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THE FEED CONVERSION, DAILY GAIN, AVERAGE BACKFAT THICKNESS AND MEAT PERCENTAGE IN PERFORMANCE TEST OF LANDRACE BOARS

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SUMMARY: This paper analyzes the characteristics of the performance test and Landrace boars to: Dutch, Swedish, German and Danish, originating from large farms in Serbia in order to analyze the variability of different characteristics of the aggregate genotype: feed conversion, daily gain and thickness of the back side of bacon and lean meat. Systemic genetic factors (race and fathers) and environmental factors (farm) have ahighly significant effect (P<0.01) on the properties of the aggregate genotype (feed conversion and meat percentage) except for the traits daily gain and backfat thickness of the side, where impact of race was not significant (P>0.05). The tested properties of the aggregate genotype showed a high degree of heritability (heritability) with a high standard error. Heritability for feed conversion was 0.84 ± 0.21 for daily gain 0.73 ± 0.18,backfat thickness of 0.74 ± 0.19, the thickness of the side of bacon 0.76 ± 0.19 and percent of meat 0,66 ± 0.18. The positive genetic correlations between traits in the aggregate genotype (from 0.266 between feed conversion and backfat thickness side to 0.984 between backfat thickness and the thickness of the side), and negative genetic correlations between the percentage of meat and feed conversion, daily gain and thethickness of the back side of bacon thickness (-0.155, -0.344, -0.904 and -0.858), were found.

***Key words:** Landrace, boars, performance test, genetic parameters, daily gain, percentage of meat.*

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INTRODUCTION

Effects can be used in models for genetic evaluation of tested animals are numerous, given that different factors influence the varying properties of growth, feed efficiency and carcass quality of pigs (Mijatovic et al., 2006). The improvement of beef traits, which include weight gain, feed conversion and meat percentage, represents a significant fattening factor for the increased pig production (Imboonta et. al., 2007). These traits have medium and high heritability and can be measured directly or indirectly on the animals. Because of the high degree of heritability, genetic improvement can be achieved using the results of performance test. ,

Candidates for the next generation of parents are selected on the basis of the data's many features (Vidovic and Košarčić, 1998). In some European countries (the Netherlands), selection in the nucleus herds for fattening and carcass quality traits using information obtained in performance and sib testing.

Central test stations offer many advantages compared to on-farm testing. One of them is that you need to enable greater standardization (control) test environment and improving the testing procedure by minimizing the potential effects of uncontrolled factors (Mijatovic et al., 2005). However, testing in a central test stations is limited by capacity, in order to provide a larger number of animals tested in many countries to apply the test farm (Sckolling at al., 1981; Hudson and Kennedy, 1985; Merx, 1987; Vidovic et al.,1993; Trivunović, 1996), while in commercial gilts and sows (f1 generation), applies only phenotypic selection (Vidovic et al., 2011). In Serbia since the beginning of the introduction of testing to date, several methodologies were applied to the test (Markovic et al., 1963, Markovic et al., 1976, Drobnjakovic et al., 1988, Vidovic et al., 1993).

MATERIALS AND METHODS

Investigations were made on four breeds Landrace boars from Vojvodina in the period since 2007. through 2011, during the performance test. Included are farms (total18) which are registered at the Department of Animal Husbandry, Faculty of Agriculture in Novi Sad, as the Main Breeding Organization for AP Vojvodina (Serbia). The study included a total of 699 tested Landrace boars of four breeds: Dutch (51); Sweden (337), Germany (306) and Danish Landrace (5). During the performance test, the aggregate genotype boars consisted of the following features: feed conversion (FC, kg) daily gain (DP, kg), average back fat thickness, (LS, mm), average thickness of the side of bacon, (BS, mm) and the percentage of meat, (PM, %).

