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DISPERSION PARAMETERS FOR LITTER SIZE AND TEAT NUMBER IN KRŠKOPOLJE PIG

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ABSTRACT

The aim of study was to estimate dispersion parameters for litter size and teat number in Krškopolje pig, the only Slovenian indigenous breed. Analysis included 1950 records for litter size and 7431 for teat number. The model for teat number included season as fixed effects, while common herd environment, common litter environment and direct additive genetic effect were treated as random. Fixed part of the model for litter size also included parity class and age at farrowing within parity class using quadratic regression. Random part also included service sire and permanent environment effect. Phenotypic standard deviation was 3.06 for liveborn piglets and 1.22 for teat number. Heritability for liveborn piglets was 8%. Service sire explained 3% of phenotypic variance. The largest variance component was permanent environment effect (10%), common herd environment ratio was 2%. Obtained heritability for teat number was 13%. Common litter environment explained 14% and common herd environment 19% of variability for teat number.

Key words: dispersion parameters / litter size / teat number / Krškopolje pig

1 INTRODUCTION

Krškopolje pig (KP) is the only Slovenian indigenous pig breed (ULRS, 2004). Under extensive management is adapted to poor rearing and feeding conditions (Šalehar, 1994). KP has a good meat quality (Čandek-Potokar *et al.*, 2003), good technological and nutritional fat quality (Žemva *et al.*, 2010), good maternal ability, and moderate fertility (Malovrh *et al.*, 2012). First breed description was published at the end of 19th century. Rohrman (1899) among other traits mentioned also number of teats (10–12) and litter size (10–12 piglets per litter). The breed was neglected from 1971 onwards (Šalehar, 1991) and was almost extinct in 1990 when breed reconstruction began. After the year 2003, the interest on rearing the KP has increased due to subsidies for indigenous breeds.

Litter size is an important reproduction trait in pigs and is often included in breeding programme of maternal breeds (MB). In modern breeds, heritabilities for litter size have been estimated around 10%, while proportion of permanent environmental effect has been 8% as summarized by Peškovičová *et al.* (2002). Fernandez *et al.* (2008) compared dispersion parameters in repeatability, multivariate and random regression models in Iberian pig. Estimated heritability and permanent environment effect with repeatability model were 7%. Based on genetic correlations between parities, multivariate analysis was recommended when large set of reproductive data over a wide range of parities was available. Heritability with repeatability model in Black Slavonian pig were 8% (Luković *et al.*, 2012), while contribution of permanent environment effect was close to zero.

With an increased litter size, the teat number (NT) becomes more important to achieve uniform piglet growth and weight at weaning. Heritability for NT varied from 7% to 59% as summarized by McKay and Rahnefeld (1990) and Malovrh and Kovač (2010). Generally, studies indicate NT to be moderately heritable (approximately 30%). In Iberian pig, estimated ratios were reported be-

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tween 30% and 75% depending on population considered (Toro *et al.*, 1986). The aim of study was to estimate dispersion parameters for litter size and NT in KP.

2 MATERIAL AND METHODS

The data of KP was provided by the central database of Slovenian Pig breeding organization. Litter size data was collected between June 1992 and May 2013. The average size of 1950 litters was 9.62 liveborn piglets per litter (NBA, Table 1) born to 507 dams and 123 sires in 88 herds. The extensive rearing caused gilts to be older at fist farrowing. Thus, a gilt gives the first litter at the average age of 14 months, while gilts on some farms were younger (close to 10 months) or older (20 months). On the average, there were 22 litter records per herd with half of the farms collecting less than 10 records and the largest farm contributing almost one third of the dataset. Due to small herds and natural mating, number of litters per sire was also small (10). There were 3.8 litters per sow in the dataset.

Teat number (TN) was recorded on 3704 male and 3727 female piglets at tagging since September 2007 (Table 1). The number of piglets tagged was 7.8 per litter. TN was assessed in 950 litters on 76 farms. Nearly 100 piglets were recorded for TN within a herd. One herd collected almost 20% of the data. On the other hand, most herds were small and 45% of them contributed less than 30 TN records during the whole period. TN in the data varied from 6 to 19 with a mean of 14.3 TN.

Pedigree contained 645 animals for NBA and 7944 piglets for TN. Only 7.75% of animals for NBA and 0.48% for TN were assigned to the base population.

