

Sources of specific variance and genetic parameters of gaits quality in 2-years old horses from the East Bulgarian breed

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Abstract

The aim of the present study was to establish the sources of specific variance and the genetic parameters of gaits in 2-years old horses from the East Bulgarian breed. The basis for the study was the data from the assessment of the gaits, walk, trot, free gallop and correctness of 228 East Bulgarian horses tested for a period of 10 years. Tests for two-years old horses were conducted on two consecutive days with a pre-adaptation period for one week. Preliminary selection was not applied to the participants. The composition of judges was relatively constant. A 10-point score system with an accuracy of 0.5 was used. The registration of the animals and traits was carried out by the East Bulgarian Horse Association.

There were statistically proven sources of a specific variance as the family belonging of horses for gaits, walk, gallop and correctness, and the mother's line for correctness and gallop. Years of birth had generated variation upon all of the studied traits, and the month of birth – on trot scores. Differences due to gender differentiation were in favor of males. The best genetic potential was possessed by the horses belonging to the families of Linia, Slavyanka, Ohota and Malta and the mares' offspring originating from the lines of Tihany, Devis Own, Ramzes and Tempelhuter.

The rate of additive variance was from a low to moderate for gaits in the aggregate (0.30–0.49), walk (0.35–0.50), trot (0.18–0.35), and free gallop (0.35–0.08) and high for correctness (0.60–0.75). There was an higher heritability value's increasing the volume of progeny groups, except for the gallop. Favorable from the breeding point of view were the established correlations between correctness and trot (0.77) and between correctness and gallop (0.49).

Key words: genetic parameters, horses, quality of gaits, sources of specific variance

Източници на специфична варианса и генетични параметри на качествата на движение при 2-годишни коне от Източнобългарска порода

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Резюме

Целта на настоящото проучване бе да установим източниците на специфичен вариант и генетичните параметри на качествата на движение при 2-годишни коне от Източнобългарска порода. За основа на проучването послужиха данните от общата оценка на движенията и от оценките на ходом, тръс, галоп и коректност на 228 коня от Източнобългарска порода, участвали в тестираня за период от 10 години. Тестовите за двегодишни коне са провеждани в два последователни дни с предварителен адаптационен период към обстановката от една седмица. Статистически доказани източници на специфичен вариант са били фамилната принадлежност на конете за признаците обща оценка, ходом, галоп и коректност, и линията на майката за коректност и галоп. Годишните на раждане са индуцирали разнообразие върху всички признаци, обект на проучването, а месецът на раждане върху оценките на тръс. Разликите, дължащи се на половата диференциация, са били в полза на мъжките животни. Най-добър генетичен потенциал са притежавали конете от фамилиите на Линия, Славянка, Охота и Малта и потомците на кобили, произхождащи от линиите на Тихани, Devis Own, Ramzes и Tempelhuter.

Наследственообусловеният вариант е бил от нисък до средновисок за признаците обща оценка (0,30–0,49), ходом (0,35–0,50), тръс (0,18–0,35), галоп (0,35–0,08) и висок за коректността на движенията (0,60–0,75). С изключение на движенията в галоп, при останалите признаци се е наблюдавало завишение на стойността на наследяемостта след увеличаване на обема на потомствените групи. Благоприятни от развѣдна гледна точка са установените корелативни връзки между оценките на коректността и тези на тръс (0,77) и галоп (0,49).

Ключови думи: генетични параметри, коне, качества на движение, източници на специфичен вариант

Introduction

The registration of the traits which were objects of selection in the countries with developed sports horsebreeding was carried out in different types of tests for young horses, stallions and mares or directly in the equestrian sports disciplines. Traits characterizing the qualities of a movement were important because of their economic significance, relation to the sports career, productive life and the market value of horses produced (Barrey, 1999, Rozanowski et al., 2013, Olsson et al., 2000, Posta et al., 2010, etc.). They are object to registration and evaluation for all cultural horse breeds. Depending on the goals set their assessments have a different weight in breeding programmes. The main traits are the allures walk, trot and gallop. The common criteria used to for the evaluation are stride length, correctness, impulse, balance, overall impression, and so on.

