

INFLUENCE OF GENOTYPE ON PRODUCTION AND QUALITY OF BOAR SEMEN*Kamanová V., Hadaš Z., Nevrkla P.**Mendel University in Brno, Department of Animal Breeding, Czech Republic***Abstract**

The aim of this study was to compare the production and quality of sperm boar between purebreds and hybrid (paternal) lines. The research material consisted of 265 boars present at the insemination station. In monitoring were included boars of three breeds (Large White Czech, Czech Landrace, Duroc) and two paternal lines (Line 38 and Line 48). Analyzed parameters were semen volume, concentration of spermatozoa, progressive motion of spermatozoa and abnormal spermatozoa. In this paper it was confirmed that there are inter-breed and inter-line differences in the quantity and quality of boar semen, but none of the breeds and lines achieved unique exceptional results in all indicators. The average value of semen volume of boars oscillated within the range from 220.91 (Duroc) to 333.03 ml (Czech Landrace), concentration of spermatozoa was from 330.27 (Czech Landrace) to 471.74 thousand spermatozoa per mm^3 (Duroc), progressive motion of spermatozoa was from 71.20 (Duroc) to 74.62 % (Line 48) and percentage of abnormal spermatozoa was from 5.56 (Czech Large White) to 9.04 % (Duroc). All of the above parameters are only partial indicators. For assessment of quality of semen from a comprehensive point of view, auxiliary data was calculated for individual breeds and lines, namely total number of spermatozoa and corrected number of spermatozoa in the ejaculate. The total number of spermatozoa oscillated within the range from 91.34 (Czech Large White) to 109.99 billion (Czech Landrace) and corrected number of spermatozoa was from 64.27 (Czech Large White) to 75.84 billion (Line 48).

Key Words: boar, genotype, semen production, semen quality

The level of profitability of insemination stations is mainly given by the characteristics of semen and the number of produced insemination doses (Ciereszko et al. 2000). The insemination stations usually have boars of various breed and hybrid groups. There is, however, a presumption that heterosis is manifested in an increased reproductive efficiency of crossbred animals as a result of a faster development, a lower age at puberty, a greater testicular weight and a higher seminal quality in comparison to purebreds (Flowers 2008; Louda et al., 2001). Some authors state that although heterosis for semen traits is high, not all crossings results in increased semen quality (Wolf and Smital, 2009). The aim of the paper was to prove the difference between production and semen quality among individual genotypes for the purpose of optimisation of the number of boars in such a way that it is possible to evenly cover the demand for insemination doses.

Material and Methods

The material analysed consisted of 14,098 samples of semen obtained during the period from January 2011 to December 2015. The samples of semen originated from 265 boars of these breeds and lines:

Czech Large White (CLW), Czech Landrace (CL), Duroc (D), Line 38: Duroc \times Pietrain and Line 48: Czech White Paternal Line \times Pietrain. All boars were at the insemination station under the same conditions of animal housing, treatment, feeding, ejaculate sampling and ejaculate assessment.

After collection and filtration of semen were determined and subsequently evaluated the following parameters: semen volume (ml), concentration of spermatozoa (in thousands per mm^3), progressive motion of spermatozoa (%) and abnormal spermatozoa (%). The semen volume was ascertained there with the help of a volumetric cylinder. The concentration of spermatozoa was ascertained in a photometric way, by using Spekol 11 apparatus. Progressive motion of spermatozoa was ascertained under the microscope by way of a subjective estimation of percentage representation of sperms with a forward straight-line motion within 15 minutes after the sampling of the semen. The percentage of abnormal spermatozoa was ascertained on the prepared sperm count in several view fields.

The data was processed in Microsoft Excel 2016 and subsequently statistically evaluated by using the STATISTICA program, version 12.0. Statistical significance was determined by analysis of variance

ANOVA - HSD test for different N (N = number of subjects in groups) at significance level $P < 0.05$.

