COMPARISON OF DIFFERENCES IN BOAR SPERM OUTPUT BETWEEN PERIODS 1990-97 AND 2000-07

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Boars in an artificial insemination centre must produce semen that will sire pigs that the ultimate consumer will buy (Robinson and Buhr, 2005). The research in the area is crucial for pig breeders because the importance of a boar for the reproductive performance of the herd is high, particularly if the boar is mated to many females (Rutten et al., 2000; Oh et al., 2003). A number of experiments demonstrate that boars differ in fertility traits due to environmental effects and due to their inherent variation (Dziuk, 1996; Rothschild, 1996; Jankeviciute and Zilinskas, 2002). Therefore, a lot of current experimental studies research the reproductive fitness of boars from the standpoint of several criterions (Kunc et al., 2000; Corcuera et al., 2000; Gadea et al., 2001; Serniene and Zilinskas, 2001; Leiding, 2002). The objective of this study was to compare the differences in boar sperm output between periods 1990-1997 and 2000-2007 using a large data set from insemination centers.

Material and methods

Data from insemination stations for boars in the Czech Republic were analyzed. Data set 1 consisted of records of semen collections from boars obtained during the period from 1990 to 1997. The boars belonged to the following breeds: Czech Large White (LW_{CZ}; 591♂), Czech Landrace (L_{CZ}; 659♂), Czech Meat Pig (CM; 828♂), Duroc (D; 255♂), Hampshire (H; 242♂), Pietrain (P; 71♂) and Large White (LW; 52♂), in addition to, the following crossbred combinations: CM×P (93♂), D×H (67♂), D×P (61♂) and H×P (162♂). Data set 2 consisted of records of semen collections from boars obtained during the period from 2000 to 2007. The boars belonged to the following breeds: LW_{CZ} (389♂), L_{CZ} (477♂), CM (89♂), D (105♂), H (22♂), P (115♂), LW (462♂) and to the following crossbred combinations: CM×P (23♂), D×H (88♂), D×P (206♂) and H×P (315♂).

Four basic semen traits were examined: semen volume in ml (VO, i.e. volume of sperm rich fraction measured by graduated cylinder), concentration of spermatozoa in 10^3/ mm^3 (CO, measured by photocolorimetry), progressive motion of spermatozoa in per cent (MO, i.e. proportion of sperm cells moving straightforward evaluated microscopically) and proportion of abnormal spermatozoa in per cent (AB, i.e. sperm cells deformed or otherwise changed also evaluated microscopically). The total number of spermatozoa (NO_T, in 10^9) and the corrected number of spermatozoa (NO_C, in 10^9) were calculated as follows:

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

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

The procedure GLM of SAS® was used (SAS Institute Inc., 1989). Data set 1 was analyzed using the following linear model (Smital et al., 2004):

$$ST_{ijkl} = \mu + S_i + B_j + Bo_{(j)k} + \left[\beta_V A_{ijkl} + \chi_V A_{ijkl}^2\right] + \left[\beta_F I_{ijkl} + \chi_F I_{ijkl}^2\right] + \varepsilon_{ijkl}$$

Data set 2 was analyzed using the following linear model (Smital, 2008):

$$ST_{ijklmn} = \mu + B_i + M_j + Y_{(j)k} + I_l + Bo_{(i)m} + \left(\beta A_{ijklmn} + \chi A^2{}_{ijklmn}\right) + \varepsilon_{ijklmn}$$

where: ST is the value of the given semen trait, μ is the overall mean, B is the effect of the breed or crossbred combination, S is the effect of the year-season, M is the effect of the month, Y is the effect of the year, I is the effect of the interval of collections, A is the age of the boar at collection (in days), Bo is the effect of the boar, β and χ are linear and quadratic regression coefficients and ε_{ijklmn} is the residual effect.

The effect of heterosis was estimated in the usual way:

$$HE = \frac{\overline{F_1} - \overline{P}}{\overline{P}} \times 100$$

where: HE is the estimated effect of heterosis in %, $\overline{F_1}$ is the average value of semen characteristics of hybrid progeny and $\overline{P}$ is the mid parent value of semen characteristics $(P_1+P_2)/2$. For testing the statistical significance of the heterosis effects, the heterosis was considered as linear contrast of the effects of the parental breeds and of the appropriate crossbred combination and the procedure GLM of SAS® was used (SAS Institute Inc., 1989).

Results and discussion

All effects included in the linear models (effect of the breed or crossbred combination, effect of the year-season, effect of the month, effect of the year, effect of the interval of collections, effect of the boar's age and effect of the boar) were statistically significant ($P<0.001$). Therefore, the least square means (LSM) values show differences between individual breeds in the observed semen characteristics.

The LSM, standard errors and estimated heterotic effects of the semen volume are summarized in Table 1 for all breeds and crossbred combinations. In the second period higher semen volume was recorded in boars LW_{CZ}, and in most sire breeds, except of boars LW. In contrast, the lower semen volume was observed in most crossbred combinations, except combination D×H. Differences between breeds decreased, respectively from the statistically significant maximal difference 188 ml in the first period to 95 ml in the second period. The statistically significant heterosis in semen volume was between 15 and 31 % for data set 1 and about 12% for data set 2.

In the second period the total number of spermatozoa was higher in all monitored breeds and crossbreeds, except LW (Table 2). The maximal increase was recorded in boars of breeds P namely about 27 milliards of spermatozoa. The statistically significant difference between breeds was 38×10^9 in the first period and 24×10^9 of spermatozoa per ejaculate in the second period. The values of the heterotic effect for the number of total spermatozoa were generally lower in comparison with semen volume. The values were statistically significant being between 9 and 18 % in the first period and statistically insignificant 0.7 and 3 % in the second period.

The results for the corrected number of spermatozoa which include also the quality of sperm are summarized in Table 3. Higher corrected number of spermatozoa was recorded only in boars of breeds LW_{CZ}, CM and P in the second period and also in crossbreeds. Other breeds showed stagnation or decline. Differences between breeds decreased from 26 to 19 milliards of sperm cells in the second period. The heterosis in the corrected number of spermatozoa was 5 to 10 % in the first period and 6 to 8 % in the second period.

In general, the second period 2000 to 2007 showed an increasing trend of sperm quantity. In contrast, the stagnation or decreasing trend of sperm quality was recorded and in crossbreds a lower manifestation of heterosis was also observed.

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