Ocena genetskih faktora i sistemskih faktora spoljne sredine

Za ispitivanje uticaja farme, rase i očeva na osobine iz agregatnog genotipa, korišćen je metod najmanjih kvadrata (Statistika 10), a statistički metod je sledeći:

Rating genetic factor and systematic environmental factors

Testing effects of farm, breed and fathers on the properties of the aggregate genotype, performed by the method of least squares (statistics 10), a statistical method is as follows:

$$Y_{ijklm} = \mu + F^{i} + R^{j} + O^{k} + S\,b\,(X - \overline{X}) + e^{ijklm}$$

Where is: Y_{ijklm} - expression of traits;
μ – overall mean value;
F_i- fixed-effect i - farm;
R_j - fixed-effect j - race;
O_k - fixed-effect k - father;
b - coefficient of linear regression of the impact of final the mass;
e_{ijklm} - random error.

The model assumes that random error is independent and normally distributed effects for all N(0, σ ²).

Genetic parameters

Ratings of genetic parameters of traits in the aggregate genotype were calculated using the method of least squares of the components of variance and covariance of the half-sib by fathers (Harvey, 1990)., A statistical model was as follows:

$$Y_{ijklm} = \mu + F_i + R_j + O_k + S\,b\,(X - \overline{X}) + e_{ijklm}$$

The formulas used to calculate genetic parameters are as follows (Harvey, 1990):

Heritability $\quad h^2 = \frac{4\sigma_s^2}{\sigma_s^2 + \sigma_e^2}$

Where is:

σ_S^2 - variance between fathers (family);

σ_e^2 - variance between fathers (family) or a random error

$$r_g = \frac{Cov_{S(xy)}}{\sigma^2_{S(x)} \times \sigma^2_{S(y)}}$$

Genetic correlation

Where is: $Cov_{S(xy)}$ - family covariance for the traits x i y;

$\sigma^2_{S(x)}$ - variance between fathers (family) for property x;

$\sigma^2_{S(y)}$ - variance between fathers (family) for property y.

$$r_p = \frac{Cov_{P(xy)}}{\sigma^2_{P(x)} \times \sigma^2_{P(y)}}$$

Phenotypic correlation

Where is: $Cov_{P(xy)}$ - phenotypic covariance for the traits x i y;

$\sigma^2_{P(x)}$ - phenotypic variance of traits x;

$\sigma^2_{P(y)}$ - phenotypic variance of traits y.

$$r_e = \frac{Cov_p - Cov_{s(xy)}}{\sqrt{\left[\sigma^2_{P(x)} - \sigma^2_{S(x)}\right] \times \left[\sigma^2_{P(y)} - \sigma^2_{S(y)}\right]}}$$

Environmental correlations

Strength of correlation was determined based on Romer-scale Ophterove (Latinović,1990).

RESULTS AND DISCUSSION

The rating system of genetic and environmental factors

The influence of race and fathers as a system of genetic factors and the farm as asystem of environmental factors on the traits of the aggregate genotype of boars is shown in Tables 1 - 4

Table 1. Influence of farm, breed and fathers on feed conversion in the test

Tabela 1. Uticaj farme, rase i očeva na konverziju hrane u testu

Source of variation / *Izvor varijabilnosti*	SS - race *SS – rase*	df-race *df-rase*	MS - race *MS – rase*	F
Farma / *Farm*	10,290	17	0,605	5,886**
Rasa / *Race*	1,111	3	0,370	3,252*
Očevi / *Fathers*	34,860	153	0,228	2,73**

* Marked effects are significant at p<0.050, *Vrednosti su statistički značajne p<0,050,

** Marked effects are significant at p<0.010, **Vrednosti su statistički značajne p<0,010

**SS-sums of squares df-degrees of freedom, MS-square environment, **SS-sume kvadrata; df-stepeni slobode; MS-sredine kvadrata

By comparing the experimental F values shown in Table 1, the tabular values, it is evident that the farm and fathers significantly (P <0.01) effect on feed conversion in boars tested, while race is influenced significantly (P <0.05).

Table 2. Influence of farm, breed and fathers on daily gain in the test

Tabela 2. Uticaj farme, rase i očeva na dnevni prirast u testu

Source of variation / *Izvor varijabilnosti*	SS - race *SS – rase*	df-race *df-rase*	MS - race *MS – rase*	F
Farma / *Farm*	1574020	17	92589	5,519**
Rasa / *Race*	93084	3	31028	1,671 ^{N}
Očevi / *Fathers*	5010221	153	32747	2,23**

** Marked effects are significant at p<0.010, **Vrednosti su statistički značajne p<0,010

**SS-sums of squares df-degrees of freedom, MS-square environment, **SS-sume kvadrata; df-stepeni slobode; MS-sredine kvadrata

In table 2 we can see that the farm and fathers significantly (P <0.01) affected daily gain in performance testing of boars, and the influence of race on the daily weight gain was not significant (P> 0.05).

