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LIBIDO AND EJACULATE TRAITS OF PERFORMANCE TESTED BOARS

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ABSTRACT

The main objective of this study was to score variability of fertility traits of boars as influenced by breed, age at first ejaculation/collection (AFE), the lean meat content (LM), lifetime average daily gain (ADG) and age of boars. The following fertility traits were analysed: libido, duration of ejaculation (DE), ejaculate volume (VOL), the density of the ejaculate (DEN) and sperm motility (MO) of boars. Boars' libido was assessed on the basis of duration of preparing to collection (DPC). The study included 7987 ejaculates from 105 boars of three breeds: Swedish Landrace (SL; n=34), Large White (LW; n=39) and Duroc (n=32). Impact assessment was carried out using the GLM procedure of the statistical package SAS 9.1.3 (SAS Inst. Inc., 2002-2003). Of all the traits analysed, only the DPC and VOL varied under the influence of all investigated impacts. Boars of SL and LW breeds demonstrated superiority in the trait VOL (+12.53 and +11.25 ml) compared to Duroc. Ejaculates of boars with AFE from 23 to 27 weeks had the highest VOL, but with the lowest qualitative properties. Contrary to the negative trend in the manifestation of libido, increase of LM and ADG indicated the trend of increasing DE and VOL. Boars with LM of 61% and higher had the highest VOL, and the differences in relation to the first and second class were +6.32 ml ($P<0.01$) and +5.18 ml ($P<0.05$), respectively. The ejaculate volume of the boars with the highest ADG compared to the other classes was higher ($P<0.001$) by 10.88 and 9.81 ml. Boars in different ADG classes produced ejaculate with differing qualitative property DEN. Correlations between production traits and fertility traits were negligible, and unlike the ADG, only the correlation between LM and DPC was statistically significant ($P<0.001$).

Key words: boar, libido, ejaculate traits, lean meat content, average life daily gain.

INTRODUCTION

High genetic potential of modern breeds of pigs is reflected in the intensive growth, high meat content and high fertility. Boars have been bred/selected primarily for properties that have economic importance, such as weight gain, age at a certain weight and productivity of their daughters (Robinson and Buhr, 2005). An important issue in the rearing of pigs is whether the selection in the direction of growth and leanness has a negative impact on the quality of sperm (Wolf, 2009). Therefore, it is necessary to determine how breeding selection in the direction of increasing weight gain and meat content reflects on the subsequent reproductive performances of boars (libido and ejaculate traits).

Selection in the direction of increasing the muscle depth and reduction of fat can result in reduced fertility of boars (Oh *et al.*, 2006). Much more attention should be paid to the existing breeding practices in selecting of boars for artificial insemination, which aims to increase the lean meat content in the carcass and decrease fat thickness, which can lead to reduced fertility of boars in the form of reduced sperm production (Wierzbicki *et al.*, 2010). In the study by Wolf (2009), low levels of genetic correlation coefficients (0.00 to 0.13) have been identified between production traits (lean meat content and average daily gain) and the properties of boar sperm.

The aim of this paper is to score variability of boars' libido and ejaculate traits of three breeds during the reproductive exploitation, depending on the age at first ejaculation/collection and phenotypic values of production traits at the end of the performance test.

MATERIALS AND METHODS

Data set and analysed traits and measurements: The study included 7987 collections from total of 105 boars of three breeds: Swedish Landrace (SL; n=34), Large White (LW; n=39) and Duroc (n=32). Boars were reared in production (farm) conditions during 2004-2012.

The following boar performance test data were used in the study: lean meat content (LM, %) and average life daily gain (ADG, kg/day). The performance test was conducted in animals weighing 30±2 kg to 100±10 kg. The group boar test was conducted under the conditions of the testing station on the farm, in grouping boxes with 1.5 m^2 floor area per animal. Measurement of body weight was performed at the beginning and end of the test. During testing, boars were fed two complete mixtures: the first contained 18% of crude proteins (30-

60 kg) and second 15% of crude proteins (60-100 kg). The lean meat content was determined using an ultrasound device PIGLOG 105 at the end of the performance test. The ADG was calculated based on the ratio of the absolute gain (difference in body weight at the end of the test and body weight at birth) and age of boars at the end of the test. Depending on the age at first ejaculation/collection (AFE; age of boars when introduced to reproduction), LM and ADG, boars were grouped into independent classes (Table 1).

