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A SELECTION INDEX FOR IMPROVING THE CARCASS TRAITS IN THE PANNON LARGE RABBIT BREED

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Abstract

Loin muscle volume and hind leg muscle volume measured by computer tomography are economically valuable traits in rabbit breeding. Hence, genetic parameters were calculated to these new selection criteria, and a two-trait selection index was created in order to modify the current selection process of the Pannon large rabbit breed. The evaluated animals (n = 312) were randomly selected from 2014 and 2018, and the total number of animals in the pedigree file was 2758. Loin muscle volume (LMV) and hind leg muscle volume (HLV) were analyzed in a two-trait animal model. The estimated heritability for LMV was $h^2 = 0.4$ and $h^2 = 0.42$ for the HLV respectively. The selection index was created with desired gains by improving each trait in the selection criteria with one additive genetic standard deviation and the final index was Z transformed. Correlation coefficients between the index and the examined traits were high, 0.86 for LMV and 0.87 for HLV, thus this method could be announced into the breeding program.

Keywords: rabbit selection, computer tomography, selection index

INTRODUCTION

In breeding programs, paternal lines are usually selected to feed efficiency, growth rate or carcass traits considering rabbit breeds (Piles *et al.*, 2000; Khalil and Al-Saef, 2008). The Pannon breeding program (Matics *et al.*, 2014) was established in Kaposvár University including three rabbit breeds selected by different purposes since the late 1980s. The selection criteria differed from time-to time according to economic reasons and the consumer's demands. Pannon white was the first breed created from New Zealand white rabbits, followed by the maternal breed; Pannon Ka and the terminal breed Pannon Large.

Applying non-invasive techniques to shorten generation intervals and improve selection intensity are well-known and commonly used in animal breeding, by making progeny testing unnecessary (Jones *et al.*, 2004; Gjerlaug-Enger *et al.*, 2012). There were many aspirations previously, to find the best phenotypic correlation between carcass traits and CT based evaluations by Szendrő *et al.*, (1992). The average surface of muscle longissimus dorsi between the 2nd and 3rd, and 4th and 5th lumbar vertebrae (L-value) obtained the strongest correlation with the dressing out percentage for the Pannon white, (r = 0.53 - 0.65) but the technology did not allow to measure the volume of the whole muscle correctly back then. During the development of Pannon large in 2005, -as a paternal line- average daily gain (ADG) between 5 and 10 weeks of age became the first step of the selection process, and thigh muscle volume (TMV) was the second part. From the abattoir's point of view,

the loin muscle (LM) represents another essential element of the valuable meat parts, and nowadays can be measured by automatic segmentation. In addition, for some specific product, the whole hind leg of the rabbit is used, so it is important, to recommend new traits in the breeding goal such as loin muscle volume (LMV) and hind leg muscle volume (HLV).

For combining multiple traits in the selection criteria, selection index method (Hazel, 1943) has the aspects to maximize genetic progress. To express the importance of the traits, selection index with desired gains can be interpreted, which was firstly described by Pesek and Baker (1969). These indices are good alternatives for breeders regarding the economic weights are changing as the market changes. Hence, the aim of the study was to put a desired gain selection index to the valuable meat parts of the Pannon Large rabbit breed.

MATERIALS AND METHODS

Data Collection

The analysis consisted of 312 randomly selected animals of Pannon Large rabbit breed from Kaposvár University, Hungary. Records were collected between 2014 and 2018, according to the changes of the scanning method (Donkó *et al.*, 2016). In the first step of data collection, average daily gain (ADG) was measured, and animals with the best ADG were selected for the CT examination. During the evaluation three rabbits were fixed in a special plastic container without any anesthetics at 11 weeks of age, as in the standard selection program. The used acquisition parameters were: tube voltage 140 kV, X-ray radiation dose 90 mAs, spiral data collection mode with pitch 1, field of view 500 mm, slice thickness 2 mm. Overlapping slices were recorded of the rabbits from head to toe during the measurement. For the segmentation process, masks were made for the loin muscle and the hind legs, and registered to the CT images for each animal.

Animal Models

To estimate genetic parameters, REML and BLUP methods were used for the LM and HL in a two-trait animal model. The pedigree file consisted 2758 individuals. PEST software (Neustadt, Germany) (Groeneveld, 1990) was used for data coding and the variance components were estimated with VCE 6 (Groeneveld *et al.*, 2008). The structure of the applied model is summarized in Tab. I.