According to Barrey research (1999), Olsson et al. (2000), Ducro et al. (2007), Viklund et al. (2008), Borowska et al. (2011), Rosanowski et al. (2013), Schopke et al. (2013), Wejer and Lewczuk (2016), Navotna et al. (2016), etc., the inheritance of walk moves ranges from 0.15 to 0.38, in a trot from 0.25 to 0.46, in a gallop from 0.20 to 0.37, and a of the gaits in the aggregate – from 0.35 to 0.53. The values of the genetic correlations between the allures were in the range of 0.03 to 0.75. Phenotypic correlations in most cases were lower than genetic ones. Wejer and Lewczuk (2016) investigated the influence of age, father and gender on the assessment of the exterior and movements of horses from the Trakenen breed in Poland, pointing out that the influence of father and age was true to all the studied traits and gender influenced significantly only on walk and gallop traits. The average values obtained by the authors for the qualities of movements ranged from 6.83–7.54 score. A similar study was also

made by Olsson et al. (2000) at 378 Swedish half thoroughbred stallions as received average values for the qualities of movements being 6.91 ± 1.18 scores for walk; 6.72 ± 1.29 for trot and 7.09 ± 1.09 for gallop.

The East Bulgarian breed is a small, long-term selected population with an established genealogical structure. The accumulated scientific information from the genetic analysis performed in sports breeds abroad showed, that the rate of the additive variance varies from low to moderate and less frequently high, depending on the breed, the age category, the registration system used and the accuracy of the statistical methods used. That was why the selection aspects of the evaluation of quality of movement were routine for each individual population.

The aim of the present study was to establish the sources of specific variance and the genetic parameters of the quality of movement in 2-years old horses from the East Bulgarian breed.

Material and methods

The basis for the study was the data from the assessment of the gaits in the aggregate, walk, trot, free gallop and correctness of 228 East Bulgarian horses tested for a period of 10 years. Tests for two-years old horses were conducted on two consecutive days with a pre-adaptation period for one week. Preliminary selection was not applied to the participants. The composition of judges was relatively constant. A 10-score system with an accuracy of 0.5 was used (Sabeva and Kaschiev, 2010). The registration of the animals and traits was carried out by the East Bulgarian Horse Association.

Analyses of the variation, estimation of the different sources of variability, heritability and correlations were done by mixed model methodology. The rate of the additive variance was calculated totally for all participants and singly with progeny groups above five. The structure of the used operational model had the following linear expression:

$$Y_{ijk\text{snlop}} = \mu + SZ_i + SX_j + AG_k + B_s + LS_n + LM_l + F_o + e_{ijk\text{snlop}}$$

where:

$Y_{ijk\text{snlop}}$ – observation vector; μ – population mean; SZ_i , SX_j , AG_k , B_s , LS_n , LM_l are F_o fixed effects of birth year ($i = 14$); birth months ($j = 12$); horse gender ($\kappa = 2$); fathers ($s = 75$); lines ($n = 16$); mother line ($l = 23$); family ($o = 16$); $e_{ijk\text{snlop}}$ – residual variance, respectively.

Results and discussion

Average score of East Bulgarian breed horses for the walk was 6.75 points, 6.76 for trot, 6.86 for gallop, 6.75 for correctness and 6.78 for the gaits in the aggregate. Standard deviations ranged from 0.44 to 0.59 and the coefficients of variation - from 5.86% to 7.85% (Table 1).

Table 1. Means, standard deviations and coefficients of variation

Trait	X (min–max)	s.d.	C
Gaits	6.78 (5.71–7.93)	0.44	5.86
Walk	6.75 (5.14–8.67)	0.59	7.85
Trot	6.76 (5.38–8.38)	0.53	7.29
Free gallop	6.86 (5.71–8.33)	0.55	7.22
Correctness	6.75 (4.50–8.13)	0.52	6.76

In the present study, the obtained results are in unison with the presented form other authors average scores for the quality of movements of other half thoroughbred horse breeds. Novotna et al. (2016) announced average values of traits walk – 6.3 ± 1.9 score, trot – 6.6 ± 2.0 score and gallop – 6.3 ± 1.9 score for Kladruber horses, pointing that these comparatively low standard deviations might be due to insufficient use of the whole score scale.

In table 2 are presented analyses of variance and coefficient of determination of used models. Among the genealogical groups, mother's line has influenced significantly in $p \leq 0.05$ on the correctness and gallop; family – on gaits in the aggregate, walk, gallop and correctness. Strongly expressed effect on the family belonging was due to the closed Stud Book from mother's side

during the last two generation intervals and wider use of grading for better sport qualities. The influence of gender is not statistically proven only regarding the trot. Differences due to gender differentiation are not great and are in favor of males – 6% for gaits, 9% for walking and correctness and 2% for galloping.

Among the environmental sources of variability, birth year has influenced significantly on the gaits ($p < 0.05$), walk ($p < 0.05$) and correctness ($p < 0.05$); birth month – on trot ($p < 0.05$). Value of determination coefficients (R^2) are above 0.5.