The study involved the following fertility traits: duration of preparing to collection (DPC), the duration of ejaculation (DE), ejaculate volume (VOL), the density of ejaculate (DEN) and sperm motility (MO). Duration of preparing to collection and duration of ejaculation were measured by a digital clock and are expressed in minutes (min). Duration of preparing to collection is the time from the entry of boars into the room with the mount phantom to early ejaculation. Boars' libido was assessed on the basis of DPC (shorter DPC showed better libido). The ejaculates were collected using a standard manual method (gloved hand method). Ejaculate volume was measured using a graduated cylinder, with an accuracy of ± 10 ml. The density of ejaculate was evaluated using the method of subjective observation, that is, by observation of sperm sample under a microscope with a standard magnification, scores ranging from 1 to 3, where: 1- rare, 2- medium thick and 3- thick sperm. The sperm motility was evaluated based on the intensity of movement/ motility and expressed as numeric value on a scale of 1 to 5 (1- extremely slow movement, i.e. flickering with no movement, 2- slow movement, 3- brisk forward movement, 4- rapid progressive movement, 5- very active progressive movement). In order to reduce subjectivity in the visual assessment of the sperm motility, in case of doubt, between two consecutive values of the scale, their mean value was considered. Traits that were not clearly measured, were without values, or had values outside of the biological limit, were not used in analysis, and therefore, the size of the subsamples per traits varied.

Statistical analysis: By applying the GLM procedure of the statistical package SAS 9.1.3 (SAS Inst. Inc., 2002-2003) the impact assessment was carried out, using the following model:

$$y_{ijklm} = \mu + B_i + F_j + M_k + G_l + b\,(x_{ijklm} - \bar{x}) + \varepsilon_{ijklm},$$

where: y_{ijklm}- observed fertility trait, μ- general population average, B_i- fixed influence of the breed (i=1,2,3), F_j- fixed influence of the class AFE (j=1,2,3), M_k- fixed influence of the class LM (k=1,2,3), G_l- fixed influence of the class ADG (l=1,2,3), b ($x_{ijklm} - \bar{x}$) – linear regression effect of the boar age at the time when ejaculates were taken and ε_{ijklm}- random error. Least Square Means (LSMeans) values were compared using the t- test with three levels of significance ($P<0.05$, $P<0.01$, $P<0.001$).

RESULTS AND DISCUSSION

Variability of the analysed traits: Basic statistical parameters are presented in Table 2. Table 3 shows the significance of the impact of factors included in the model on the variability of boars' libido and ejaculate traits. Of all the traits analysed, only DPC and VOL varied under the influence of all investigated impacts.

Linear regression coefficients of influence of boar age on the variability of observed traits had low values, indicating linear increase of ejaculate VOL and longer DPC (impaired libido) with increasing age of boars, while the qualitative properties of ejaculate (DEN and MO) decreased linearly. A number of studies (Jankevičiūtė and Žilinskas, 2002; Wolf and Smital, 2009a; Wolf and Smital, 2009b; Banaszewska and Kondracki, 2012; Savić *et al.*, 2013), have come to similar conclusions on the increase of VOL with the age of boars. The reason for the VOL increase with the increasing age of the boars is the increase of testicular mass and, consequently, their ability to produce sperm. According to Ford *et al.* (2006) and Kanokwan (2011), the primary factor for the daily sperm production is the Sertoli cell count associated with the mass of the testicles. The process of ejaculation in boars is multiphase. The first phase is pre-spermal, ejaculate without sperm (prostate secretion). The second phase is the most important, being the seminal fluid of the ejaculate and as most sperm is found in this seminal fluid (according to the various sources, 70-80%). The third phase is the post-spermal, secretions from accessory sex glands contribute the largest volume to the ejaculate. Contrary to these results, in the study by Tomiyama *et al.* (2008), no regression effect of age on variability of VOL was found. Contarary to our study, Wierzbicki *et al.* (2010) determined that sperm density tended to increase with increasing age of the boars. Wolf and Smital (2009a) determined that dependence of sperm concentration on age started with a short increase until one year of age followed by a long moderate decrease until 3 years and thereafter, relative stabilization. Research by Oberlender *et al.* (2012) has shown that there are no differences in the sperm motility between the boars' age groups. In contrast, decreased sperm motility with boar age was found in another study (Wolf and Smital, 2009a).