Selection Index

After the calculation of the genetic parameters, a two-trait desired gain selection index was created by MIX software (Nath *et al.*, 2002).

The desired gain was calculated by the method of Yamada *et al.* (1975), as follows:

Q is the m × 1 vector of the desired gain of the traits included:

$$Q = (Q1, Q2). \quad (1)$$

In order to attain desired gains, selection was made on the basis of the index.

$$I = b'X, \quad (2)$$

where X = n × 1 vector of LMV and HLV, b = n × 1 vector of weighting coefficients.

The expected genetic gain per generation of the i^{th} trait was computed as:

$$\Delta G_i = \frac{i_i Cov(G_i, I)}{\sigma_I}, \quad (3)$$

where i_i = selection intensity; σ_I = (b'Pb)1/2(standard deviation of the index), and/ P = n × n matrix of phenotypic variance-covariance between the elements of X. Cov.(G_i, I) = (*G*'b) (covariance of the breeding value of trait and the index).

The final index was Z-transformed to get 100 as mean of the index and 20 for standard deviation.

$$Index = 6.3 \times LMV + 4.13 \times TMV. \quad (4)$$

Number of generations required to attain the goal (t) were calculated as: $t = \sigma_I/i_I = (b'Pb)^{1/2}/i_I$.

I: *The applied animal model*

Effect	Type	Levels	Trait	
			LMV	HLV
Sex	F	2	X	X
Year_month	F	17	X	X
Pixel	F	1	X	X
CT_weight	C	1	X	X
A	A	2758	X	X

Where: LMV: Loin muscle volume; HLV: hind leg muscle volume; Sex: sex of growing rabbits; Year_month: year and month of kindling; Pixel: density range of the muscle tissue; CT_weight: bodyweight at the CT meaurement; A: additive genetic effect

II: *Descriptive statistics of the traits*

Trait	N	Minimum	Maximum	Mean	SD
LMV (cm^3)	312	98.58	232.68	157.11	23.99
HLV (cm^3)	312	278.91	478.48	374.33	39.43
CT_weight (g)	312	2350	3620	2957	212.55

Where: LMV is the volume of the loin muscle; HLV is the volume of the hind legs; CT_weight: bodyweight at the CT measurement

III: *Heritabilities, genetic correlations and standard errors of the measured traits*

Traits	h^2	rg LMV-HLV
LMV	0.4	0.68 ±0.08
HLV	0.42	

RESULTS

The mean values of HLV are in accordance with the results for thigh muscle volume (TMV) of the Pannon white rabbit breed (Ács *et al.*, 2018), however, the results are somewhat higher due to the breed differences and the slight changes in the CT segmentation method.

The genetic correlations, estimated heritabilities are summarized in Tab. III.

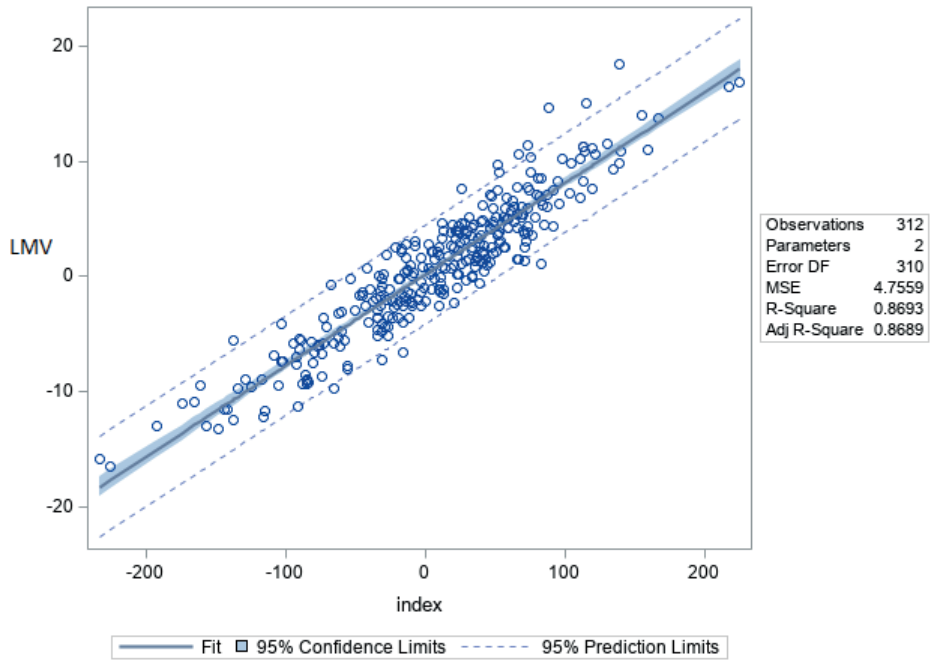
Correlation coefficients between the examined traits and the selection index are presented in Fig. 1 and Fig. 2.

