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EFFECT OF BREED OF PERFORMANCE TESTED BOARS ON EJACULATE TRAITS

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Abstract: The main objective of the study was to determine the influence of breed on the traits of boar ejaculate: ejaculate volume (VOL, ml), sperm concentration (CON, $x10^6$ sperm/ml), total sperm count in ejaculate (TNS, $x10^9$ spermatozoa), sperm motility in native ejaculate (MON, %), sperm motility after dilution (MOD, %) and number of doses produced (NPD). The aim was also to evaluate the correlation of the boar performance test traits: average life daily gain (g), backfat thickness measured in two locations (mm), depth of longissimus dorsi muscle (mm) and carcass meat content (%) with ejaculate traits. Total of 931 ejaculates of 36 boars during reproductive exploitation were analysed (16 Landrace boars and 20 Large White boars). The effect was assessed using the procedure of the general linear model of the statistical package SAS 9.1.3 (*SAS Inst. Inc., 2002-2003*). The model for analysis included the influence of breed, season and the linear regression influence of body weight at the end of the performance test. The correlation of the traits was determined by applying the Pearson's correlation coefficient. Most of the examined ejaculate traits (VOL, CON, MOD and NPD) varied under the influence of boar breed ($p<0.01$; $p<0.001$). Weight at the end of the test ($p<0.05$; $p<0.01$; $p<0.001$) affected all examined traits, except CON and TNS. A weak association was found between production performance and ejaculate traits.

Key words: pig, boar, breed, performance test, ejaculate traits

Introduction

Modern pig breeds are characterized by intensive growth, high meat content in the carcass and high fertility. The primary goals in the selection of male heads are focused on traits that have economic significance such as growth, weight at a certain age and productivity of their daughters *(Robinson and Buhr, 2005).*

Intensive selection for meat content caused a significant reduction in the content of subcutaneous and even the content of intramuscular fat *(Bahelka et al., 2007).* Therefore, it is necessary to know whether the improvement of boar production performance (growth and meatiness) can have a negative impact on sperm quality *(Wolf, 2009).*

The use of high-value, genetically superior boars for artificial insemination has a great economic impact on intensive pig production *(Gadea et al., 2004).* The maximum number of insemination doses per ejaculate (or per boar per year) should be obtained from such boars, which is the main indicator of successful reproductive exploitation of boars. The average manifestation and variability of boar ejaculate traits is influenced by breed, age, season, intensity of use, and other factors (*Kondracki et al., 2009; Smital, 2010; Kunowska-Slósarz and Makowska, 2011).*

As important as it is to pay attention to the reproductive traits of the boar, it is also important to know how they relate to the boar performance test traits, in order to prevent the consequences of unilateral selection. The aim of this study was to determine the influence of the boar breed on ejaculate traits and whether there is a correlation between production performance and ejaculate traits.

Material and Method

The research was conducted on a pig farm, which has its own reproductive and commercial herd. Total of 931 ejaculates collected from 36 boars of two fertile meat breeds were analysed (Landrace, n = 16 with 450 ejaculates; Large White, n = 20 with 481 ejaculates). The influence of season was examined as a cold (October-March) and warm (April-September) season.

The boars were kept in a separate building, in boxes measuring 2 × 4 m, with a partial grid concrete floor. The microclimatic conditions in the boar housing facility were under semi-automatic control, with vertical and horizontal ventilation. The animals were fed balanced feed mixtures, and fresh water was available to them at will. The average body weight at the end of the performance test was 110 kg at the age of 175 days.

Following performance test traits were analysed: ALDG- average life daily gain (g), FT- backfat thickness (mm), DLD- depth of longissimus dorsi muscle (mm) and CMC- carcass meat content (%). At the end of the performance test of the boar, certain ultrasound measuring was performed using the ultrasonic device PIGLOG 105. Back fat thickness was measured in two places: the first measurement in the loin area (FT1) between the 3rd and 4th lumbar vertebrae (measured from the last lumbar vertebra), 7 cm lateral to the dorsal line, and the second measurement of back fat thickness in the lumbar region (FT2) between the

3rd and 4th ribs counting from the last, 7 cm lateral to the dorsal line. At the FT2 measurement site, DLD was also measured.

