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PRODUCTION AND QUALITY OF SEMEN IN BOARS IN INSEMINATION CENTRE

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Abstract

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The aim of this study was to analyze production and quality of semen in boars in an insemination centre. Experimental material consisted of 8,052 semen samples collected from 146 boars. During the period of 5 years, an analysis of semen parameters was conducted. The obtained data were divided according to age of boars at the time of semen collection. Results showed that boars between 8 months and 3 years of age reached higher levels of semen volume, percentage of abnormal spermatozoa and number of spermatozoa. Older boars had lower sperm concentration levels. The largest total number of spermatozoa and corrected number of spermatozoa were observed in boars between 13 and 36 months of age. Later, the production of spermatozoa decreased. Based on the results of the presented study, the age category of 13–36 months can be recommended to dominate in the herd of boars in the insemination centre.

Keywords: boar, age, semen production, semen quality, insemination centre

INTRODUCTION

The basic reproduction techniques include artificial insemination, which has become an important element in pig breeding. Currently, more than 95% of sows are inseminated artificially in the countries that produce pork. The economy and the profitability of pig breeding in the Czech Republic is based mainly on reducing the costs per kilogram of meat produced and ways to achieve it must be constantly searched for. Level of economy in insemination centres depends primarily on the ability of sires to produce high quality semen in sufficient quantities (Robinson and Buhr, 2005). Semen used for insemination must be high quality, with a high fertilization capacity and a high breeding value. The level of high quality semen production is directly related to production levels of insemination doses, therefore it is important to check the semen parameters constantly (Sancho *et al.*, 2004).

Ability of boars to produce quality semen is limited by many external and internal factors, notably heritability (Oh *et al.*, 2006), size of testicles (Clark *et al.*, 2003), nutrition (Khan *et al.*, 2005), age of boar (Jankevičiūtė and Žilinskas, 2002), sampling frequency (Frangež *et al.*, 2005), photoperiod (Sancho *et al.*, 2004), outdoor temperature and social environment (Kunavongkrit *et al.*, 2005).

With age, certain hormonal and cellular changes appear in boars (Huang *et al.*, 2010). There is an assumption that these changes affect the quality and fertilization ability of semen. The aim of this study was therefore to investigate the development of semen parameters in boars during their performance in insemination.

MATERIAL AND METHODS

The analysis of semen production and quality was conducted in 146 boars with total of 8,052 semen samples collected during the period from January 2011 to December 2015. Quantitative and qualitative parameters of individual semen samples were divided according to age of boars into four categories (8–12 months, 13–24 months, 25–36 months, 37–48 months). The conditions of housing, nursing, feeding, semen collection and its evaluation were equal for all boars in the insemination centre.

The following parameters were assessed and analyzed: semen volume, sperm concentration, motility of spermatozoa, percentage of abnormal spermatozoa, total number of spermatozoa and corrected number of spermatozoa. Semen volume was measured using a tempered graduated cylinder with an accuracy of 1 ml. Motility of spermatozoa was determined microscopically within 15 minutes after collection from gently mixed semen at the magnification of 1:200 in five vision fields. Sperm concentration was assessed by a photometric method using Spekol 11 apparatus and the calibration tables. Evaluation of abnormal spermatozoa was performed microscopically at a magnification of 1500×. Based on the semen volume and the sperm concentration, total number of spermatozoa was calculated. To calculate corrected number of spermatozoa, the semen volume, the sperm concentration, the motility of spermatozoa and the percentage of abnormal spermatozoa were considered.

Data were statistically evaluated using STATISTICA version 12.0. Statistical significance was determined using one-way analysis of variance ANOVA – HSD test for unequal n. All results were expressed as mean ± standard error and were considered significant when $p < 0.05$. Correlation dependence between semen parameters was assessed using Pearson's coefficient, and was also considered conclusive when $p < 0.05$.

RESULT AND DISCUSSION

Tab. I shows the average and standard deviation for each parameter of semen. The table shows that with age, the semen volume had increasing tendency, namely from 198.85 ml (at the age of 8–12 months) to 319.45 ml (at the age of 25–36 months) ($p < 0.05$). Later, the semen volume remained without statistically significant changes until the age of 37–48 months (321.05 ml). These results correspond to the statement of Kennedy and Wilkins (1984), who claim, that the maximum semen volume can be obtained from boars aged 24 to 29 months. Bonet *et al.* (2013) reported that the semen volume in boars increased with age, while the highest semen volumes were collected from boars older than 3.5 years, which does not correspond to the results of this work.