Dispersion parameters for NBA and TN were estimated in two single trait analyses. The model for TN (y_{ijkl}, eq. 1) included season at birth (S_i), common herd environment (h_j), common litter environment (c_{ijk}), and direct additive genetic effect (a_{ijkl}). Sex of a piglet was excluded based on preliminary results. Common litter environment describes environment shared by piglets born in the same litter from birth to weaning or even later, if pigs from the same litter are kept together for a longer period.

$$y_{ijkl} = \mu + S_i + h_j + c_{ijk} + a_{ijkl} + e_{ijkl} \qquad \text{[eq. 1]}$$

Fixed part of the model for NBA ($y_{ijklmno}$, eq 2) included season at farrowing (S_i), parity class (P_j), and age at farrowing ($x_{ijklmno}$) as independent variable nested within parity class. Parity class had three levels: 1 for gilts, 2 for primiparous and 3 for multiparous sows. Common herd environment (h_k), service sire (s_l), common litter environment (c_m), permanent environment (p_{kmn}), and direct additive genetic effect (a_{kmn}) were treated as random. Permanent environment is mainly caused by gilt rearing conditions and their influence on lifetime fertility. During preliminary analyses more models were tested, but other effects like previous lactation length and weaning to conception interval were not significant most probably due to extensive management.

$$\begin{aligned} y_{ijklmno} = {} & \mu + S_i + P_j + b_{Ij}(x_{ijklmno} - \bar{x}) + \\ & + b_{IIj}(x_{ijklmno} - \bar{x})^2 + h_k + s_l + \\ & + c_m + p_{kmn} + a_{kmn} + e_{ijklmno} \end{aligned} \qquad \text{[eq. 2]}$$

Fixed part of model was developed by SAS/STAT statistical package (SAS Institute Inc., 2008). Covariance

Table 1: *Descriptive statistics and data structure*

	Litter size data				Teat number data			
	N	Mean	Min	Max	N	Mean	Min	Max
Teat number					7431	14.3	6	19
Litter size	1950	9.62	0	20				
Age at farrowing (d)								
1st parity	434	427.3	299	600				
2nd parity	365	652.3	491	1123				
later parities	1151	1266.0	649	3079				
No. records per								
herd	88	22.2	1	642	76	97.8	3	1477
service sire	123	10.2	1	99				
sow	507	3.8	1	16				
common litter	307	6.4	1	39	950	7.8	1	23

Table 2: *Dispersion parameters with standard errors for liveborn piglets (NBA) and teat number (TN)*

	Variance		Ratio	
	NBA	TN	NBA	TN
Phenotype	9.34	1.50		
Additive genetic effect	0.76 ± 0.43	0.18 ± 0.04	0.08 ± 0.04	0.13 ± 0.02
Service sire	0.28 ± 0.13		0.03 ± 0.01	
Permanent environment	0.91 ± 0.34		0.10 ± 0.04	
Common litter environment	(0.00)	0.19 ± 0.02		0.14 ± 0.01
Common herd environment	0.21 ± 0.20	0.27 ± 0.06	0.02 ± 0.02	0.19 ± 0.04
Residual	7.14 ± 0.26	0.75 ± 0.01	0.76 ± 0.03	0.54 ± 0.03

components were estimated by the residual likelihood method (REML) as implemented in the package VCE-6 (Groeneveld *et al.*, 2010).

3 RESULTS AND DISCUSION

Phenotypic standard deviation was 3.06 NBA (Table 2), which is slightly higher than in Slovenian population of MB (2.62 NBA; Malovrh and Kovač, 2012). The higher variability was expected already from distribution of NBA. Luković *et al.* (2012) reported smaller litter size (6 to 8 NBA) as well as smaller standard deviation (1.58 NBA) in Black Slavonian pigs. Moreover, genetic standard deviation was 0.87 NBA. Heritability was thus estimated to 8% and was very close to the estimate in MB (Malovrh and Kovač, 2012) as well as results in Iberian (Fernandez *et al.*, 2008) and Black Slavonian pigs (Luković *et al.*, 2012). This means that NBA can be improved by selection. Nevertheless, because of small population size, intensity of selection is rather low.

Variance for permanent environment effect was slightly higher than genetic components (Table 2). Standard deviation for permanent environment (0.95 NBA) is larger than in MB (0.66 NBA, Malovrh and Kovač, 2012) and explaining 10% of total variability. Estimates in other indigenous breeds reported by Fernandez *et al.* (2008) and Luković *et al.* (2012) were lower. The results are not surprising because KP gilts are sold to a new location early in life when they weigh only 20 to 40 kg. Herds are small and rearing conditions are more variable than in modern breeds including various indoor and outdoor systems under enriched as well as barren environment. Variance for common litter environment was close to zero, while its variance in MB was substantial (0.12 NBA, Malovrh and Kovač, 2012). A smaller proportion of variability is explained by common herd environment (2 %, Table 2). In MB (Malovrh and Kovač, 2012), herds were larger and were considered as interaction with year clarifying 4.8 %. Standard deviation was 0.46 NBA in KP to 0.57 NBA in MB. This means that variations in herd practice alone can bring a substantial difference among herds, up to 3 NBA per litter.

