TMV, LW21) animal models based on the REML method using ASREML (Gilmour et al., 2009) software. Regarding the considered environmental factors, animal effects were included for all traits, random litter effects and permanent environmental effects were considered for ADG, TMV and for LW21, respectively. Based on the population structure and on the estimated genetic parameters, selection indices for ADG, LW21 and TMV and expected genetic trends were calculated using the Selection software (Rutten and Bijma, 2001).

RESULTS

Table 1: Genetic parameters of the analyzed traits

Genetic parameter	ADG	TMV	LW21
h^2_2_ trait	0.16±0,01	0.23±0.03	-
h^2_3_ trait	0.17±0.02	0.24±0.03	**0.16±0.04**
c^2_2_ trait g	0.16±0.01	0.09±0.01	-
c^2_3_ trait	0.17±0.01	0.09±0.02	-
pe_2_ trait	-	-	-
pe_3_ trait	-	-	**0.17±0.03**

Among the analyzed traits, the highest heritability and the lowest relative importance of random litter effects was observed for TMV.

Table 2: Calculated selection indices for the examined traits

Trait	ADG-TMV	ADG-LW21	TMV-LW21
2_trait	-0.22±0.07	-	-
3_trait	**-0.20±0.08**	**0.50±0,10**	**0.22±0.12**

Table 3: Calculated selection indices for the examined traits

Trait	ADG	TMV	LS21
2_trait	**0.8**	**0.42**	-
3_trait	**0.6**	**0.34**	**10**

Table 4: Expected selection responses for the analyzed traits

Trait	ADG	TMV	LS21
2_trait	0.51	4.70	-
3_trait	**0.75**	**4.28**	**0.06**

ADG, average daily gain between the ages of 5 and 10 weeks; TMV, thigh muscle volume; LW21, litter weight at day 21

The estimated genetic correlation coefficients between ADG and TMV are not favourable. The expected selected responses were positive for all traits except for LW21.

CONCLUSION

In the breeding programme of the Pannon Large rabbit breed, the use of the genetic parameters estimated with ASREML (3 trait model) and the connected selection indices can be advocated as all estimated responses were positive. Although the main interest of the slaughterhouse is to process rabbits with high TMV from the breeders' perspective it cannot coincide with deteriorating rearing performance of the rabbit does.