

## THE EFFECT OF SEASON ON SEMEN PARAMETERS IN POLISH LANDRACE AND POLISH LARGE WHITE BOARS AND PHENOTYPIC CORRELATIONS BETWEEN SEMEN CHARACTERISTICS IN DIFFERENT SEASONS

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### Abstract

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The study evaluated ejaculates of Polish Landrace and Polish Large White boars and the effect of the season of the year on the qualitative and quantitative parameters of the semen of these boars. Phenotypic correlations between semen characteristics in different seasons were estimated as well. The analysis included 2028 ejaculates collected manually from 2-year-old boars at intervals of 3-4 days. The following traits were analysed: ejaculate volume (ml), sperm concentration (1000/mm<sup>3</sup>), live sperm count (in billions) and the number of insemination doses obtained per ejaculate. No significant differences between breeds were observed in the semen traits of the Polish Landrace and Polish Large White boars, but the season of the year had a significant impact in both breeds. The greatest volume was noted for the ejaculates collected in the spring in the case of the Polish Large White boars, and in the winter in the Polish Landrace boars. The highest live sperm count was recorded in the ejaculates collected in the autumn and winter. In the summer the ejaculate volume decreased substantially, and with it the sperm count, which adversely affected the number of insemination doses obtained per ejaculate. The phenotypic correlations between sperm traits were not significantly influenced by season, with the exception of ejaculate volume and sperm concentration, which were most strongly correlated in the winter and least in the spring.

*Key words:* boars, ejaculates, seasons, correlations

### Introduction

The breed structure of Polish pedigree breeding is dominated by boars of the breeds Polish Landrace and Polish Large White, which translates to a greater number of insemination procedures performed with semen from these breeds (Mucha and Tyra, 2013).

The results of numerous studies indicate that seasonal changes occur in the qualitative and quantitative parameters of boar semen (Ciereszko et al., 2000; Pokrywka et al., 2001;

Sławeta and Morstin, 1982; Pietruszka et al., 2006; Marchev and Szostak, 2013). The extent of the effect of the season on these parameters varies depending on their breed and the conditions in which they are raised (Okere et al., 2005). Thus the need arises to conduct further research and observations regarding the reaction of breeders of different genotypes in different seasons.

In the present study an attempt was made to evaluate the effect of the season of the year on semen parameters in Polish Landrace and Polish Large White boars and to determine

phenotypic correlations between semen characteristics in different seasons.

## Materials and Methods

The material for the analysis consisted of data pertaining to 2028 ejaculates collected from Polish Landrace and Polish Large White boars. The boars were about 2 years old and were fed individually according to norms. They were kept in closed housing that met the requirements for animal well-being. The ejaculates were collected by the manual method at 3-4-day intervals. The ejaculates were supplied by the Sow Insemination Station in Białka.

The following physical characteristics were evaluated in each ejaculate:

- volume of the ejaculate (ml)
- sperm concentration (1000/mm<sup>3</sup>)
- live sperm count (in billions)
- number of insemination doses obtained per ejaculate

The volume of the ejaculate was determined after filtering out the gel fraction. Sperm concentration in the ejaculate was determined by the colorimetric method. The total number of sperm in the ejaculate exhibiting progressive motion and the number of insemination doses that could be obtained per ejaculate were calculated using SYSTEM SUL software.

The data collected were arranged according to the season when the semen was collected: spring, summer, autumn or winter.

The effect of the breed of boar and the season on the semen characteristics was analysed using two-way ANOVA and Tukey's post hoc test. Correlations between semen char-

acteristics were expressed by Pearson's correlation coefficient.

## Results

Table 1 shows the values for the physical characteristics of the ejaculates from the Polish Landrace boars in each season of the year. Analysis of the data shows pronounced and substantial differences in the main ejaculate parameters between ejaculates collected during different seasons of the year.

Ejaculates collected in the winter had the greatest mean volume – 296.48 ml, which was 56.5 ml more than the ejaculates collected in the summer. The differences in volume between ejaculates collected in the winter and summer were highly significant ( $P < 0.001$ ). Highly significant differences in ejaculate volume were also noted between spring and winter and between autumn and summer ( $P < 0.001$ ). The difference in ejaculate volume between autumn and winter was significant at  $P < 0.05$ .

