

## **THE EFFECT OF GROWTH RATE IN PURE-BRED AND CROSS-BRED BOARS ON THEIR SEMEN CHARACTERISTICS**

BOGDAN SZOSTAK<sup>1</sup>; ŁUKASZ PRZYKAZA<sup>2</sup>; APOSTOL APOSTOLOV<sup>3\*</sup>

<sup>1</sup> University of Life Sciences in Lublin, Institute of Animal Nutrition and Bromatology, Faculty of Biology, Animal Sciences and Bioeconomy, 22-950 Lublin, Poland;

<sup>2</sup> Polish Academy of Sciences, Medical Research Centre, 02-106 Warsaw, Poland;

<sup>3</sup> Agrarian Academy, Agricultural institute, 9700 Shumen, Bulgaria

### **Abstract**

Szostak B., Ł. Przykaza and A. Apostolov, 2018. The effect of growth rate in pure-bred and cross-bred boars on their semen characteristics, *Bulg. J. Agric. Sci.*, 24 (Suppl.2): 106-111

The aim of the study was to examine the effect of daily growth rate on the semen characteristics of purebred boars (Polish Large White and Polish Landrace) and crossbred boars (Duroc x Pietrain and Pietrain x Duroc). The research was carried out on 29 purebred boars (2024 ejaculates) and 22 crossbred boars (1156 ejaculates). The following characteristics were analysed: ejaculate volume, sperm concentration, percentage and number of live spermatozoa, and number of insemination doses obtained per ejaculate. A high rate of growth in the boars was found to have no negative effect on the quality of their ejaculates. In both purebred and crossbred boars, the largest ejaculate volume, the highest percentage of live sperm and the most insemination doses per ejaculate were obtained for the boars with the highest daily weight gain (over 851 g).

The semen of crossbred boars with the same intensity of growth as purebred boars (801-850 g and > 851 g) was characterized by significantly greater ejaculate volume, a higher sperm concentration, a higher live sperm count in the ejaculate, and a higher average number of insemination doses prepared from one ejaculate. The results indicate that the level of the selection index currently used in the breeding of boars has no negative impact on the characteristics of their ejaculates.

*Key words:* growth rate, boars, ejaculates

### **Introduction**

The dynamic growth and increasing importance of artificial insemination in pig breeding is linked to the measurable benefits of its use. Artificial insemination can significantly accelerate genetic gain and reduce the risk of spreading infectious diseases. It also substantially reduces breeding costs and enables improvement of the spatial organization of pig breeding. To obtain the desired results from the use of insemination, particular attention should be paid to the proper selection and proper use of boars kept at sow insemination stations involved in the production and distribution of semen. Apart from proper development of the reproductive organs,

sufficient libido and high-quality semen, males should also have very good fattening and carcass performance. In work on the improvement of pigs, special attention is paid to growth rate and lean meat content. However, intensive selection in this direction not only has benefits, but may have negative effects as well, manifested as poorer development of the reproductive, digestive and musculoskeletal systems, an increase in cardiac insufficiency, and lower resistance to stress (Radhamer 1993; Kawęcka 2002). Studies by many authors have shown significant negative correlations between some fattening and reproductive characteristics of boars (Weeb et al. 1998; Milewska 2007; Udała et al. 2015). Fiałkowska et al. (2000), in a study of the influence of the growth parameters of Duroc

\*Corresponding author: agr\_inst@abv.bg

boars during the rearing period on their semen characteristics, concluded that this factor had no effect on semen traits. Many authors express the view that the correlations between growth rate and semen characteristics in boars are generally low and insignificant (Dziadek and Kamyczek 1991; Oh, et al. 2006). The inconsistent results published in the scientific literature by different authors may result from genetic differences in the animals or the scale of the factors studied. Boars of different breeds or crossbreds may produce ejaculates that differ significantly in the physical characteristics of the semen (Bertoni et al. 2002; Kondracki 2003; Wysokińska and Kondracki 2005]. Crossbred boars generally produce ejaculates with more favourable characteristics than purebred boars.

In view of the lack of unambiguous and consistent opinions on the possible effect of the growth rate of boars on their breeding value, the aim of the research was to determine the effect of weight gains in purebred boars (Polish Large White and Polish Landrace) and crossbred boars (Duroc x Pietrain and Pietrain x Duroc) during the period rearing on their semen parameters.