In order for a boar to be included in this analysis, it was necessary to have a minimum of 5 ejaculates during reproductive use. The average interval between two ejaculations was 10 days. The study included ejaculate traits: ejaculate volume (VOL, ml), sperm concentration (CON, $x10^6$ spermatozoa/ml), total sperm count in ejaculate (TNS, $x10^9$ spermatozoa), sperm motility in native ejaculate (MON, %), sperm motility after dilution (MOD, %) and number of doses produced (NPD). Ejaculates were collected by the standard manual method, by introducing the boar into the box with the phantom. Ejaculate volume was measured with a graduated cylinder, with an accuracy of ± 2 ml. The concentration of native sperm was assessed using a photo-colorimeter. All ejaculates with subjectively estimated motility of sperm mass in the native state less than 70% were excluded from use, so they were not included in the research. Insemination doses are standardized to a volume of 100 ml and 3.5 billion sperm per dose. The total number of sperm in the ejaculate was obtained by multiplying the sperm concentration by the ejaculate volume. Evaluation of sperm mass motility in native ejaculate and after dilution was performed by subjective assessment, observation under a microscope.

The effect was assessed using the procedure of the general linear model of the statistical package SAS 9.1.3 (*SAS Inst. Inc., 2002-2003*), using the following model:

$$y_{ijk} = \mu + B_i + S_j + b(x_{ijk} - \bar{x}) + e_{ijk},$$

where: y_{ijk}- analysed ejaculate trait, μ- general population average, B_i- influence of the breed (i = 1,2), S_j- effect of the season (j=1,2), $b(x_{ijk}-\bar{x})$ - linear regression effect of body weight at the end of the test and e_{ijk}- random error. Testing of differences between Least Square Means (LSMeans) values was performed by t-test.

The correlation of traits was assessed by applying Pearson's correlation coefficient. The strength of the correlation was interpreted on the basis of a rough approximation of the height of the correlation according to *Petz (2004):* 0.0-0.2 (slight correlation), 0.2-0.4 (weak correlation), 0.4-0.7 (medium correlation) and 0.7-1.0 (strong correlation).

Results and Discussion

Ejaculate traits vary under the influence of breed and boar body weight at the end of the performance test (Table 1).

Table 1. Statistical significance (p) of the influence of factors included in the model

Trait	Breed	Season	Body weight at the end of the test		R^2
			b	p	
VOL	***	ns	1.608	*	0.035
CON	**	ns	1.417	ns	0.022
TNS	ns	*	0.762	ns	0.017
MON	ns	ns	-0.185	***	0.024
MOD	**	ns	-0.164	***	0.031
NPD	***	ns	-0.144	**	0.039

VOL-ejaculate volume (ml), CON-concentration of sperm ($x10^6$ spermatozoa/ml), TNS -total number of spermatozoa in ejaculate ($x10^9$ spermatozoa), MON-motility of spermatozoa in native ejaculate (%), MOD-motility of spermatozoa after dilution (%), NPD-number of doses produced, ns=p>0.05; * = p<0.05; ** = p<0.01; *** = p<0.001, b- regression coefficient, R^2- determination coefficient.

Ejaculate volume increased by 1.61 ml, i.e. the total number of sperm in the ejaculate by $0.76x10^9$ for each kg of increase in body weight of boars at the end of the test. However, the increase in body weight at the end of the test resulted in a decrease in the motility of the sperm mass in the native state and after dilution, as well as the number of doses, which is shown by negative regression coefficients. Low values of the coefficients of determination indicate that the factors included in the model to a small extent explain the variability of the examined traits.

The results of this study are partially similar to those of *Smital (2010)* and *Wierzbicki et al. (2010)* in which the influence of different genetic and non-genetic influences on sperm traits was determined. Also, this research partly correspond to the research of *Savić et al. (2013)* in wich the effect of all analyzed factors for both sperm traits (volume and motility) was significant. In this study, the season influenced only on the TNS, which is in contrast to the study of *Savić et al. (2015)* in which all analyzed ejaculate traits varied under the influence of the season.