The highest concentration of live cells was also recorded in the winter as well – 279.69 (1000/mm<sup>3</sup>).

The total sperm count in the ejaculate is of fundamental importance in insemination practice because it determines the number of semen portions that can be prepared from the ejaculate. The table shows that the number of sperm showing progressive motion in the Polish Landrace ejaculates ranged from 49.44 billion in the summer to 67.89 billion in the winter, but the differences were not statistically significant. From 19 to 27 insemination doses were prepared from the ejaculates collected. The fewest were prepared from the ejaculates collected in the spring and summer (19) and the

**Table 1**  
The effect of season on semen parameters in Polish Landrace boars

Traits of semen	Spring (1)		Summer (2)		Autumn (3)		Winter (4)		Significance of differences
	X	SE	X	SE	X	SE	X	SE	
Ejaculate volume, ml	272.55	1.832	239.95	2.964	286.17	6.377	296.48	3.324	1-2***, 3 <sup>n.s.</sup> , 4*** 2-3***, 4*** 3-4*
Concentration of spermatozoa, 1,000/mm <sup>3</sup>	256.79	1.698	255.29	2.716	262.04	4.021	279.69	3.682	1-2 <sup>n.s.</sup> , 3 <sup>n.s.</sup> , 4*** 2-3 <sup>n.s.</sup> , 4*** 3-4*
Number of live spermatozoa, bln	51.16	0.545	49.44	0.928	58.91	1.428	67.89	1.358	1-2 <sup>n.s.</sup> , 3***, 4*** 2-3 <sup>n.s.</sup> , 4 <sup>n.s.</sup> 3-4 <sup>n.s.</sup>
Number of insemination doses	19.92	0.226	19.54	0.370	23.24	0.571	27.04	0.542	1-2 <sup>n.s.</sup> , 3***, 4*** 2-3***, 4*** 3-4***

X – mean, SE – standard error; \* -  $p < 0.05$ ; \*\*\* -  $p < 0.001$ ; n.s. – no significances

most (27) from those collected in the winter. The mean number of insemination doses prepared from the ejaculates collected in the spring and summer differed highly significantly ( $P < 0.001$ ) from the mean number of doses prepared in the autumn and winter.

Table 2 illustrates the effect of the season on the ejaculate characteristics of the Polish Large White boars. Comparison of the quantitative and qualitative characteristics of the semen of the Polish Landrace boars (Table 1) with the semen of the Polish Large White boars (Table 2) shows that the values are similar. No significant differences between breeds were noted in the traits characterizing the semen of the boars from these groups. Significant differences were noted, however, in the characteristics of the semen collected in different seasons. The effect of the season on individual semen characteristics of the Polish Large White boars was similar to the effect observed in the case of the Polish Landrace boars. The greatest differences in the volume of the ejaculates were noted be-

tween those collected in the summer and in the other seasons ( $P < 0.001$ ). No significant seasonal changes were observed in the sperm concentration in the ejaculates of the Polish Large White boars, but the live sperm count was significantly lowest in the summer. The number of insemination doses (16) prepared per ejaculate from the boars of this breed was lowest in the summer as well, and was highly significantly different from the mean number of doses prepared in the other seasons ( $P < 0.001$ ).

Table 3 presents the phenotypic correlations between the ejaculate characteristics of Polish Landrace boars in each season. The study found a high phenotypic correlation between ejaculate volume and the number of sperm per ejaculate: 0.73 in the spring ( $P < 0.01$ ), 0.85 ( $P < 0.01$ ) in the summer, 0.87 ( $P < 0.01$ ) in the autumn and 0.86 ( $P < 0.01$ ) in the winter. High, significant phenotypic correlations were found between the volume of the ejaculate and the number of insemination doses (rp from 0.75 to 0.86, at  $P < 0.01$ ), and between the live cell