Table 4 shows LSMean values of the analysed fertility traits by factors included in the model.

Effect of breed: Pig breed, or genotype, significantly affected the variability of the studied traits, except for MO. SL boars exhibited the best libido, with respect to having the minimum duration of DPC, and ejaculates with the highest density. In regard to the VOL, fertile breeds (SL and LW) demonstrated superiority compared to Duroc (+12.53 and +11.25 ml).

There is a discrepancy in the results of this study in regard to the evaluation of libido compared to the results obtained by Okere *et al.* (2005), who found stronger libido in Landrace compared to Yorkshire boars during different seasons, but these differences were not significant. This discrepancy in libido may be due to different genetic structure of the studied populations, and differences in boar libido assessment methods. There is also a discrepancy in regard to VOL, since Okere *et al.* (2005) established that Yorkshire boars' ejaculate was significantly superior in volume compared to that of Landrace (336.05 and 144.42 ml, respectively). The superiority of fertile pig breeds (SL and LW) in relation to the meat-producing breed Duroc with respect to VOL, as determined in this study, is consistent with the results of research by Savić *et al.* (2013). In other research, Wolf and Smital (2009a) identified small differences between pig breeds in the properties of sperm, as Czech LW boars produced ejaculates with 6 ml less VOL compared to Czech Landrace boars, but with a higher concentration of sperm.

Effect of age at first ejaculation: The age of boars when introduced to reproduction, i.e. age at first ejaculation/collection, had a statistically significant impact on the variation of the studied traits except on the duration of ejaculation. Differences in sperm motility were determined only between AFE groups. Boars who had the first ejaculation/collection at an early age (23-27 weeks) exhibited the weakest libido during their reproductive life. In fact, premature introduction of boars to reproduction had a negative impact on subsequent sexual activity, regardless of the higher VOL ($P<0.05$) compared to the boars introduced at a later age. Quantitatively, the ejaculates of such boars had the highest VOL, but with the lowest qualitative properties (DEN and MO), which indicated that by the end of the performance test for the young boar a preparatory period was required before the introduction in the reproduction.

Effect of production traits: Libido of boars varied ($P<0.001$, Table 3), influenced by production traits (LM and ADG). Boars with lower carcass meat yield at the end of the performance test (less than 60%) demonstrated the best libido, and the preparation time for collection was 0.11 min less ($P<0.001$) compared to the boars with higher carcass meat yield (60% or more). The increase in ADG indicated the trend of weakening of libido, as in boars of the first class (ADG=0.481-0.579 kg/day), preparation time for collection was shorter by 0.14 and 0.22 minutes compared to the second (ADG=0.580-0.619 kg/day) and third class (ADG=0.620-0.701 kg/day) boars. Contrary to the negative trend of the manifestation of libido, increase in LM and ADG indicated the trend of increasing DE and VOL. Boars with the highest carcass meatiness (third class LM) had the highest VOL, and the differences compared to the first or second class were +6.32 ml ($P<0.01$) and +5.18 ml ($P<0.05$), respectively. The ejaculate volume of the boars with the highest ADG (class 3), in relation to other two classes, was greater ($P<0.001$) by 10.88, and 9.81 ml, respectively. In regard to the qualitative properties of ejaculate, differences existed only between the ADG classes in the average density manifestation, so that boars with the lowest daily gain (first class) had ejaculates with a density score higher by 0.02 compared to the general average. Increase of the preparation time for the collection (impaired libido) should not be a limiting factor in breeding selection directed towards the increase of LM and ADG, given the great economic importance of these production traits. On the other hand, however, it is necessary to appreciate biological limits in the selection and monitor the level of sexual drive with mandatory inclusion of libido in the estimation of breeding values of boars.