Table 2. Average LSM ± SE values of ejaculate traits by breeds

Trait	Breed	
	Landrace	Large White
VOL	$294.59±4.90^A$	$319.48± 4.62^B$
CON	$271.24±7.03^a$	$239.71±6.64^b$
TNS	84.75±2.87	77.99± 2.70
MON	86.02±0.33	85.70±0.31
MOD	$82.12±0.29^a$	$80.85±0.27^b$
NPD	$22.14±0.37^A$	$19.53±0.35^B$

VOL-ejaculate volume (ml), CON-concentration of sperm ($x10^6$ spermatozoa/ml), TNS -total number of spermatozoa in ejaculate ($x10^9$ spermatozoa), MON-motility of spermatozoa in native ejaculate (%), MOD-motility of spermatozoa after dilution (%), NPD-number of doses produced; Statistical significance: $^{a, b}$=p<0.01; $^{A, B}$=p<0.001.

Large White boars had a higher ejaculate volume (+24.89 ml), but less doses per ejaculate (-2.61) compared to Landrace boars (Table 2). The sperm concentration of Landrace boars was higher by 31.53x10^6 spermatozoa per ml of ejaculate, which had a crucial effect on obtaining a higher number of doses per ejaculate.

Contrary to our study, *Wolf and Smital (2009)* have found slight differences in ejaculate traits, with Large White boars having lower ejaculate volume and higher sperm concentration compared to Landrace boars. Contrary to our study, *Banaszewska and Kondracki (2012)* have established lower ejaculate volume of Large White boars compared to Landrace (247.03: 257.03 ml). The average values of Large White boar ejaculate traits determined by this research are lower in compared to the results of the research of *Savić et al. (2015)*. In our study, an average of 22.14 and 19.53 doses were obtained from ejaculates with an average volume of 294.59 and 319.48 ml, respectively, while in the study of *Wierzbicki et al. (2010)* significantly more doses were obtained from the ejaculate with an average volume of 221.15 ml (on average 24.52 doses). This difference in the exploitation of boars is most likely a consequence of the different number of spermatozoa per dose produced. In recent years, sperm plasma research are actual, so *Ivanova et al. (2015)* established a correlation between high level of one specific sperm plasma protein with the low cryotolerance and low motility of boar spermatozoa.

A slight to weak correlation of performance traits and ejaculate traits was found within both breeds (Table 3 and Table 4).

Table 3. Correlations between production traits and ejaculate traits of Landrace boars

Trait	ALDG	FT1	FT2	DLD	CMC
VOL	0.09^{ns}	0.00^{ns}	0.45***	-0.14**	-0.37***
CON	0.20***	0.23***	0.18**	-0.16**	-0.12**
TNS	0.17**	0.17**	0.30***	-0.19**	-0.24***
MON	0.00^{ns}	-0.12**	-0.18**	0.20***	0.24***
MOD	0.00^{ns}	-0.09^{ns}	-0.11**	0.14**	0.20***
NPD	0.04^{ns}	0.08^{ns}	0.24***	-0.13**	-0.11**

VOL-ejaculate volume (ml), CON-concentration of sperm (x10^6 spermatozoa/ml), TNS-total number of spermatozoa in ejaculate (x10^9 spermatozoa), MON-motility of spermatozoa in native ejaculate (%), MOD-motility of spermatozoa after dilution (%), NPD-number of doses produced. ALDG-average life daily gain (g), FT-backfat thickness (mm), DLD-depth of longissimus dorsi muscle (mm), CMC-carcass meat content (%); Statistical significance: ns=p>0.05; **=p<0.01; ***=p<0.001.

In Landrace boars, a positive correlation between back fat thickness (FT1 and FT2) and ejaculate traits (VOL, CON, TNS and NPD) was found, and on the other hand, meatiness traits (DLD and CMC) were slightly or weakly negatively correlated to ejaculate traits, with the exception of sperm mass motility (Table 3).