To compare the semen quality of individual breeds and lines, the total number of spermatozoa per ejaculate (NO_T , in billions) was ascertained, together with the corrected number of spermatozoa per ejaculate (NO_C , in billions) (Smital et al., 2004):

$$NO_T = \frac{VO \times CO}{1000}$$

$$NO_C = NO_T \times \frac{MO}{100} \times \left(1 - \frac{AB}{100}\right)$$

where VO is the semen volume (ml), CO is the concentration of spermatozoa (thousand. mm^{-3}), MO is the progressive motion of spermatozoa (%) and AB is the percentage of abnormal spermatozoa (%).

Results and Discussion

Average values and standard deviations of semen volume, concentration of spermatozoa, progressive motion of spermatozoa and abnormal spermatozoa for individual genotypes are provided for in Table 1. The highest average semen volume was ascertained at the Czech Landrace breed, namely $333.03 \text{ ml} \pm 146.58 \text{ ml}$, which partially corresponds to conclusions of Smital (2002) and Pinart and Piugmulé (2013), who state that the breeds excelling in this parameter are Czech Landrace together with Czech Large White. In this study it has been found out that the volume achieved for the Czech Large White boars was some lower than the volume achieved for the Czech Landrace boars ($P < 0.05$). A volume lower by 26.98 ml was achieved at the Line 38 boars, namely $306.05 \pm 117.51 \text{ ml}$ ($P < 0.05$). The semen volume acquired from boars of the Czech Large White breed was on average $257.87 \pm 108.20 \text{ ml}$, which represented reduction by 48.18 ml compared to Line 38 ($P < 0.05$). In comparison to Czech Large White, the volume ascertained at Line 48 was some 9.75 ml lower ($248.12 \pm 90.37 \text{ ml}$). The difference in the values of the volume between Czech Large White and Line 48 was, however, not statistically proven ($P > 0.05$). The lowest semen volume was obtained from the Duroc breed boars, with an average value of $220.91 \pm 88.89 \text{ ml}$, which is a volume 27.21 ml lower in comparison to Line 48 ($P < 0.05$). The lowest semen volume was acquired from the Duroc breed boars, which is in conformity with conclusions of Pinart and Piugmulé (2013). Wysokińska and Kondracki (2013) state that Line 38 achieves a volume higher than the Duroc breed, which has been confirmed in the present study. The largest values of concentration of spermatozoa were achieved for the

Duroc breed, namely 471.74 ± 187.01 thousand per mm^3 . Kliment (1986) states that Duroc and its crossbreeds feature a higher concentration of spermatozoa in comparison to the other breeds. In this study it is possible to agree only with the statement that Duroc exceeds the other breeds and crossbreeds. Semen of the Line 48 boars contained a lower amount (by 33.06 thousand per mm^3), compared to the Duroc breed, namely 438.68 ± 157.34 thousand per mm^3 . For other breeds, the concentration of spermatozoa oscillated below the value of 400 thousand per mm^3 . Particularly for the Czech Large White breed, the average concentration was 355.29 ± 157.82 thousand per mm^3 , compared to the previous line (Line 48) this is some 108.41 thousand per mm^3 less ($P < 0.05$). Lower values of concentration at Czech Large White in comparison to the Line 48 are confirmed also by Ciereszko et al. (2000). Compared to the Czech Large White breed concentration, the value achieved at Line 38 was lower by 2.63 thousand per mm^3 , namely 352.66 ± 151.70 thousand per mm^3 ($P > 0.05$). The Line 38 boars (Duroc \times Pietrain) achieved lower concentration than Duroc, which corresponds to the conclusions of Wysokińska and Kondracki (2013). The lowest concentration of spermatozoa was contained in the semen of boars of the Czech Landrace breed (330.27 ± 146.52 thousand per mm^3). The difference in the concentration of spermatozoa (22.39 thousand per mm^3) between Czech Landrace and Line 38 was not statistically proven ($P > 0.05$).