There was a positive genetic correlation between the size of the testicles (testicular mass) and production traits (back fat thickness, body mass) when the measurements were taken at a constant age (Johnson *et al.*, 1994). There was also a strong correlation between boar body weight and measures of boar testicular size (length and width) with sperm production (correlation coefficient 0.79 to 0.91), according to a study by Ugwu *et al.* (2009). Research results obtained by Huang and Johnson (1996) suggest that the selection in the direction of increase of the size of the testicles can be a way of improving the reproductive capacity of boars used for artificial insemination. Because of the nature of these correlations, it can be concluded that in boars with intensive growth, the testicular size will be larger, and thus, the production of sperm and ejaculate volume will also be greater.

Correlations between analysed traits: The linear correlation between production traits and fertility traits of boars is shown in Table 5. The correlations between the production traits LM and ADG and fertility traits were extremely weak. Correlation coefficients had low values, and contrary to ADG, only the correlation between the traits LM and DPC was statistically significant ($P<0.001$). Increased ADG had a positive effect on the VOL, but conversely, led to decreases in qualitative semen traits and weakening of libido (longer DPC).

According to a rough approximation of the value of correlations in Petz (2004), correlations between fertility traits and production traits found in current study were negligible. Therefore, increasing the lean meat content and lifetime daily gain will not have a negative impact on the subsequent reproductive performance of boars, i.e. this negative effect is negligible. One reason for the negligible correlations may be the different ages of animals at the time when phenotypic values of these traits were measured. In fact, the phenotypic values of production traits were determined when the boars were

around 6 months of age, while fertility traits were necessarily measured later in the boars' reproductive life. Similar conclusions were highlighted in the study by Wolf (2009), in which the genetic correlation of production traits and properties of sperm were close to zero (i.e. LM and ADG to VOL and concentration, -0.05 and -0.03, and 0.08 and 0.08, respectively). Oh *et al.* (2006) showed that there was low phenotypic correlation of average daily gain and ejaculate volume (r = -0.02) and concentration (r = 0.11).

Table 1. Classes of the age at first ejaculation, lean meat content and average life daily gain of the analysed boars.

Variable					
Age at first ejaculation		**Lean meat content**		**Average life daily gain**	
Classes	**Value (weeks)**	**Classes**	**Value (%)**	**Classes**	**Value (kg/day)**
1	23-27	1	57.1-59.9	1	0.481-0.579
2	28-31	2	60.0-60.9	2	0.580-0.619
3	32-52	3	61.0-64.1	3	0.620-0.701

Table 2. Basic statistical parameters of the studied boars.

Trait	N	Mean±SD	Interval
Duration of preparing to collection (min)	7543	3.56±0.63	1.00-7.00
Duration of ejaculation (min)	7535	6.09±0.70	3.00-8.00
Volume of ejaculate (ml)	7576	235.81±77.41	40.00-810.00
Density of ejaculate	7504	2.02±0.29	1.00-3.00
Sperm motility	7516	3.98±0.15	1.00-5.00
Lean meat content (%)[#]	-	60.28±1.38	57.10-64.10
Average life daily gain (kg/day)[#]	-	0.593±0.044	0.481-0.701

N= number of ejaculations; SD= Standard Deviation; [#]= The value for 105 studied boars

Table 3. Effect of involved factors in the model on variability of the analysed traits.

Trait	Factor				
	b	**Breed**	**AFE (weeks)**	**LM (%)**	**ADG (kg/day)**
Duration of preparing to collection (min)	0.0001***	***	***	***	***
Duration of ejaculation (min)	0.0006***	***	NS	**	***
Volume of ejaculate (ml)	0.0643***	***	*	*	***
Density of ejaculate	-0.0001***	*	***	NS	***
Sperm motility	-0.0000***	NS	***	NS	NS

b= linear regression coefficient of the effect of age of the boars at ejaculation; AFE= age at first ejaculation/collection; LM= lean meat content; ADG= average life daily gain; Significance: NS- not significant, *= P<0.05, **= P<0.01, ***= P<0.001

Table 4. Least square mean (LSMean) of the analysed traits by factors.