## Materials and Methods

The present study aims to assess the influence of the daily weight gain in pure-bred (Polish Large White, Polish Landrace – pulled in one group) and cross-bred (Pietrain x Duroc, Duroc x Pietrain – pulled in one group) boars on their semen characteristics in conditions of the insemination station. Additionally, the differences of semen features between pure- and cross-bred boars were evaluated. The material for the study consisted of 29 pure-bred (2024 ejaculates) and 22 cross-bred (1156 ejaculates) boars used at the Sow Insemination Station in Białka (Poland). On the basis of the results of performance testing carried out on the boars' 180th day of life, taken from breeding documentation, the boars were divided into three groups according to the daily weight gain (I – 700 – 800 g, II – 801 – 850 g, III – > 851 g). During the growth period the boars were kept in groups and fed complete mixed rations according to Nutrient Requirements of Pigs (1993). From the start of their exploitation for breeding the boars were kept in identical environmental conditions, in individual pens with litter.

Semen was collected from the boars by the manual method, using a phantom. A detailed quantitative and qualitative evaluation of the ejaculates was performed using common methods and based on the following characteristics: volume, sperm concentration, percentage of sperm with progressive movement, number of sperm with progressive movement per

ejaculate and per insemination dose, number of insemination doses obtained per ejaculate. Statistical analyses were performed using Statistica software. All results were expressed as the means  $\pm$  standard error of the mean (SEM). The influence of the growth rate was evaluated using a one-way ANOVA, followed by the Tukey's post hoc test. The differences between pure- and cross-bred boars were analyzed with unpaired t-test. A value of  $P < 0.05$  was considered to be statistically significant.

## Results and Discussion

Tables 1 and 2 show the values of semen parameters measured in pure-bred and hybrid boars depending on the daily weight gain. Our studies have indicated that the volume of semen of the both pure- and cross-bred boars was significantly higher in the groups II ( $268.458 \pm 1.541$  ml,  $P < 0.01$ ;  $287.034 \pm 2.408$  ml,  $P < 0.001$ ) and III ( $270.258 \pm 3.992$  ml,  $P < 0.05$ ;  $294.855 \pm 4.817$  ml,  $P < 0.001$ ) than in the group I ( $255.090 \pm 3.136$  ml;  $260.673 \pm 4.133$  ml). Similarly, the percentage of sperm with progressive movement, number of sperm with progressive movement per ejaculate and number of insemination doses obtained per ejaculate significantly ( $P < 0.05 - P < 0.001$ ) increased simultaneously with the range of the daily weight gain. The concentration of spermatozoa was significantly higher in groups II and III only in cross-bred boars ( $P < 0.05$ ). However, there were no significant differences of number of spermatozoa per insemination dose between groups in both breeds.

Both the purebred boars (Polish Large White and Polish Landrace) and crossbreds (Duroc x Pietrain and Pietrain x Duroc) used in the study had very good daily weight gains, ranging from 751 to 851 grams. Analysis of features characterizing the ejaculates of boars with different growth rates showed that boars with daily gains of over 851 g produced ejaculates with the most favourable parameters. These results confirm our earlier research (Szostak et al. 2016) carried out on Duroc x Pietrain x Pietrain x Duroc crossbreds, where significantly the largest average ejaculate volume was obtained for boars with daily weight gains in the range of 851-900 g. Falkenberg et al. (1989) reported a stronger libido in faster growing boars, which according to the authors may indicate earlier sexual maturity in faster growing individuals. In a study on selected fattening and meat performance traits and semen quality in young purebred and crossbred boars, Udala et al. (2015) found that ejaculate volume and total ejaculate sperm count were positively correlated with daily weight gains, while sperm concentration and growth rate were negatively correlated. A significant effect of daily weight gains on ejaculate volume in

boars of the breeds Swedish Landrace, Large White and Duroc has also been reported by Savić et al. (2014). According to the authors, selection aimed at increasing carcass meat content and weight gains in growing boars has no negative impact on their future reproductive capacity. Despite the great economic importance of production traits (growth and carcass quality), they should not be the only selection criterion; assessment of the breeding value of boars should be based on evaluation of their libido and ejaculate characteristics.

A study by Petz (2004) found negligible correlations between semen characteristics and the performance parameters of young boars, which according to the author means that meatiness and growth rate have no negative effect or an insignificant effect on subsequent reproductive results.

The author states that one of the reasons for the insignificant correlations between these traits may be the measurement of phenotypic values in different age groups of animals. A study by Wolf (2009) found that the genetic correlations between the growth rate and meatiness of young boars and ejaculate volume and sperm concentration were close to zero. Oh et al. (2006), on the other hand, reported a low, negative phenotypic correlation between average daily weight gains in young boars and the volume of their ejaculates ( $r = -0.02$ ) and a low but positive relationship between daily gains and the ejaculate sperm concentration.

