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Effect of boar breed and chosen crossing variants on the development of basic traits of boar semen

Wpływ rasy i wybranych wariantów krzyżowania na kształtowanie się podstawowych cech nasienia knurów

Summary. The main aim of the survey was to determine the influence of selected breeds and crossbreed variants on the basic semen traits in the station boars. The studies comparised 25 787 ejaculates taken by the manual method from 205 the station boars: 26 PWL (wbp) boars (3353 ejaculates), 124 PL (pbz) boars (14711 ejaculates), 16 crossbreds hampshire × pietrain (2081 ejaculates), 16 crossbreds duroc x pietrain (2313 ejaculates), 9 crossbreds pietrain × duroc (1082 ejaculates), and 14 pietrain boars (2247 ejaculates) used at the Sow Insemination Station in Kraśnik and Białka near Radzyń Podlaski. A significant effect of breed and crossbreed structure of the crossbred boars was shown on most analysed semen traits. In the purebred boars group the highest semen volume was found for PWL boars (226 ml). Significantly the smallest volume was found for PL ejaculates (221 ml) and pietrain ejaculates (216.8 ml). In the crossbred boars the highest semen volume was for hampshire × pietrain boars (261.8 ml), the smallest semen volume had duroc × pietrain boars (182.7 ml). The studies confirmed the negative correlation between semen volume and the concentration of spermatozoa. A highly significant difference was revealed in the number of alive spermatozoa in ejaculates of different crossbreds of boars group.

Key words: boar, ejaculate, insemination, sperm

INTRODUCTION

The effect of a boar breed on the quantitative and qualitative parameters of ejaculate remains a subject of numerous research reports [Borg *et al.* 1993, Ciereszko *et al.* 2000, Koćwin-Podsiadła *et al.* 1990, Kondracki and Banaszewska 1999]. Interestingly, the research findings appeared to be not only divergent but they frequently failed to support the previous research-based assumptions. However, the majority of studies indicate higher libido and better quality of the semen from crossbred boars as compared to pure-

bred individuals [Ciereszko *et al.* 2000, Dubiel *et al.* 1985, Koćwin-Podsiadła *et al.* 1990, Nitzsche *et al.* 1988].

Discrepancy between the research results pertaining to the influence of genetic and non-genetic factors on boar sperm traits highlights the need for continuing the research work in this field.

The objective of the present study was to assess the impact of chosen breeds and crossing variants from which the boars were derived on their basic semen traits.

MATERIAL AND METHODS

The research material comprised a total of 25 787 ejaculates manually collected by the gloved hand method from 205 boars housed in the Sow/Gilt Artificial Insemination Centres, in that: 26 boars of Polish White Large breed (PWL) – 3353 ejaculates, 124 boars of Polish Landrace (PL) – 14 711 ejaculates,16 crosses after hampshire × pietrain – 2081 ejaculates, 16 crossbreds after duroc × pietrain – 2313 ejaculates, 9 crosses after pietrain × duroc – 1082 ejaculates and 14 boars of pietrain breed – 2247 ejaculates. The Sow/Gilt Animal Insemination Centres were localized in Kraśnik and Białka near Radzyń Podlaski (Lublin Province).

Boar semen was collected manually twice a week and sperm evaluation was carried out immediately after its collection in compliance with the regulatory procedures in the Sow/Gilt Artificial Insemination Centres.

Evaluation was based on the following semen traits:

- volume of gel-free semen (ml),
- sperm cell concentration ($\times 10^6/cm^3$),
- percentage of progressively motile spermatozoa (%),
- total sperm count in ejaculate (billion),
- number of insemination doses from one ejaculate.

The volume of the semenal fraction was estimated after the gel fraction separation, on the grounds of ejaculate mass measurement performed on an electronic balance. Spermatozoon concentration was assessed with the colorimetric method using a spectrophotometer, while the percentage of sperm cells displaying progressive forward motion (motility) in the ejaculate – by the microscopic study. The total sperm cell count in the ejaculate and the number of insemination doses in a single ejaculate was calculated with computer program SYSTEM SUL application.

The impact of factors determining the level of the traits under investigation was verified by means of the analysis of variance, the least square method. The level of all the characteristics analyzed was illustrated with the means of the least squares (LSM), together with standard error values (SE) which determine reliability of estimates.

Significance of differences between means was tested by Tukey test.