Table 3. Influence of farm, breed and fathers on backfat thickness of boars in the test
Tabela 3. Uticaj farme, rase i očeva na debljinu leđne slanine nerastova u testu

Source of variation / *Izvor varijabilnosti*	SS - race *SS – rase*	df-race *df-rase*	MS - race *MS – rase*	F
Farma / *Farm*	2404,85	17	141,46	6,864**
Rasa / *Race*	173,85	3	57,95	2,476 *N*
Očevi / *Fathers*	6519,00	153	42,61	2,341**

** Marked effects are significant at p<0.010, **Vrednosti su statistički značajne p<0,010

**SS-sums of squares df-degrees of freedom, MS-square environment, **SS-sume kvadrata; df-stepeni slobode; MS-sredine kvadrata

As in daily gain, systemic factors, farm and fathers were highly significant (P <0.01) affected the thickness of back fat, however, the impact of race was not significant (P>0.05) effect on this traist (table 3).

Table 4. Influence of farm, breed and fathers on thickness of the side of bacon of boars in the test
Tabela 4. Uticaj farme, rase i očeva na debljinu bočne slanine nerastova u testu

Source of variation / *Izvor varijabilnosti*	SS - race *SS – rase*	df-race *df-rase*	MS - race *MS – rase*	F
Farma / *Farm*	2479,28	17	145,84	7,292**
Rasa / *Race*	215,89	3	71,96	3,1491*
Očevi / *Fathers*	6259,75	153	40,91	2,266**

* Marked effects are significant at p<0.050, *Vrednosti su statistički značajne p<0,050,

** Marked effects are significant at p<0.010, **Vrednosti su statistički značajne p<0,010

**SS-sums of squares df-degrees of freedom, MS-square environment, **SS-sume kvadrata; df-stepeni slobode; MS-sredine kvadrata

Sistemski faktori farme i očeva su visoko signifikantno (P< 0,01), a rase signifikantno (P< 0,05) uticali na osobinu debljine bočne slanine kod performans testiranih nerastova.

Systemic factors (farm and fathers) were significantly (P <0.01), and race significantly (P<0.05) affected the thickness of bacon side of the performance tested boars (table 4).

Table 5. Influence of farm, breed and fathers on the percentage meat of boar in the test
Tabela 5. Uticaj farme, rase i očeva na procenat mesa kod nerastova u testu

Source of variation / *Izvor varijabilnosti*	SS - race *SS – rase*	df-race *df-rase*	MS - race *MS – rase*	F
Farma	2254,5	17	132,6	7,13**
Rasa	285,9	3	95,3	4,53**
Očevi	5761	153	38	2,24**

** Marked effects are significant at p<0.010, **Vrednosti su statistički značajne p<0,010

**SS-sums of squares df-degrees of freedom, MS-square environment **SS-sume kvadrata; df-stepeni slobode; MS-sredine kvadrata

All of the systemic factors (farm, breed and fathers) were significantly (P <0.01) affected the percentage of meat performance tested boars (table 5).

As can be seen from the results, the results of testing boars affect systemic genetic influences such as the influence of race and fathers and systematic environmental factors, such as a farm. All of these factors during testing, the impact on the expression characteristics of the aggregate genotype, except for daily gain and backfat thickness of the side where the race was not significant (P> 0.05) affected.

Similar results have come many authors (Merx, 1986; Petrovic et al., 1991; Radivojevic et al., 1992; Tuan, 1992; Sreckovic et al., 1993; Das and Mishra, 1993; Merx and Oijen, 1994; Park et al., 1994; Short et al., 1994; Trivunovic, 1996; Brkic et al., 2000; Mijatovic et al., 2005; Mijatovic et al., 2006; Deer et al., 2007). It is therefore necessary to introduce the methods of estimation of breeding values that will eliminate these influences in order to obtain pure additive value of the animal. One of these methods is the BLUP (best linear objective indicator) and AM (individual model).