Table 4. Correlations between production traits and ejaculate traits of Large White boars

Trait	ALDG	FT1	FT2	DLD	CMC
VOL	-0.09^{ns}	-0.14**	-0.14**	0.14**	-0.05^{ns}
CON	0.00^{ns}	0.02^{ns}	0.01^{ns}	0.05^{ns}	-0.04^{ns}
TNS	-0.06^{ns}	-0.05^{ns}	-0.05^{ns}	0.13**	-0.05^{ns}
MON	0.15**	0.14**	0.12**	0.00^{ns}	-0.07^{ns}
MOD	0.14**	0.18**	0.17**	-0.03^{ns}	-0.11**
NPD	0.05^{ns}	0.12**	0.12**	0.07^{ns}	-0.11**

VOL-ejaculate volume (ml), CON-concentration of sperm ($x10^6$ spermatozoa/ml), TNS-total number of spermatozoa in ejaculate ($x10^9$ spermatozoa), MON-motility of spermatozoa in native ejaculate (%), MOD-motility of spermatozoa after dilution (%), NPD-number of doses produced. ALDG-average life daily gain (g), FT-backfat thickness (mm), DLD-depth of longissimus dorsi muscle (mm), CMC-carcass meat content (%); Statistical significance: ns=p>0.05; **=p<0.01.

Contrary to Landrace, Large White boars were found to have a weak positive correlation between sperm mass motility traits and back fat thickness and average daily life gain (Table 4). Similar to Landrace, the higher meat content in the carcass of Large White boars implied obtaining less doses during reproductive exploitation.

The weak correlation between the examined traits is similar to the results of the study by *Wolf (2009)*, who has found low values of genetic correlation coefficients between production traits and boar sperm traits (0.00-0.13). Similar to the above, *Oh et al. (2005)* have found a weak phenotypic correlation of growth and ejaculate traits (sperm volume and concentration; -0.02 and 0.11). One of the important factors that could have influenced the strength of the correlation between these two groups of traits is the age of the boars when measuring the phenotypic values of these traits. Production performance of boars was determined at the age of about 6 months, and the characteristics of ejaculate later, during reproductive use. A similar conclusion was reached by *Wolf (2009)*.

Conclusion

The traits of boar ejaculate varied under the effect of breed. Body weight at the end of the test affected the variability and average manifestation of all examined traits, except sperm concentration and total sperm count in ejaculate. There was a slight to weak correlation between the traits from the performance test and the ejaculate traits, so that the selection with the aim of improving the carcass will not have a great negative impact on the later reproductive performance of the boar. Production traits (growth, food utilization and carcass quality) are the ones that will have priority in selection work in the future, but it is important to monitor ejaculate traits, so that selection does not lead to worsening of the sperm traits by improving production performance.

Uticaj rase performans testiranih nerasta na osobine ejakulata

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Rezime

Osnovni cilj istraživanja bio je da se utvrdi uticaj rase na osobine ejakulata nerasta: volumen ejakulata (VOL, ml), koncentracija sperme (CON, x106 spermatozoida/ml), ukupan broj spermatozoida u ejakulatu (TNS, x109 spermatozoida) pokretljivost spermatozoida u nativnom ejakulatu (MON, %), pokretljivost spermatozoida nakon razređenja (MOD, %) i broj proizvedenih doza (NPD). Cilj je bio i da se oceni povezanost osobina iz performans testa nerasta: prosečan životni dnevni prirast (g), debljina slanine merena na dva mesta (mm), dubina dugog leđnog mišića (mm) i sadržaj mesa u trupu (%) sa osobinama ejakulata. Analiziran je 931 ejakulat od 36 nerasta tokom reproduktivne eksploatacije (16 nerasta landrasa i 20 nerasta velikog jorkšira). Procena uticaja izvršena je primenom procedure opšteg linearnog modela statističkog paketa SAS 9.1.3 (SAS Inst. Inc., 2002-2003). Model za analizu obuhvatao je uticaj rase, sezone i linearni regresijski uticaj telesne mase na kraju performans testa. Povezanost osobina utvrđena je primenom Pirsonovog koeficijenta korelacije. Većina ispitivanih osobina ejakulata (VOL, CON, MOD i NPD) varirala je pod uticajem rase nerasta ($p<0,01$; $p<0,001$). Masa na kraju testa ($p<0,05$; $p<0,01$; $p<0,001$) uticala je na sve ispitivane osobine, osim na CON i TNS. Između proizvodnih performansi i osobina ejakulata utvrđena je slaba povezanost.

Ključne reči: svinja, nerast, rasa, performans test, osobine ejakulata

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