**Table 1. The influence of the daily weight gain on the semen characteristics of pure-bred boars**

Traits of semen	Daily weight gain [g]						Significance of differences
	751 - 800 (I)		801 - 850 (II)		> 851 (III)		
	X	SEM	X	SEM	X	SEM	
Ejaculate volume [ml]	255.090	3.136	268.458	1.541	270.258	3.992	I-II**; I-III*
Concentration of spermatozoa [thous./mm <sup>3</sup> ]	252.848	2.591	258.166	1.325	257.271	3.537	n.s.
Percent of live spermatozoa [%]	76.254	0.303	76.704	0.127	79.208	0.175	I-III***; II-III***
Number of live spermatozoa [bln]	50.219	0.970	54.118	0.499	56.720	1.415	I-II*; I-III***
Number of spermatozoa per insemination dose [bln]	2.567	0.010	2.568	0.003	2.554	0.007	n.s.
Number of insemination doses	19.713	0.399	21.218	0.201	22.321	0.566	I-II*; I-III***

\*P < 0.05, \*\*P < 0.01, \*\*\*P < 0.001, n.s. – no significances

**Table 2. The influence of the daily weight gain on the semen characteristics of cross-bred boars**

Traits of semen	Daily weight gain [g]						Significance of differences
	751 - 800 (I)		801 - 850 (II)		> 851 (III)		
	X	SEM	X	SEM	X	SEM	
Ejaculate volume [ml]	260.673	4.133	287.034	2.408	294.855	4.817	I-II***; I-III***
Concentration of spermatozoa [thous./mm <sup>3</sup> ]	251.623	4.333	270.320	1.830	271.590	4.686	I-II**; I-III**
Percent of live spermatozoa [%]	78.141	0.294	76.684	0.175	85.202	5.202	I-III*; II-III**
Number of live spermatozoa [bln]	53.041	1.538	59.854	0.719	65.869	1.860	I-II**; I-III***; II-III*
Number of spermatozoa per insemination dose [bln]	2.565	0.009	2.547	0.005	2.539	0.008	n.s.
Number of insemination doses	20.889	0.638	23.680	0.292	26.179	0.744	I-II**; I-III***; II-III*

\*P < 0.05, \*\*P < 0.01, \*\*\*P < 0.001, n.s. – no significances

Table 3 shows the levels of significance of differences in semen characteristics between pure-bred and cross-bred boars within the ranges of the daily weight gain. We have observed significant differences of studied semen parameters between pure- and cross-bred boars. The cross-bred boars have significantly higher: volume of semen ( $P < 0.001$ ), concentration of spermatozoa ( $P < 0.001$ ), number of sperm with progressive movement per ejaculate ( $P < 0.001$ ) and number of insemination doses obtained per ejaculate ( $P < 0.001$ ), observed in the range II (801 – 850 g) of daily weight gain. Only number of spermatozoa per insemination dose was significantly higher in pure-bred boars ( $P < 0.001$ ). In the range III (> 851 g) were similar differences with exception of the percent of live spermatozoa and the number of spermatozoa per insemination dose – that did not differ. In the range I (700 – 800 g) only percent of live spermatozoa was significantly higher in cross-bred boars ( $P < 0.001$ ), there were no differences in the other parameters in this range of the daily weight gain.

In general, the manifestation and variability of the ejaculate characteristics of boars during their use for breeding are influenced by a variety of genetic (Bertani et al. 2002, Szostak 2003, Borucka-Jastrzębska et al., 2008) and non-genetic factors (Knecht et al. 2013, Szostak et al. 2015). In our study, differences were noted between purebred boars (Polish Large White and Polish Landrace) and crossbreds (Duroc x Pietrain and Pietrain x Duroc). The crossbreds were characterized by better semen characteristics. Our results are in agreement with those reported by other authors (Muczyńska et al., 2010, Udała et al., 2015). The superior semen parameters of crossbred boars are due to heterosis, which occurs when pigs of different breeds are crossbred. Particularly high ejaculate parameters were noted for the crossbred boars with daily weight gains of 801-850 g (group II) and above 851 g (group III). Our results confirm that a high rate of daily growth does not negatively affect the quantity and quality of boar semen, which may indicate that faster growing boars attain sexual maturity and stabilization of the spermatogenesis process earlier.

**Table 3. The differences between pure- and cross-bred boars in semen characteristics within the ranges of the daily weight gain**

Traits of semen	Daily weight gain [g]		
	751 - 800 (I)	801 - 850 (II)	> 851 (III)
Ejaculate volume [ml]	n.s.	P < 0.001	P < 0.001
Concentration of spermatozoa [thous./mm <sup>3</sup> ]	n.s.	P < 0.001	P < 0.05
Percent of live spermatozoa [%]	P < 0.001	n.s.	n.s.
Number of live spermatozoa [bln]	n.s.	P < 0.001	P < 0.001
Number of spermatozoa per insemination dose [bln]	n.s.	P < 0.001	n.s.
Number of insemination doses	n.s.	P < 0.001	P < 0.001

n.s. – no significances

## Conclusion

The high rate of growth of the boars studied had no negative effect on the quality of their ejaculates. In both the purebred and crossbred boars, the largest ejaculate volume, the highest percentage of live sperm and the most insemination doses per ejaculate were obtained for the boars with the highest daily weight gains (over 851 g).