Heritability, genetic and phenotypic correlations

Heritability and standard error of the heritability of traits and genetic and phenotypic correlations between observed traits in the aggregate genotype are shown in Table 6.

Table 6. Heritability and standard error of heritability (on diagonal), genetic correlations and standard errors of genetic correlations (below diagonal) and phenotypic correlations (above diagonal).
Tabela 6. Heritabilnost i standardna greška heritabilnosti (na dijagonali), genetske korelacije i standardne greške genetskih korelacija (ispod dijagonale) i fenotipske korelacije (iznad dijagonale).

Traits / *Osobine*	KH	DP	LS	BS	PM
KH	**0,84** ± 0,21	0,495	0,096	0,136	-0,085
DP	0,513 ± 0,15	**0,73 ± 0,18**	0,316	0,269	0,053
LS	0,328 ± 0,19	0,700 ± 0,13	**0,74 ± 0,19**	0,686	-0,529
BS	0,266 ± 0,19	0,545 ± 0,16	0,984 ± 0,03	**0,76 ± 0,19**	-0,731
PM	-0,155± 0,21	-0,344± 0,20	-0,904± 0,18	-0,858± 0,21	**0,66 ± 0,18**

We can see that all the properties of the aggregate genotype boars show a high degree of heritability with high standard error. Heritability for feed conversion is 0.84 ± 0.21 for daily gain 0.73 ± 0.18, backfat thickness, 0.74 ± 0.19, the thickness of the side of bacon 0.76 ± 0.19 and percent of meat 0.66 ± 0.18. The obtained values for the heritability of properties from the aggregate genotype, are located within the literature cited by many (Biyelis at al., 2000; Chen at al., 1999; Huff-Lonergan at al., 2002; Schwab at al., 2010).

Heritability of traits indicates the degree of genetic variability in the total phenotypic variability. If heritability is high, meaning that differences between individuals are genetically determined, and based on the phenotype of animals we can determine the genotype. This further means that animals are the best phenotype, and also represent genetically superior animals. So, as well as phenotypic variability, high heritability, indicating that it is possible to apply the successful selection of properties from the aggregate genotype.

Genetic correlations between feed conversion and daily gain, feed conversion, and backfat thickness, feed conversion and backfat thickness of the side were positive and high (rg = 0.513 ± 0.15, rg = 0.328 ± 0.19, rg = 0.266 ± 0.19). Between feed conversion and lean meat, genetic correlations were negative and weak (rg = -0.155 ± 0.21) Genetic correlations between daily gain and backfat thickness and backfat thickness of the side are positive and strong (r g = 0.700 ± 0.13, rg = 0.545 ± 0.16), while the genetic correlation between daily gain and percentage of meat were negative (rg = -0.344 ± 0.20). Genetic correlation between backfat thickness and backfat thickness of the side showed a positive and complete (rg = 0.984 ± 0.03), while between backfat thickness and lean meat were also full, but negative (rg = -0.904 ± 0.18). Between the backfat thickness of the side and percentage of meat, genetic correlations were negative and very strong (rg = -0.858±0.21)

Positive and high phenotypic correlations were found between feed conversion and daily gain (r p = 0.495), and positive and the poor between feed conversion and backfat thickness of the side (rp = 0.136). Phenotypic correlations between feed conversion and backfat thickness, feed conversion and percenatge of meat were not established. Phenotypic correlations between daily gain and backfat thickness and backfat thickness of the side were high and positive (rp = 0.316, rp =0.269). There were no phenotypic correlation between daily gain and percentage of meat. Positive and strong phenotypic correlations were found between backfat thickness and the backfat thickness of the side of bacon (rp = 0.68), while between backfat thickness and persenateg of meat were negative and high (rp = - 0.52). Negative and strong phenotypic correlations were observed between the backfat thickness of the side and percenatage of meat (rp = - 0.73).

The established genetic and phenotypic correlations between traits of the aggregate genotype in this study are the same sign and phenotypic correlations were lower than genetic, but the correlation between the percentage of meat and other traits which are negative. The lower phenotypic correlation of genetic, can be explained by the influence of environmental factors.