Despite the fact that the month of birth has influenced significantly only on the trot, the horses born in January, June and July had constants above average population for all studied traits, and those born in September were with lower than the average constants only for correctness.

On the basis of two parallel analyzes, the additive variation was from low to moderate for gaits, walk, trot and gallop and high for correct-

ness of the movements (Table 3). There was an higher heritability value's increasing the volume of progeny groups, except for the gallop.

Phenotypic and genetic correlations were high between the gaits walk, trot, gallop and correctness, respectively. There were low genetic correlations and moderate phenotypic correlations between walk and the other studied traits. Favorable from the breeding point of view were the established correlations between correctness and trot (0.77) and between correctness and gallop (0.49).

Horses originated from the Nagaika and Hana families have received negative and lowest constants with respect to all the studied traits (Table 4). Horses from Krastanka family had a negative constant only for walk whereas to the trait correctness they surpassed all other families. From the Hodeida family only the trot constant was a positive sign. The other constants were negative but close to the average for the population.

Table 2. Anova

Sources of variability	df	Gaits	Walk	Trot	Free gallop	Correctness
		F- test	F-test	F-test	F-test	F-test
Father	74	random	random	random	random	random
Line	16	n.s.	n.s.	n.s.	n.s.	n.s.
Mother's line	27	n.s.	n.s.	n.s.	+	+
Family	16	+	+	n.s.	+	+
Month of birth	11	n.s.	n.s.	+	n.s.	n.s.
Birth year	13	+	+	+	+	+
Gender	1	+	+	n.s.	+	+
R^2 of model		0.50	0.66	0.50	0.50	0.51

+ – $P < 0.05$; ++ – $P < 0.01$; +++ – $P < 0.001$; n.s. – lack of significance (non significant)

Table 3. Heritability (diagonally), phenotypic (under the diagonal) and genetic correlations (above the diagonal)

	Gaits	Walk	Trot	Free gallop	correctness
Gaits	0.30–0.49	0.53	0.66	0.61	0.72
Walk	0.70	0.35–0.50	0.26	0.05	0.14
Trot	0.77	0.49	0.18–0.35	0.48	0.77
Gallop	0.85	0.55	0.65	0.35–0.08	0.49
correctness	0.71	0.38	0.49	0.51	0.60–0.75

Table 4. Effect of genealogical families

Family	n	Complex assessment	Walk	Trot	Free gallop	Correctness
		BLUE-constant	BLUE-constant	BLUE-constant	BLUE-constant	BLUE-constant
Krastanka	2	0.25	-0.77	0.14	0.05	0.89
Hana	8	-0.62	-0.70	-0.73	-0.60	-0.46
Hodeida	5	-0.04	-0.24	0.37	-0.09	-0.18
Liniya	4	0.31	0.68	0.09	0.18	0.27
Kiliya	7	0.03	0.18	0.16	-0.15	-0.09
Longuza	12	0.05	0.07	-0.06	0.24	-0.04
Slavyanka	5	0.28	0.14	0.18	0.60	0.21
Likuyushta	20	0.17	0.24	0.11	0.30	0.02
Leila	24	-0.01	0.04	-0.02	-0.04	0.01
Nerazdelna	18	0.05	0.18	0.10	-0.07	-0.02
Ohota	31	0.28	0.38	0.09	0.27	0.40
Genoveva	4	-0.12	0.15	-0.26	0.11	-0.06
Malta	3	0.25	0.44	0.40	0.33	-0.15
Nagaika	2	-0.70	-1.37	-0.30	-0.65	-0.51
Vodka	3	0.15	0.39	-0.07	0.04	0.32
Non-family	86	0.19	0.23	0.10	0.22	0.21
$\mu \pm$ s.e.	228	6.75 ± 0.09	6.62 ± 0.13	6.84 ± 0.12	6.94 ± 0.12	6.59 ± 0.11

The effects of the Likuyushta, Ohota, Liniya and Slavyanka families were positive as the representatives of the last two families exceeded all the others in gaits and walk. The horses of the Malta family were the best in trot. The constants of the other families were close to the average. The representatives of the Kiliya and Nerazdelna had a slight negative effect for the gallop and correctness, Longuza – for trot and correctness, Leila – for gaits trot and gallop, Genoveva – for gaits, trot and correctness, and Vodka – for trot. Horses from the non-family group had positive and close to average constants. However, the representatives of the families received the best BLUE estimations surpassed the horses from the non-family group on the studied traits.