RESULTS AND DISCUSSION

Table 1 summarizes the data displaying the volume of ejaculates and sperm cell concentration in the ejaculate from boars of various breeds and crossbreds. The data

analysis revealed that the highest volume of semen collected from purebred boars was recorded for PWL breed (226.1 ml), whereas the lowest value of this trait – the boars of pietrain breed (216.8 ml). There were established highly significant differences ($p \leq 0.001$) between the aforementioned boar groups. As for crossbred boars, the highest volume of ejaculates was obtained from hampshire × pietrain boars (261.8 ml), while the lowest from duroc × pietrain individuals (182.7 ml). Similarly, there were determined highly significant differences between these boar groups ($p \leq 0.001$). Out of all the groups under study, the crossbreds (hampshire × pietrain) were characterized by the highest volume of the ejaculate and the differences between them and other groups were significant.

Similar results pertaining to ejaculate volume from purebred boars were reported by Kondracki and Banaszewska [1999], who determined relatively high volume of ejaculates collected from boars of PWL breed (239.8 ml) and PL breed (235.4 ml).

In the other studies of the present author [Szostak 2003], the highest volume of ejaculate was collected from crossbred boars hampshire × pietrain (230 ml). The substantial quantity of ejaculates was also obtained from the boars of duroc × pietrain (ca 218 ml), hampshire × duroc (ca 216 ml) and duroc × hampshire (ca 211 ml). The research findings from the present study are similar to those obtained earlier and support the dependence of ejaculate volume on a boar breed as well as the impact of crossing on the characteristics of the ejaculate collected from crossbred boars. This statement is consistent with the results reported by Milewska [2007], who found that pietrain × hampshire crossbred boars produced higher volume of ejaculate than hampshire boars and hampshire × pietrain crossbreds.

Spermatozoon concentration was shown to be lowest in the semen obtained from PWL boars – 407.1 × 10^6/cm^3. A substantially higher concentration of sperm cells was determined for the ejaculates from the other groups of purebred boars – PL (435.2 cm^3 × 10^6) and pietrain (431.8 × 10^6/cm^3). Highly significant differences ($P \leq 0.01$) were noted between the boars of PWL and PL breed. On the other hand, in a group of crossbred boars, the lowest sperm concentration was established for hampshire × pietrain boars and the highest for the pietrain × duroc ones. The data support the assumption that an increased semen volume is associated with a lower sperm cell concentration. There were observed highly significant differences ($P \leq 0.001$) between the crossbred boar groups.

Similar results were reported by Kondracki and Banaszewska [1999], who determined spermatozoon concentration of 473 × 10^6/cm^3 in the semen collected from pietrain boars. Besides, the authors noted that the boars of this breed showed a high percentage of sperm cells with normal progressive motility, which distinguished them from the other breeds.

The fact of high sperm concentration in the ejaculates from pietrain boars is also congruent with the supportive findings from Milewska's [2007] studies. This author reported 388 × 10^6/cm^3 sperm cell concentration in the semen obtained from pietrain boars. However, apparently divergent results were presented by Michalski *et al.* [1982], who showed spermatozoon concentration in the semen of PWL boars at 498 × 10^6/cm^3 level, which proved to be the highest value of the analyzed trait in the breeds under investigation.

Szostak [2003] found higher sperm concentration in PWL boars as against PL breed animals and for the sires of the former breed, this semen trait value reached ca 416 × 10^6/cm^3.

Table 1. The effect of breed and selected crossbreeding variants on the volume of ejaculate and concentration of spermatozoa in the sperm
Tabela 1. Wpływ rasy i wybranych wariantów krzyżowania na objętość ejakulatu i koncentrację plemników w nasieniu knurów

Group Grupa	Breed and crossbred variant Rasa i wariant krzyżowania	Volume of ejaculate, ml Objętość ejakulatu, ml		Concentration of spermatozoa $cm^3 \times 10^6$ Koncentracja plemników $cm^3 \times 10^6$	
		LSM	SE	LSM	SE
I	PWL wbp	226.06	1.12	407.08	2.00
II	PL pbz	221.82	0.56	435.17	1.00
III	hampshire × pietrain	261.78	1.65	408.73	2.94
IV	duroc × pietrain	182.67	1.40	427.93	2.49
V	pietrain × duroc	216.94	2.20	450.50	3.92
VI	pietrain	216.80	1.82	431.78	3.24