Factors		Traits				
		DPC (min)	**DE (min)**	**VOL (ml)**	**DEN**	**MO**
Breed	SL	3.45^{AA}	6.11^{AA}	239.62^{AA}	2.05^{Aa}	3.99
	LW	3.60^{BB}	6.13^{AA}	238.34^{AA}	2.02^{Bb}	3.98
	Duroc	3.63^{BB}	6.04^{BB}	227.09^{BB}	2.03	3.99
Age at first ejaculation/collection (weeks)	23-27	$3.65^{AA,Aa}$	6.12^{aa}	238.68^{aa}	2.00^{AA}	3.97^{AA}
	28-31	$3.59^{AA,Bb}$	6.09	233.52^{bb}	2.04^{BB}	3.99^{BB}
	32-52	3.44^{BB}	6.07^{bb}	232.85^{bb}	2.05^{BB}	3.99^{BB}
Lean meat content (%)	57.1-59.9	3.49^{AA}	6.06^{AA}	232.53^{Aa}	2.03	3.98
	60.0-60.9	3.60^{BB}	6.08^{Aa}	233.67^{aa}	2.02	3.99
	61.0-64.1	3.60^{BB}	$6.14^{BB,Bb}$	$238.85^{Bb,bb}$	2.04	3.98
Average life daily gain (kg/day)	0.481-0.579	3.44^{AA}	6.06^{AA}	231.03^{AA}	$2.05^{AA,aa}$	3.99
	0.580-0.619	3.58^{BB}	6.07^{AA}	232.10^{AA}	2.02^{BB}	3.99
	0.620-0.701	3.66^{CC}	6.16^{BB}	241.91^{BB}	2.03^{bb}	3.98
µ		3.56	6.09	235.02	2.03	3.99

µ= general population average; SL= Swedish Landrace; LW= Large White; DPC= duration of preparing to collection; DE= duration of ejaculation; VOL= volume of ejaculate; DEN= density of ejaculate; MO= sperm motility; Diferences between LSMean values by traits within analysed factors with different superscripts are statistically significant: aa,bb= P<0.05; Aa,Bb= P<0.01; AA,BB,CC= P<0.001.

Table 5. Correlation coefficient (r) between production and fertility traits.

Trait	Duration of preparing to collection (min)	Duration of ejaculation (min)	Volume of ejaculate (ml)	Density of ejaculate	Sperm motility
Lean meat content (%)	0.04^{***}	0.00^{NS}	-0.01^{NS}	0.01^{NS}	0.01^{NS}
Average life daily gain (kg/day)	0.15^{***}	0.05^{***}	0.06^{***}	-0.08^{***}	-0.04^{**}

Significance: NS= not significant; **= P<0.01; ***= P<0.001

Conclusions: Overall, the demonstration/manifestation and variability of fertility traits of boars during reproductive exploitation is influenced by various genetic and paragenetic factors/effects. In the current study, there were differences between pig breeds, and Duroc boars, by comparison with fertile breeds, showed inferiority in use in reproduction. After completion of the performance test, a preparatory period is required before the introduction of young boars to reproduction, because too early an introduction has negative impact on their later sexual activity. Given the extremely low, or negligible correlation between production traits and fertility traits, selection aimed to increase the lean meat content and lifetime daily gain will not have a negative impact on the subsequent reproductive performance of boars. Regardless of the great economic importance of production traits (growth and carcass quality), they should not be the only criterion for selection, but rather, it is necessary to also evaluate the breeding value of boars based on assessment of their libido and ejaculate traits. This approach to breeding and selection should achieve faster genetic progress and successful expansion of genes of genetically valuable breeding males, while also optimising their use in reproduction.

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