Results from our studies showed that the horses belonging to the Krustanka, Liniya, Slavyanka and Ohota families possessed the best genetic potential regarding the gaits in the aggregate and correctness. Liniya, Slavyanka, Ohota and Malta families were the best for all studied traits.

Data in table 5 showed differentiation by linear belonging of the broodmares. Horses from Tihany lines and origins from Devis Own, Ramzes and Tempelhuter were distinguished with positive constants regarding all studied traits, as the representatives from the last one surpassed the others by total and gallop score. Line representatives of Vustershire and progeny of Kaius, Grapholog, Dracedion, Giacint and Derslav got negative constants for all traits, except for the correctness in horses with origin from Caius and for walk in those with origin from Dracedion. Their constants were close to the average mean. The following representatives were distinguished with negative effect from the rest genealogical structures: Zenger for correctness and trot; Edelknabe – total score, trot and correctness; Nem Igas – correctness; Markar – walk; Yerot – correctness; Galego – walk; Dampfross – trot, gallop and correctness, Adeptus XX – walk; Alme Z – walk and trot; Cor de la Bryere – walk; Ladykiller – walk and Gagne

Table 5. Effects of linear belonging of mothers

Line	n	Total score	Walk	Trot	Gallop	Correctness
		BLUE-constant	BLUE-constant	BLUE-constant	BLUE-constant	BLUE-constant
Tihany	16	0.16	0.14	0.07	0.13	0.15
Zenger	15	0.03	0.21	-0.07	0.08	-0.08
Vustershir	38	-0.12	-0.25	-0.08	-0.05	-0.10
Edelknabe	3	-0.01	0.18	-0.19	0.09	-0.10
With origin from						
Nem Igas	2	0.11	0.33	0.07	0.24	-0.20
Makar	6	0.10	-0.23	0.24	0.28	0.12
Caius	9	-0.20	-0.25	-0.36	-0.20	0.01
Grapholog	5	-0.25	-0.38	-0.10	-0.47	-0.07
Synop	3	-0.02	0.02	0.40	0.25	-0.75
Dracedion	4	-0.10	0.08	-0.15	-0.07	-0.26
Gyacinth	6	-0.34	-0.39	-0.40	-0.20	-0.39
Derslav	2	-0.28	-0.34	-0.11	-0.38	-0.29
Yerot	2	0.16	0.99	0.18	0.23	-0.73
Galego	7	0.04	-0.32	0.26	0.11	0.11
With origin from						
Devis Own	26	0.28	0.16	0.24	0.31	0.41
Dampfross	15	0.26	0.03	-0.29	-0.12	-0.01
Adeptus XX	24	0.01	-0.02	0.02	0.05	0.11
Ramzes	4	0.18	0.09	0.35	0.13	0.16
Alme z	3	0.09	-0.20	-0.19	0.13	0.60
Cor de la Bryere	5	0.14	-0.09	0.26	0.24	0.18
Ladykiller	5	0.08	-0.30	0.41	0.13	0.08
Gagne Si Pen	7	0.05	0.17	0.15	-0.21	0.08
Tempelhuter	2	0.44	0.26	0.08	0.55	0.17
other	15	0.07	-0.26	-0.03	-0.04	0.09
$\mu \pm$ s.e.		6.75 ± 0.09	6.62 ± 0.13	6.84 ± 0.12	6.94 ± 0.12	6.59 ± 0.11

Si Pen – gallop. Despite the negative sign, all constants are close to the average mean, except for the correctness in descendants of Yerot. Representatives with origin from Yerot, Alme Z and Ladykiller surpassed all the others respectively, by walk, correctness and trot scores. Horses from the rest of the mothers' origins had positive and close to average constants by gaits in aggregate and correctness.

Conclusions

There were statistically proven sources of a specific variance as the family belonging of horses for gaits, walk, gallop and correctness, and the mother's line for correctness and gallop. Years of birth had generated variation upon all of the studied traits, and the month of birth – on trot scores. Differences due to gender differen-

tiation were in favor of males. The best genetic potential was possessed by the horses belonging to the families of Liniya, Slavyanka, Ohota and Malta and the mares' offspring originating from the lines of Tihany, Devis Own, Ramzes and Tempelhuter.

The rate of additive variance was from a low to moderate for gaits in the aggregate walk, trot, and free gallop and high for correctness. There was an higher heritability value's increasing the volume of progeny groups, except for the gallop. Favorable from the breeding point of view were the established correlations between correctness and trot and between correctness and gallop.

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