While the semen volume increased with higher age, the opposite trend was found in the parameter of sperm concentration. The highest sperm concentration was achieved in the youngest boars (8–12 months), with the mean value of 442.85×10^3 spermatozoa in 1 mm^3. With increasing age, the concentration decreased. In the category of 13–24 months old boars, the sperm concentration was $407.20 \times 10^3/mm^3$, in the category 25–36 months it was $348.76 \times 10^3/mm^3$ and the category of 37–48 months reached sperm concentration of $327.37 \times 10^3/mm^3$ ($p < 0.05$). Kennedy and Wilkins (1984) reported that, together with the maximum semen volume, also the highest sperm concentration was achieved in age category between 24 and 29 months, which is in contradiction with the results of this work.

In comparison with the previous characteristics, the motility of spermatozoa showed fewer changes with increasing age. There were no statistically significant differences between the categories of 8–12 months (73.29%) and 13–24 months (72.87%). After reaching the age of 24 months there was a statistically significant decrease in the percentage of motile spermatozoa to 72.30% ($p < 0.05$). In the category of 37–48 months, the motility re-increased to 72.62% ($p < 0.05$).

Regarding the percentage of abnormal spermatozoa, the lowest percentage values were found in the semen of boars between 8 and 12 months of age (6.56%). Then there was an increase to the level of 9.27%, achieved in the category of 25–36 months of age ($p < 0.05$). In the category of 37–48 months, the percentage of abnormal spermatozoa dropped to 8.72%, however this decrease was not statistically significant.

Evaluation of the number of spermatozoa showed, that the lowest total and corrected number of spermatozoa were found in the semen of the youngest boar category (8–12 months), with the total number of spermatozoa of 86.16 bn and the corrected number of spermatozoa of 58.27 bn ($p < 0.05$). In the category of 13–24 months, there was a sharp increase in the number of spermatozoa, the total number of spermatozoa was 105.83 bn and the corrected number of spermatozoa 70.14 bn, which is in correspondence with the conclusions of the authors Huang *et al.* (2010) and Youngquist and Threlfall (2007), who reported in their works, that semen of 18-month old boars contained more spermatozoa than in younger boars. At the age of 25–36 months, the total number of spermatozoa and the corrected number of spermatozoa reached similar levels as in the previous categories, exactly 107.42 bn in the case of the total number of spermatozoa and 69.58 bn in the case of corrected number of spermatozoa. These data agree with the results of Kennedy and Wilkins (1984), who found that the maximum number of spermatozoa was measured in boars between 24–29 months of age. After reaching the age of 3 years, the numbers of spermatozoa in ejaculate recorded a decrease to 101.71 bn in the case of total number of spermatozoa and 66.81 bn in the case of corrected number of spermatozoa ($p < 0.05$). Many authors have stated that quality of boar semen increased with age (Bonet *et al.*, 2013; Kumaresan *et al.*, 2011; Tsakmakidis *et al.*, 2012), which is confirmed in this work, but only up to 3 years of age. According to Bonet *et al.* (2013), Zduńczyk *et al.* (2011) and Araujo and Wittert (2011), the production of spermatozoa depends on the testosterone level, which varies during testicular development, puberty and sexual maturity.

I: *Effect of age on semen parameters in boars (mean ± SE)*

Age (mo)	Parameters					
	VO (ml)	CO (× 10^3/mm^3)	MO (%)	AB (%)	NO_T (bn)	NO_C (bn)
8–12	198.85 ± 1.79[a]	442.85 ± 3.14[a]	73.29 ± 0.13[a]	6.56 ± 0.12[a]	86.16 ± 0.68[a]	58.27 ± 0.47[a]
13–24	269.03 ± 1.37[b]	407.20 ± 2.40[b]	72.87 ± 0.10[a]	7.96 ± 0.09[b]	105.83 ± 0.52[b]	70.14 ± 0.36[b]
25–36	319.45 ± 1.84[c]	348.76 ± 3.22[c]	72.30 ± 0.13[b]	9.27 ± 0.13[c]	107.42 ± 0.69[b]	69.58 ± 0.48[b]
37–48	321.05 ± 2.58[c]	327.37 ± 4.52[d]	72.62 ± 0.18[a]	8.72 ± 0.19[c]	101.71 ± 0.97[c]	66.81 ± 0.68[c]

SE = standard error, VO = semen volume, CO = sperm concentration, MO = motility of spermatozoa, AB = percentage of abnormal spermatozoa, NO_T = total number of spermatozoa, NO_C = corrected number of spermatozoa
a, b, c, d – between the values with different superscripts there are statistically significant differences ($p < 0.05$).