Significance of differences between the groups for the volume of ejaculate – Istotność różnic między grupami dla objętości ejakulatu: I–II***, I–III***, I–IV***, I–V***, I–VI***, II–III***, II–IV***, II–V*, II–VI**, III–IV***, III–V***, III–VI***, IV–V***, IV–V***
Significance of differences between the groups for the concentration of spermatozoa – Istotność różnic między grupami dla koncentracji plemników: I–II***, I–IV***, I–V***, I–VI***, II–III***, II–IV**, II–V***, III–IV***, III–V***, III–VI***, IV–V***
*** $P \leq 0.001$, ** $P \leq 0.01$, * $P \leq 0.05$

The data presented in Tab. 2 indicate that the breed of boar and crossing variant it comes from, has a significant influence on the percentage of spermatozoa with progressive motility in an ejaculate. The highest value of this trait was recorded for PWL boars (79.1%), while the lowest for purebred boars of pietrain breed (77.8%). Similar results pertaining to the ejaculates produced by pietrain boars were obtained from hampshire × pietrain and duroc × pietrain crossbreds (77.7%). No significant differences were found between these boar groups.

The total live sperm count in the ejaculates of the boars under study (Tab. 2) ranged between 58.9 and 79.4 billion. The differences between the boar groups appeared to be substantial and they predominantly relate to crossbred boars. In the individuals from duroc × pietrain group, this semen trait value was the lowest – 58.9 billion, while crossbreds after hampshire × pietrain were characterized by the highest sperm cell count in the ejaculate – 79.4 billion. Significance of differences between the studied groups was high ($P \leq 0.001$). The PWL and pietrain boars were shown to produce a similar total motile sperm count in the ejaculate (69.8; 69.7 billion). The differences between the other boar groups proved to be highly significant ($P \leq 0.001$).

Similar research findings were found in other studies [Szostak 2003] which indicated the highest sperm count in the ejaculates from boars after hampshire × pietrain crosses (ca 76.1 billion), whereas in purebreds – PL boars (71.6 billion).

The study by Milewska [2007] revealed the highest percentage of progressively motile spermatozoa in the semen from hampshire × pietrain crossbred boars (ca 75.6%). The highest live sperm count in the ejaculate was recorded in purebred boars (ca 76 billion). Kondracki *et al.* [2003] reported the highest values in total sperm count in the ejaculates from duroc × pietrain crossbreds. It reached 88.83 billion so it was higher by 3.95 billion as compared to the ejaculates collected from pietrain boars ($P \leq 0.01$).

Table 2. The effect of breed and selected crossbreeding variants on the percentage and the number of a live spermatozoa and the number of insemination doses per ejaculate
Tabela 2. Wpływ rasy i wybranych wariantów krzyżowania na odsetek plemników wykazujących ruch postępowy i liczbę plemników żywych w ejakulacie oraz liczbę dawek inseminacyjnych z jednego ejakulatu

Group Grupa	Breed and crossbred variant Rasa i wariant krzyżowania	Percentage of a spermatozoa with progressive motility % plemników o ruchu postępowym		Number of a live spermatozoa in ejaculate, mld Liczba plemników żywych w ejakulacie, mld		Number of insemination doses Liczba dawek inseminacyjnych	
		LSM	SE	LSM	SE	LSM	SE
I	PWL wbp	79.09	0.07	69.80	0.39	20.54	0.09
II	PL pbz	78.32	0.03	72.33	0.19	21.60	0.04
III	hampshire × pietrain	77.75	0.10	79.38	0.57	23.54	0.14
IV	duroc × pietrain	77.74	0.08	58.87	0.48	18.12	0.12
V	pietrain × duroc	78.91	0.13	73.15	0.76	21.28	0.19
VI	pietrain	77.85	0.11	69.72	0.63	20.28	0.15

Significance of differences between the groups for the percentage of spermatozoa with progressive motility – Istotność różnic między grupami dla % zawartości plemników o ruchu postępowym – I–II***, I–III***, I–IV***, I–VI***, II–III***, II–IV***, II–V***, II–VI***, III–V***, IV–V***, V–VI***
Significance of differences between the groups for the number of live spermatozoa in ejaculate – Istotność różnic między grupami dla liczby plemników żywych w ejakulacie – I–II***, I–III***, I–IV***, I–V***, II–III***, II–IV***, II–VI***, III–IV***, III–V***, III–VI***, IV–V***, IV–VI***, V–VI***
Significance of differences between the groups for the number of insemination doses – Istotność różnic między grupami dla liczby dawek inseminacyjnych: I–II***, I–III***, I–IV***, I–V***, II–III***, II–IV***, II–VI***, III–IV***, III–V***, III–VI***, IV–V***, IV–VI***, VVI***
*** $P \leq 0.001$, ** $P \leq 0.01$, * $P \leq 0.05$