Correlations obtained in this study are in agreement with results of other authors (Gajic et al., 1975; Pohar et al., 1977, Young et al., 1978; Pathiraja et al., 1991; Trivunović, 1996).

On the basis of phenotypic and genetic correlations necessary to define the breeding program to achieve the desired breeding objective.

CONCLUSION

By analyzing the results of performance test of boars and features included in the aggregate genotype (feed conversion, daily gain, backfat thickness, backfat thickness of the sid, meat percentage), genetic parameters and based on the cited literature, can be drawn the following conclusions:

- Systemic genetic factors (race and fathers) and environmental factors (farm) are highly significant ($P<0.01$) effect on the traits of the aggregate genotype, except for daily gain and backfat thickness of the side, where the race was not significant ($P>0,05$) affected. It is therefore necessary to introduce the methods of estimation of breeding values (BLUP – best linear objective indicator) and AM (individual model) that can as much as possible to eliminate these impacts.
- The tested properties of the aggregate genotype showed a high degree of heritability (heritability). Heritability for feed conversion was 0.84 ± 0.21 for daily gain 0.73 ± 0.18, backfat thickness of 0.74 ± 0.19, the thickness of the side of bacon 0.76 ± 0.19 and percent of meat 0.66 ± 0.18. This allows the work to improve the properties of the aggregate genotype based on the selection.
- The established genetic and phenotypic correlations between traits in the aggregate genotype in this study are the same sign and phenotypic correlations were lower than genetic, but the correlation between the percentage of meat and other traits which are negative. The lower phenotypic correlation of genetic, despite the fact that the phenotype includes genotype, can be explained by the influence of environmental factors. The existence of positive and negative genetic and phenotypic correlations, indicating that the simultaneous assessment of the breeding values and selection of traits from the aggregate genotype, it is necessary to have information about correlations and include them in the method of assessment of breeding values.
- For the application of BLUP methods need to be in the elite boars for AI centers, This would be the model for the evaluation of breeding values include the effect of the farm, which would contribute to greater accuracy of assessment.
- To allow simultaneous selection on multiple traits, with respect to heritability, genetic, phenotypic and environmental correlations, as well as economic value of traits, recommended the use of multiple trait BLUP (AM) model.

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KONVERZIJE HRANE, DNEVNI PRIRAST, PROSEČNA DEBLJINA SLANINE I PROCENAT MESA U PERFORMANS TESTU NERASTOVA RASE LANDRAS

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Izvod

U radu su analizirane osobine iz performans testa nerastova rase landras i to: holandski, švedski, nemački i danski, poreklom sa nekoliko farmi na teritoriji AP Vojvodine, u cilju analize varijabilnosti različitih osobina iz agregatnog genotipa: konverzije hrane, dnevnog prirasta debljine leđne i bočne slanine i procenta mesa. Sistemski genetski faktori (rase i očevi) i faktori spoljne sredine (farma) imaju visoko signifikantan uticaj (P< 0,01) na osobine iz agregatnog genotipa (konverzija hrane i procenat mesa), izuzev na osobine dnevnog prirasta i debljine bočne slanine na koje rasa nije signifikantno uticala (P>0,05). Ispitivane osobine iz agregatnog genotipa pokazuju visok stepen heritabilnosti (naslednosti) sa visokom standardnom greškom. Heritabilnost za konverziju hrane iznosila je 0,84±0,21, za dnevni prirast 0,73±0,18, debljinu leđne slanine 0,74±0,19, debljinu bočne slanine 0,76±0,19 i procenat mesa 0,66±0,18. Ustanovljene genetske korelacije između osobina iz agregatnog genotipa su pozitivne i kreću se od 0,266 između konverzije hrane i debljine bočne slanine do 0,984 između debljine leđne slanine i debljine bočne slanine. Ustanovljene su negativne genetske korelacije između procenta mesa i konverzije hrane, dnevnog prirasta, debljine leđne i debljine bočne slanine (-0,155; -0,344; -0,904 i -0,858).

Ključne reči: Landras, nerastovi, performance test, genetski parametri, dnevni prirast, procenat mesa.

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