The highest motility was ascertained at Line 48 ($74.62 \pm 5.94 \%$), the motility lower by 0.11 % was achieved at Czech Large White breed, namely $74.51 \pm 5.40\%$ ($P > 0.05$). For the Line 38 boars the average motility ascertained was $73.90 \pm 4.94 \%$, which is a value 0.61 % lower in comparison to Czech Large White ($P > 0.05$). Semen of the Czech Landrace boars contained $73.72 \pm 7.80 \%$ of spermatozoa with a progressive motility. The difference between Line 38 and Czech Landrace breed was statistically non-provable and amounted to 0.18 % ($P > 0.05$). The lowest representation of spermatozoa with a progressive motility was ascertained at the Duroc breed boars ($71.20 \pm 7.88 \%$) ($P < 0.05$). These results are different from the study by Smital (2002), who states that lower percentages of spermatozoa with a progressive motility are contained in the semen of boars of the Czech Landrace and Czech Large White breeds. Wysokińska and Kondracki (2013) did not register any difference between motilities of the Duroc and Line 38 boar breeds, unlike the present study where the motility values between Duroc and Line 38 differed statistically in a highly provable way. The highest percentage of abnormal spermatozoa was ascertained at the Duroc breed ($9.04 \pm 7.55 \%$). Semen of the Czech Landrace breed boars contained $7.60 \pm 6.92 \%$ of abnormal spermatozoa, i.e. some 1.44 %

less than it was the case for the Duroc breed ($P < 0.05$). The high percentage of abnormal spermatozoa in the semen of boars of Czech Landrace breed Czech Landrace found his work also Smital (2002). In comparison with Czech Landrace, the Line 38 boars had some 0.40 % of abnormal spermatozoa less, i.e. 7.20 ± 5.62 % ($P > 0.05$). Semen of the Line 48 boars contained 6.63 ± 5.35 % of abnormal spermatozoa, which is some 0.57 % less compared to Line 38 ($P > 0.05$). The lowest representation of abnormal spermatozoa was identified at boars of the Czech Large White breed, namely 5.56 ± 4.97 %, which does not correspond with the conclusions of Smital (2002). The difference in the percentage of abnormal spermatozoa between Czech Large White and Line 48 was 1.07 % ($P > 0.05$).

In Figure 1 it is possible to see the total and corrected number of spermatozoa. As far as the total number of spermatozoa is concerned, the highest value was achieved by the Czech Landrace breed (109.99 billion of spermatozoa), for Line 48 the number

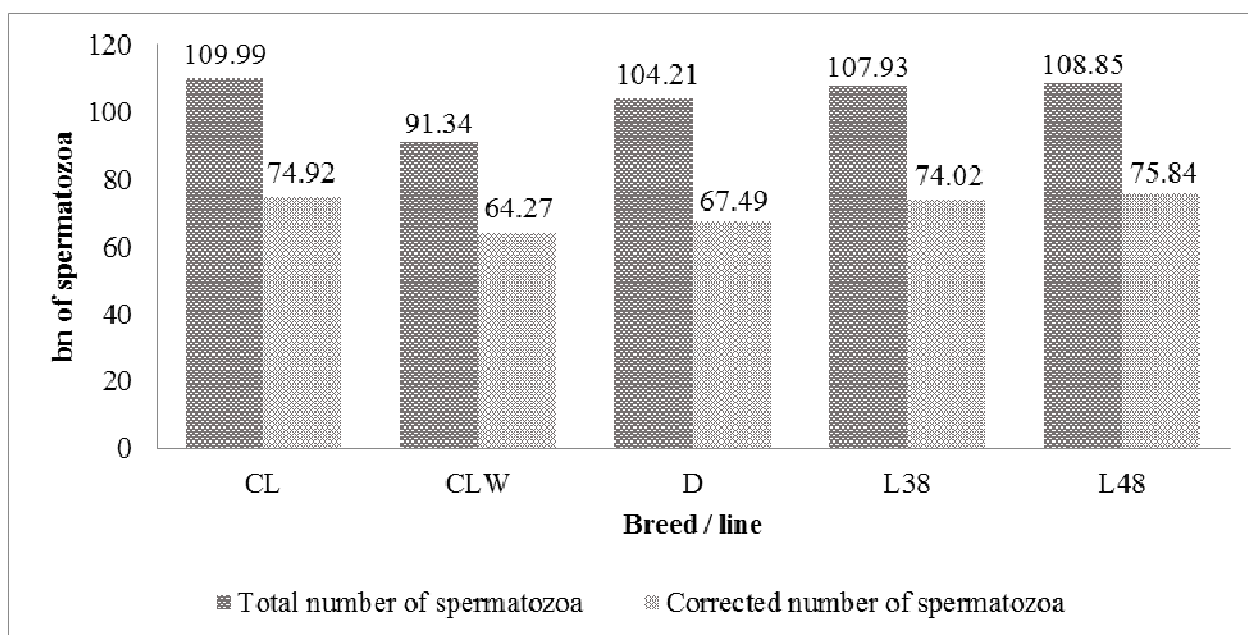
ascertained was 108.85 billion, for Line 38 it was 107.93 billion, for Duroc it was 104.21 billion and the number ascertained for Czech Large White was 91.34 billion. In the case of the corrected number of spermatozoa, however, the order was changed. The highest content was ascertained for Line 48, namely 75.84 billion, the corrected number of sperms for Czech Landrace was 74.92 billion, for Line 38 it was 74.02 billion, at Duroc 67.49 billion and for Czech Large White this number was 64.27 billion. According to Smital (2001), the last place in the number of sperms belongs to boars of the Duroc breed. In the case of the present study it was found out that in comparison to Duroc, the Czech Large White breed features a lower number of sperms, which is confirmed also by Knecht et al. (2014). Wysokińska and Kondracki (2013) state that the total number of sperms of the Line 38 boars is higher than the one of the Duroc boars, which is in conformity with the results of this paper.