Out of purebred sires, the highest number of insemination doses was obtained from PL boars (21.6 units), whereas from PWL and pietrain – 20.5 and 20.3 units, respectively. Differences in the number of semen doses from one ejaculate collected from PL, PWL and pietrain boars were highly significant ($P \leq 0.001$). As for crossbred boars, the number of doses obtained was more differentiated. Only 18.1 doses were obtained from the ejaculate of duroc × pietrain boars and 23.6 doses from the semen of hampshire × pietrain ones. Thus, significance of differences for these boar groups was high ($P \leq 0.001$).

The number of insemination doses obtained from single ejaculate is of great economic and practical value. According to Kondracki *et al.* [2003], from each ejaculate collected from crossbred boars, approximately 2 more doses were obtained as compared to the ejaculates from pietrain boars ($P \leq 0.01$). Another research paper by Kondracki and Banaszewska [1999] presented the data indicating that the number of semen portions from PL and PWL boars was similar and amounted to ca 22 units. On the other hand, from the semen from piterain boars, about 23.7 insemination doses were obtained.

Milewska [2007] states that the largest number of semen portions was prepared from the ejaculates collected from hampshire boars (about 21.8 units), whereas the lowest number from those obtained from pietrain × duroc crossbreds (ca 16.7 units).

The findings of this study appear to be consistent with those presented in the earlier studies [Szostak 2003] where the largest number of semen doses was obtained from the

semen from hampshire × pietrain crossbred boars (ca 23.1 units) and a lower number of doses from duroc × pietrain crossbreds (16.3 units).

CONCLUSIONS

1. There was established a significant impact of a breed and crossing variant from which boars were derived, on semen amount and quality. Out of purebred boars, the highest semen volume was obtained from PWL boars (226.07 ml). As regards crossbred boars, the highest value of this trait was recorded for hampshire × pietrain boars (261.79 ml).

2. The highest sperm concentration was determined in the semen collected from pietrain × duroc crossbreds (450.51 × 10^6/cm^3), while out of purebred boars, PL boars produced ejaculates of the highest spermatozoon concentration (435.18 × 10^6/cm^3).

3. The ejaculates obtained from PWL boars were characterized by the highest percentage of progressively motile sperm (79.09%). In crossbred boars, the largest percentage of sperm with progressive motility in the ejaculate was reported for pietrain × duroc individuals (78.91%).

4. The largest number of insemination doses was obtained from the semen from hampshire × pietrain crossbred boars (23.55 units) and purebreds (21.6 units).

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Streszczenie. Celem badań było określenie wpływu wybranych ras i wariantów krzyżowania na podstawowe cechy nasienia knurów stacyjnych. Materiał badawczy stanowiło 25 787 ejakulatów pobranych metodą manualną od 205 knurów stacyjnych, w tym: 26 rasy wbp (3353 ejakulatów), 124 rasy pbz (14711 ejakulatów), 16 mieszańców hampshire × pietrain (2081 ejakulatów), 16 mieszańców duroc × pietrain (2313 ejakulatów), 9 mieszańców pietrain × duroc (1082 ejakulatów) i 14 knurów rasy pietrain (2247 ejakulatów) stacjonujących w Stacji Unasienniania Loch w Kraśniku (woj. lubelskie) i Białce k. Radzynia Podlaskiego (woj. podlaskie). Wykazano istotny wpływ rasy i wariantu krzyżowania knurów na większość analizowanych cech nasienia. Z grupy knurów czysto rasowych największą objętością nasienia charakteryzowały się ejakulaty knurów rasy wbp (226 ml). Istotnie mniejszą objętość miały ejakulaty rasy pbz (221,8 ml) i pietrain (216,8 ml). Wśród knurów mieszańców największą objętością ejakulatów charakteryzowały się knury hampshire × pietrain (261,8 ml), najmniejszą zaś duroc × pietrain (182,7 ml). Badania potwierdziły ujemną zależność między objętością ejakulatu a koncentracją plemników. Wykazano istotne różnice w liczbie plemników żywych w ejakulatach różnych grup knurów mieszańców.

Słowa kluczowe: knury, ejakulaty, inseminacja, plemniki