Tab. II shows the correlation dependences between the analyzed semen parameters. A moderately strong negative correlation was found between semen volume and sperm concentration in all age categories (–0.48 to –0.55) ($p < 0.05$). Higher correlation coefficients between these parameters were noted in studies conducted by Wolf (2010), Wolf and Smital (2009) and Knecht *et al.* (2013). A moderate positive correlation was observed in the category of 8–12 months between the semen volume and the total number of spermatozoa (0.59) and the semen volume and the corrected number of spermatozoa (0.59) ($p < 0.05$). The correlation dependence between these characters decreased with age. From 25 to 48 months of age, the correlation coefficients between these parameters dropped to the levels of 0.26 to 0.28 ($p < 0.05$). On the contrary, the correlation dependence between the sperm concentration and the total number of spermatozoa, and between the sperm concentration and the corrected number of spermatozoa was weak in boars between 8 and 12 months of age (0.39 in the case of CO/NO_T and 0.35 in the case of CO/NO_C). These results correspond to the statement of Knecht *et al.* (2013). With increasing age, the correlation dependence between these parameters grew and in the category of 37 to 48 months it reached the value of 0.65 for CO/NO_T and 0.63 for CO/NO_C) ($p < 0.05$). High correlation (0.73) between these parameters reported Ren *et al.* (2009). A very weak negative correlation (–0.13 to –0.19) ($p < 0.05$) was found between the motility of spermatozoa and the percentage of abnormal spermatozoa throughout the age categories, which is contrary to the conclusions of the Wolf (2010), who found that the correlation coefficient between these parameters was at level –0.57. A very weak negative correlation was also observed between the percentage of abnormal spermatozoa and the corrected number of spermatozoa (–0.18 to –0.20). A weak correlation was also recorded between the motility of spermatozoa and

II: *Effect of age on Pearson's correlation coefficients between the semen parameters in boars*

Parameters	Age			
	8 – 12	13 – 24	25 – 36	37 – 48
VO/CO	–0.48*	–0.54*	–0.55*	–0.53*
VO/MO	0.00^{NS}	0.06*	0.05*	0.04^{NS}
VO/AB	–0.08*	–0.10*	–0.06*	0.02^{NS}
VO/NO_T	0.59*	0.42*	0.27*	0.28*
VO /NO_C	0.59*	0.44*	0.26*	0.27*
CO/MO	0.00^{NS}	–0.07*	$–0.01^{NS}$	0.04^{NS}
CO/AB	0.16*	0.09*	0.00^{NS}	$–0.06^{NS}$
CO/NO_T	0.39*	0.49*	0.64*	0.65*
CO /NO_C	0.35*	0.43*	0.58*	0.63*
MO/AB	–0.17*	–0.19*	–0.18*	–0.13*
MO/NO_T	0.01^{NS}	$–0.02^{NS}$	0.01^{NS}	0.06*
MO/NO_C	0.23*	0.24*	0.26*	0.26*
AB/NO_T	0.07*	0.04*	$–0.01^{NS}$	$–0.06^{NS}$
AB/NO_C	–0.18*	–0.19*	–0.20*	–0.19*
NO_T/NO_C	0.96*	0.95*	0.94*	0.96*

VO = semen volume, CO = sperm concentration, MO = motility of spermatozoa, AB = percentage of abnormal spermatozoa, NO_T = total number of spermatozoa, NO_C = corrected number of spermatozoa
* – correlations are statistically significant, with ($p < 0.05$), NS = correlations are not statistically significant, with ($p > 0.05$)

the corrected number of spermatozoa (0.23 to 0.26) ($p < 0.05$). The strongest correlations were found between the total number of spermatozoa and the corrected number of spermatozoa (0.94 to 0.96) ($p < 0.05$) in the boars of all age categories. Only very weak to no correlations were found in the other analyzed parameters, which corresponds to the results by Wolf and Smital (2009).

CONCLUSION

The results of this work show, that the parameters of boar semen change with age. There is no ideal age at which all the parameters would reach the ideal level. With age, there is an increasing trend in the semen volume and the total and corrected number of spermatozoa, but also the percentage of abnormal spermatozoa increases. On the contrary, the sperm concentration decreases with age. An important indicator of semen production and quality from a complex perspective is the number of spermatozoa. The maximum values of the corrected and the total number of spermatozoa in ejaculate were achieved in boars between 13 and 36 months of age. After reaching the age of 3 years, the production of spermatozoa started to decrease. The results of this work document that the age category of 13–36 months can be recommended to represent the greatest possible part of the breeding boars herd in the insemination centre.

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