**Table 2**  
The effect of season on semen parameters in Polish Large White boars

Traits of semen	Spring (1)		Summer (2)		Autumn (3)		Winter (4)		Significance of differences
	X	SE	X	SE	X	SE	X	SE	
Ejaculate volume, ml	280.84	4.077	215.27	5.391	255.08	6.068	278.34	4.658	1-2***, 3 <sup>n.s.</sup> , 4 <sup>n.s.</sup> 2-3***, 4*** 3-4 <sup>n.s.</sup>
Concentration of spermatozoa, 1,000/mm <sup>3</sup>	261.54	3.420	240.44	4.711	246.48	5.386	262.21	5.957	1-2 <sup>n.s.</sup> , 3 <sup>n.s.</sup> , 4 <sup>n.s.</sup> 2-3 <sup>n.s.</sup> , 4 <sup>n.s.</sup> 3-4 <sup>n.s.</sup>
Number of live spermatozoa, bn	53.56	1.296	41.85	1.688	52.15	2.044	60.04	1.967	1-2** 3 <sup>n.s.</sup> , 4 <sup>n.s.</sup> 2-3***, 4*** 3-4 <sup>n.s.</sup>
Number of insemination doses	20.90	0.551	16.34	0.679	20.55	0.821	23.85	0.825	1-2***, 3 <sup>n.s.</sup> , 4 <sup>n.s.</sup> 2-3***, 4*** 3-4 <sup>n.s.</sup>

X – mean, SE – standard error; \*\* -  $p < 0.01$ ; \*\*\* -  $p < 0.001$ ; n.s. – no significances

**Table 3**  
Phenotypic correlation coefficients between selected semen traits of Polish Landrace boars in each season of year

Correlation between	Season of year	Spring	Summer	Autumn	Winter
Ejaculate volume [ml] & Concentration of spermatozoa [1,000/mm <sup>3</sup> ]		0.24 ***	0.39 ***	0.44 ***	0.60 **
Ejaculate volume [ml] & Number of live spermatozoa [bn]		0.73 **	0.85 **	0.87 **	0.86 **
Ejaculate volume [ml] & Number of insemination doses		0.74 **	0.84 **	0.85 **	0.86 **
Number of live spermatozoa [bn] & Number of insemination doses		0.91 **	0.98 **	0.99 **	0.98 **

\*\* -  $p < 0.01$ ; \*\*\* -  $p < 0.001$

**Table 4**  
**Phenotypic correlation coefficients between selected semen traits of Polish Large White boars in each season of year**

Correlation between	Season of year	Spring	Summer	Autumn	Winter
Ejaculate volume [ml] & Concentration of spermatozoa [1,000/mm <sup>3</sup> ]		0.47 ***	0.54 ***	0.59 ***	0.66 ***
Ejaculate volume [ml] & Number of live spermatozoa [bn]		0.85 **	0.89 **	0.88 **	0.87 **
Ejaculate volume [ml] & Number of insemination doses		0.84 **	0.91 **	0.88 **	0.85 **
Number of live spermatozoa [bn] & Number of insemination doses		0.96 **	0.98 **	0.99 **	0.97 **

\*\* -  $p < 0.01$ ; \*\*\* -  $p < 0.001$

count and the number of insemination doses (rp from 0.91 to 0.99, at  $P < 0.01$ ). The differences in the size of these correlations in different seasons were slight, with the exception of ejaculate volume and sperm concentration, which were most strongly correlated in the winter (rp 0.60,  $P < 0.01$ ) and least in the spring (rp 0.24,  $P < 0.01$ ).

Table 4 presents the values for the phenotypic correlations between characteristics of ejaculates from Polish Large White boars within each season. Analysis of the data reveals that the values for these correlations were similar to the corresponding correlations in the Polish Landrace boars. As in the case of the Polish Landrace boars, no significant differences were noted between different seasons of the year, with the exception of ejaculate volume and sperm concentration, which in the Polish Large White boars were also most strongly correlated in the winter (rp 0.66,  $P < 0.01$ ) and least in the spring (rp 0.47,  $P < 0.01$ ).