After the Z transformation, the means of the estimated breeding values for the examined traits were somewhat higher (4.9 for LMV and 4.9 for HLV) than the index score (4.6). A favorable genetic correlation was found between LMV and HLV (0.68) and the correlation coefficients of both the LMV and the HLV were strongly positive, therefore it is advisable to link them with a selection index.

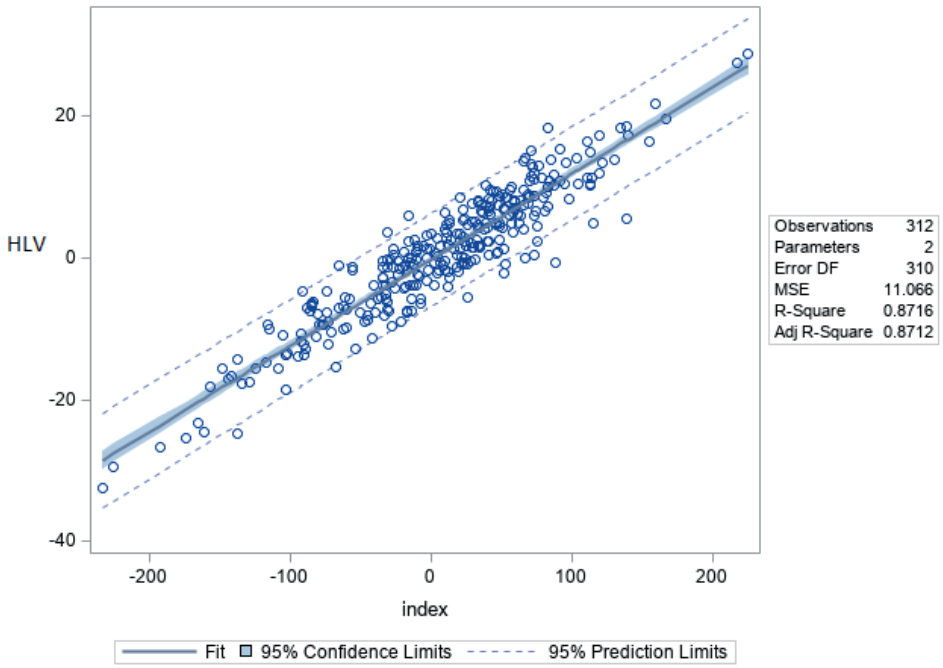
DISCUSSION

LMV showed relatively high heritability (h^2 = 0.4), in contrast with Lenoir and Morien, (2016), where CT evaluation was substituted with ultrasound device due to economic reasons. They measured the surface of the *m. longissimus dorsi*, and observed a moderate heritability (h^2 = 0.2). In the Pannon White rabbit breed, previous selection criteria (L-value) was expressed in cm^2 and the heritability of the trait was h^2 = 0.33 (Matics *et al.*, 2014), thus adding LMV to the breeding goal may result a more accurate selection decision.

For the hind legs, the heritability of the muscle volume is also high (h^2 = 0.4). Heritability estimations were reported previously for thigh muscle volume in the Pannon large and the Pannon white breed, but these results were moderate (h^2 = 0.21 - 0.25) (Gyovai *et al.*, 2012).



1: *Correlation coefficient of the selection index and the loin muscle volume*



2: *Correlation coefficient of the selection index and the muscle volume of the hind legs*

Matics *et al.*, (2014) reported high genetic correlations between thigh muscle volume and the dressing out percentage (0.45–0.47) earlier. The number of generations required to improve the traits with one additive genetic standard deviation was 11.9, which can be achieved in approximately 5 years of selective breeding.

CONCLUSION

Applying selection index method is reasonable in the Pannon large breed, especially for carcass traits. As a paternal crossing partner, the amount of the valuable meat parts has to be improved, thus more profit can be obtained for the slaughterhouse. If traits are difficult to determine from an economic point of view the implementation of "desired gains" can be a good alternative to create a new breeding goal.

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