Variation caused by service sire is even slightly higher (3%, Table 2). The effect covers some genetic components bounded with semen quality and embrio survival, as well as some environmental effect because the same boar was used for oestrus stimulation. Additionally, there can be some confounding effects common to all litters within the period when only one boar was used. Maximum number of records per service sire was high (99, Table 1), although 10% of boars were used for one mating only.Phenotypic standard deviation was 1.22 teats in KP (Table 2), which is more than 0.97 teats in MB (Malovrh and Kovač, 2010). Heritability estimate for TN was unexpectedly low (0.13) which is much lower as in MB (Malovrh and Kovač, 2010) where genetic component explained 33% of total variation. It was higher also in Iberian pigs (Toro *et al.*, 1986). The highest variance proportion (0.27, Table 2) for TN was caused by common herd environment. That was almost one fifth of phenotypic variance. Common litter environment explained 14% of phenotypic variance. Litter variance as well as its ratio was twice higher than in MB (Malovrh and Kovač, 2010).

4 CONCLUSION

Heritability estimates were 8% for NBA and 13% for TB. Permanent environment explained 10% of phenotypic variance for NBA, while ratio for common herd environment was 2% and for service sire 3%. For TN contribution to the total variance was 14% for common litter environment and 19% for common herd environment. Further studies are needed to analyse non-additive genetic effect. Additional attention must be also given to data quality, especially to the verification of pedigree and reliability of reproduction data.

5 REFERENCES

Čandek-Potokar M., Žlender B., Kramar Z., Šegula B., Fazarinic G., Uršič M. 2003. Evaluation of Slovene local pig breed Krškopolje for carcass and meat quality. Czech Journal of Animal Science, 3: 120–128

Fernandez A., Rodriganez J., Zuzuarregui J., Rodriguez M.C., Silio L. 2008. Genetic parameters for litter size and weight at different parities in Iberian pigs. Spanish Journal of Agricultural Research, 6: 98–106

Groeneveld E., Kovač M., Mielenz N. 2010. VCE6 User's Guide and Reference Manual. Mariensee, Institute of Farm Animal Genetics, FLI: 125 pp.

Luković Z., Karolyi D., Klišanić V., Mahnet Z., Gantner V., Škorput D. 2012. Genetic parameters and trends for litter size in Black Slavonian pigs. 7th International Symposium on the Mediterranean Pig, Cordoba, Spain. In: Options Méditerranéennes, Series A 101, De Pedro E. J., Cabezas A. B. (ed.). Zaragoza: CIHEAM: 71–73

Malovrh Š., Kastelic A., Pavlin S., Kovač M. 2012. Slovenske lokalne pasme prašičev – stanje v letu 2012 (Slovenian local pig breeds – situation in year 2012) http://www.genska-banka.si/fileadmin/uploads/Porocilo_GB/Lokalne_pasme_-porocila_2012/Porocila_prasici_2012.pdf (18.4.2013) [in Slovenian]

Malovrh Š., Kovač M. 2012. Vključitev maternalnega genetskega vpliva pri velikosti gnezda. (Estimation of maternal genetic effect for litter size.) In: Spremljanje proizvodnosti prašičev, VIII. del. Kovač M., Malovrh Š. (ed.). Domžale, Univerza v Ljubljani, Biotehniška fakulteta, Enota za prašičerejo: 5–16 [in Slovenian]

Malovrh Š., Kovač M., 2010. Ocena genetskih parametrov za število seskov pri prašičih. (Estimation of genetic parameters for teat number in pigs). 19th International Scientific Symposium on Nutrition of Farm Animals "Zadravec-Erjavec days", Radenci, Slovenia. In: Zbornik predavanj, Čeh T. (ed.). Murska Sobota, Kmetijsko gozdarska zbornica Slovenije, Kmetijsko gozdarski zavod: 115–122 [in Slovenian]

McKay R.M., Rahnefeld, G.W. 1990. Heritability of teat number in swine. Canadian Journal of Animal Science, 70: 425–430

Peškovičová D., Wolf J., Groeneveld E., Wolfová M. 2002. Simultaneous estimation of the covariance structure of traits from field test, station test and litter recording in pigs. Livestock Production Science, 77: 155–165

Rohrman V. 1899. Prašičje pleme na Dolenjskem. (Pig stock in the Lower Carniola Region) Kmetovalec, 16: 9–11 [in Slovenian]

SAS Institute Inc. 2008. SAS/STAT® 9.2User's Guide. Cary, NC

Šalehar A. 1991. Ostanki krškopoljskega prašiča. (The remains of Krškopolje pig.) Sodobno kmetijstvo, 24: 234 [in Slovenian]

Šalehar A. 1994. The Krškopolje pig. Pig News Information, 15: 59–61

Žemva M., Malovrh Š., Levart A., Kovač M. 2010 Fatty acid composition of meat and adipose tissue from Krškopolje pigs and commercial fatteners in Slovenia. Archiv Für Tierzucht, 53, 1: 73–84

Toro M.A., Dobao M.T., Rodrigáñes J., Silio L. 1986. Heritability of a canalized trait: teat number in Iberian pigs. Genetics Selection Evolution, 18: 173–184

ULRS 2004. Seznam avtohtonih in tradicionalnih pasem domačih živali. (List of indigenous and traditional breeds of domestic animal.) Ur.l. RS št. 77/2004: 9309 [in Slovenian]