## Discussion

Many studies have shown that the origin of boars (breed or cross-breeding variant) plays a significant role in shaping the quantitative and qualitative characteristics of their ejaculates (Gączarzewicz et al., 2000; Foote, 2003; Park and Yi, 2002; Kondracki et al., 2003; Knecht et al., 2004). A study by Milewska (2008) showed that ejaculates of Polish Landrace boars had higher values for semen characteristics than Polish Large White breeders. The results of the present study showed that the breed of the boars (Polish Landrace or Polish Large White) did not affect semen characteristics, either quantitative or qualitative. What did significantly influence these traits was the season in which the ejaculates were collected. The effect of the season on semen characteristics is mainly considered in terms of day length and ambient temperature (Claus and Weiler, 1985; Trudeau and Stanford,

1990; Sancho et al., 2004). Kozdrowski and Dubiel (2004), who studied the effect of the season on semen characteristics in the wild boar, conclude that the functioning of its reproductive organs is seasonal, and the direction of the seasonal changes in the volume and qualitative traits of ejaculates is similar to that observed in ejaculates produced by boars of modern breeds. The authors observed an increase in the volume of the ejaculates and the number of sperm per ejaculate during the period when the days were shorter (November, December). These observations confirm that the activity of the reproductive organs in the wild boar is highest in the autumn, as Mauget and Boissin (1987) and Weiler et al. (1996) had previously reported, explaining that this was due to the higher serum level of testosterone observed during this period. Observations of sexual behaviour and the effect of the season on semen quality in boars of the primitive East Balkan breed, which is phenotypically similar to the wild boar, have also confirmed that the quality of ejaculates is highest in the autumn (Marchev and Szostak, 2013). The results of the present study show that Polish Landrace and Polish Large White boars have retained the tendency towards better semen quality (ejaculate volume, sperm concentration, sperm count) during periods when the day is shorter and the temperatures are lower.

In the summer, when temperatures are high, boars respond with lower libido (Szostak and Przykaza, 2011) and lower semen production. The data from the present study show that the ejaculates had the lowest volume, sperm concentration, and total number of sperm with progressive motion in the summer. We previously observed a similar effect of seasonal factors on the characteristics of ejaculates in boars of modern breeds in the climate conditions of Bulgaria (Marchev et al., 2003). There have been reports (Flowers, 2008) concerning the possibility of breeding a line of boars with the trait of heat tolerance. Huang et al. (2010), however,

point out that this resistance to high temperature decreases with the age of the boars.

To sum up, it should be emphasized that no significant differences between breeds were observed in the characteristics of semen from Polish Landrace and Polish Large White boars, whereas the season of the year had a significant effect on the characteristics of the ejaculates. The greatest volume, sperm concentration and sperm count were noted in the ejaculates collected in the winter in the case of the Polish Landrace boars, and in the spring in the case of the Polish Large White, which may be a residual effect of the winter increase. In the summer the volume of the ejaculates substantially decreased, and with it the sperm count, which adversely affected the number of insemination doses obtained per ejaculate. The value for the phenotypic correlations between the semen characteristics was not significantly affected by the season, with the exception of ejaculate volume and sperm concentration, which were most strongly correlated in the winter and least in the spring.