Table 1. Basic statistical characteristics of sperm parameters (mean \pm SD)

	N of samples	VO	CO	MO	AB
		ml	$\times 10^3/\text{mm}^3$	%	%
CL	2097	$333.03 \pm 146.58^{\text{abcd}}$	$330.27 \pm 146.52^{\text{abc}}$	$73.72 \pm 7.80^{\text{a}}$	$7.60 \pm 6.92^{\text{ab}}$
CLW	821	$257.87 \pm 108.20^{\text{aef}}$	$355.29 \pm 157.82^{\text{ade}}$	$74.51 \pm 5.40^{\text{b}}$	$5.56 \pm 4.97^{\text{acd}}$
D	9791	$220.91 \pm 88.89^{\text{begh}}$	$471.74 \pm 187.01^{\text{bdfg}}$	$71.20 \pm 7.88^{\text{abcd}}$	$9.04 \pm 7.55^{\text{bcef}}$
L38	736	$306.05 \pm 117.51^{\text{cfgi}}$	$352.66 \pm 151.70^{\text{fh}}$	$73.90 \pm 4.94^{\text{c}}$	$7.20 \pm 5.62^{\text{de}}$
L48	653	$248.12 \pm 90.37^{\text{dhi}}$	$438.68 \pm 157.34^{\text{cegh}}$	$74.62 \pm 5.94^{\text{d}}$	$6.63 \pm 5.35^{\text{f}}$

a, b, c, d, e, f, g, h, i – between the values marked with the same letters is statistically significant difference ($P < 0,05$)
SD – significant difference

Figure 1. Total and corrected number of spermatozoa per ejaculate by the different breeds and lines



Conclusion

In this study it was confirmed that there are differences between breeds and lines in terms of quantity and quality of boar semen, but there was not any genotype which would be excellent in all indicators in an unambiguous way. Furthermore, it was not confirmed that the hybrid boars achieve better sperm parameters. Also from the results of the total and corrected number of spermatozoa it is obvious that from each breed and line it is possible to expect a different number of spermatozoa in the ejaculate, and this is associated also with the different quantity of the insemination doses produced. This factor should be taken into consideration during organisation of breeding activities, e.g. during inclusion of new boars and rejection of older boars. This can help to maintain the continuity of production of insemination doses.

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