## References

- Ciereszko, A., J. S. Ottobre and J. Glogowski**, 2000. Effects of season and breed on sperm acrosin activity and semen quality of boars. *Animal Reproduction Science*, **64**: 89-96.
- Claus, R., D. Schopper, H. G. Wagner and U. Weiler**, 1985. Photoperiodic influences on reproduction of domestic boars. I. Light influences on testicular steroids in peripheral blood plasma and seminal plasma. *ZBL-VET-MED.-A*, **32**: 86-98.
- Flowers, W. L.**, 2008. Genetic and phenotypic variation in reproductive traits of AI boars. *Theriogenology*, **70**: 1297-1303.
- Footo, R. H.**, 2003. Fertility estimation a review of past experience and future prospects. *Animal Reproduction Science*, **75**: 119-139.
- Gączarzewicz, D., J. Udała, B. Lasota and B. Błaszczuk**, 2000. Analysis of the selected parameters of qualitative and biochemical evaluation of the semen of boars, used in AI centre. *Zeszyty Naukowe Przeglądu Hodowlanego, PTZ Warszawa*, **48**: 93-102.
- Huang, Y. H., L. L. Lo, S. H. Liu and T. S. Yang**, 2010. Age-related changes in semen quality characteristics and expectations of reproductive longevity in Duroc boars. *Animal Science Journal*, **81**: 432-437.
- Knecht, D., S. Jasek, A. Procaj and P. Krzyżewski**, 2004. Efficiency of inseminating sows with pure breed and crossbred boars. *Medycyna Weterynaryjna*, **60** (11): 1208-1211.
- Kondracki, S., A. Wysokińska and Z. Kowalczyk**, 2003. Wpływ krzyżowania ras duroc i pietrain na cechy ejakulatów knurów mieszańców dwurasowych. The effects of crossing of Duroc and Pietrain breeds on semen quality of crossbred boars. *Zeszyty Naukowe Przeglądu Hodowlanego, PTZ Warszawa*, **68** (2): 105-112 (Pl).
- Kozdrowski, R. and A. Dubiel**, 2004. The effect of season on the properties of wild boar (*Sus scrofa* L.) semen. *Animal Reproduction Science*, **80**: 281-289.
- Marchev, Y. and B. Szostak**, 2013. The season effect on sexual behavior and sperm quality of East-Balkan boars. *Acta Scientiarum Polonorum Zootechnica*, **12** (2): 31-38.
- Marchev, Y., A. Apostolov and B. Szostak**, 2003. Season and age effect on sperm quality and quantity in boars from the Danube White breed. *Bulgarian Journal of Agricultural Science*, **9**: 703-706.
- Mauget, R. and J. Boissin**, 1987. Seasonal changes in weight and testosterone concentration in the European wild boar (*Sus scrofa* L.). *Animal Reproduction Science*, **13**: 67-74.
- Milewska, W.**, 2008. Przydatność do rozplodu knurów ras wielka biała polska i polska biała zwisłoucha oraz loch wielka biała polska, selekcyjonowanych w kierunku zwiększenia mięsności. *Rozpr. i Monogr.*, 137, UWM, Olsztyn (Pl).
- Mucha, A. and M. Tyra**, 2013. Inseminacja trzody chlewnej. Stan Hodowli i Wyniki Oceny Świń w Roku 2012, *Inst. Zoot. Kraków* (Pl).
- Okere, C., A. Joseph and M. Ezekwe**, 2005. Seasonal and genotype variations in libido, semen production and quality in artificial insemination boars. *Journal of Animal and Veterinary Advances*, **4** (10): 885-888.
- Park, C. S. and Y. J. Yi**, 2002. Comparison of semen characteristics, sperm freezability and testosterone concentration between Duroc and Yorkshire boars during seasons. *Animal Reproduction Science*, **73**: 53-61.
- Pietruszka, A., E. Jacyno, M. Kawęcka, A. Kolodziej and B. Delikator**, 2006. Sexual activity and semen traits in boars entering reproduction in different seasons. *Annals of Animals Science, Supplement 2/2*: 405-408.
- Pokrywka, K. and M. Ruda**, 2001. Wartość wybranych cech ejakulatów knurów w zależności od odstępu między pobieraniem nasienia i pory roku. *Zeszyty Naukowe Akademii Rolniczej, Wrocław*, **405**: 211-218 (Pl).
- Sancho, S., E. Pinart, M. Briz, N. Garcia-Gil, E. Badia, J. Basols, E. Kadar, A. Pruneda, E. Bussalleu, M. Yeste M., M. G. Coll and S. Bonet**, 2004. Semen quality of postpubertal boars during increasing and decreasing natural photoperiods. *Theriogenology*, **62**: 1271-1282.
- Slaweta, R. and J. Morstin**, 1981. Zmiany morfologiczne w nasieniu knurów rasy polskiej białej zwisłouchej i wielkiej białej polskiej obserwowane w różnych porach roku. *Medycyna Weterynaryjna*, **37**: 410-413. (Pl).
- Szostak, B. and L. Przykaza**, 2011. The influence of breed age of boars and exploitation season on their libido in conditions of the insemination station. *J. Cent. Eur. Agr.* **12** (1): 124-134.
- Trudeau, V. L. and L. M. Stanford**, 1990. Influence of season and social environment on the reproductive-endocrine status of the adult Landrace boar. *Canadian Journal of Animal Science*, **70**: 121-128.
- Weiler, U., R. Claus, M. Dehnhard and S. Hofacker**, 1996. Influence of photoperiod and a light reverse program on metabolically active hormones and food intake in domestic pigs compared with a wild boar. *Canadian Journal of Animal Science*, **76** (4): 531-539.