There were also significant differences between the semen characteristics of the purebred and crossbred boars. These differences were particularly pronounced in boars with higher daily weight gains (801-850 and > 851 g).

The results obtained indicate that the intensity of current selection in breeding of boars of the breeds analysed does not adversely affect their future reproductive performance.

## Acknowledgements

The publishing of the present scientific paper is co-financed by "Scientific Researches" Fund Contract №01/31 from 17.08.2017.

## References

- Bertani, G. R., I. R. Scheid, R. Irgang, W. Barioni, I. Wentz and B. Alfonso, 2002. Gonadalsperm reserve in purebred Landrace and Large White boars of high average daily gain. *Theriogenology*, **57**: 859-867.
- Borucka-Jastrzębska, E., M. Bialek, M. Brzezińska, D. Kawczuga, W. Drewnowski and L. Lisiecki, 2008. Parametry ejakulatu w zależności od rasy świń [Semen parameters in relation to pig breed]. *Medycyna Weterynaryjna*, **64**(10): 1248-1251.
- Ciereszko, A., 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.
- Dziadek, K. and M. Kamyczek, 1991. Wartość biologiczna nasienia knurów w zależności od ich tempa wzrostu. *Zesz. Nauk. Prz. Hod.* **9**: 283.
- Falkenberg, H. and H. Hammer, 1989. Genetische und phänotypische Beziehungen zwischen Merkmalen der Mast- und Ansatzleistung von Ebern in zentralen Aufzuchtstationen der Besamungseignung dieser Tiere sowie der Wurfleistung ihrer Schwestern. *Archiv für Tierzucht. Berlin*, **32**(2): 163-171.
- Fialkowska, B., J. Owsiany, A. Kołodziej and P. Kocięcki, 2000. Wpływ parametrów wzrostu knurów rasy duroc w okresie odchowu na ich cechy nasienia. *Zeszyty Naukowe AR Szczecin*, **39**: 45-53
- Kawęcka, M. 2002. Zależność między tempem wzrostu i mięsnością młodych knurów populacji ojcowskich a ich przydatnością do rozrodu. Praca habilitacyjna, AR Szczecin, nr 206.
- Kondracki, S., 2003. Breed differences in semen characteristics of boars used in artificial insemination in Poland. *Pig News and Information*, **24**(4): 119-122.
- Kondracki, S., A. Wysokińska and Z. Kowalczyk, 2003. Wpływ krzyżowania rasy duroc i pietrain na cechy ejakulatów knurów mieszańców dwurasowych. *Zeszyty Naukowe Przeglądu Hodowlanego*, **68**(2): 109-112.
- Knecht, D., S. Środoń, K. Szulc and K. Duźński, 2013. The effect of photoperiod on selected parameters of boar semen. *Livestock Sci.*, **157**(1): 364-371.
- Milewska, W., 2007. Ocena przyżyciowa knurów rasy hampshire i pietrain oraz mieszańców dwurasowych a efekty użytkowania rozplodowego w stacjach unasienniania loch. *Medycyna Weterynaryjna*, **6**, pp. 708-711.

- Muczyńska, E., S. Kondracki, and A. Wysokińska**, 2010. Betweenbreed variation in physical characteristics of ejaculates from boars used in Sow Insemination Station. *Rocz. Nauk. Zoot.*, **37**(2): 151-157.
- Nutrient Requirements of Pigs. Nutritive Value of Feedstuffs (in Polish). 1993. PAN, Warszawa. The Kielanowski Institute of Animal Physiology and Nutrition (Editor), Jabłonna (Poland).
- Oh, S. H., M. T. See, T. E. Long and J. M. Galvin**, 2006. Estimates of genetic Correlations between Production and Semen traits in Boar. *Asian-Austral. J. Anim. Sci.*, **19**(2): 160-164.
- Petz, B.**, 2004. Osnovne statističke metode za nematematičare. V izdanje. Naklada slap: Zagreb (croatia).
- Rydhmer, L.**, 1993. Pig reproductive genetics and correlations between reproduction and production traits. Dissertation, 106, SLUInfo/Repro, Uppsala.
- Savić, R., M. Petrović, D. Radojković, Ć. Radović and N. Parunović**, 2014. Libido and ejaculate traits of performance tested boars. *J. of Animal. and Plant Sci.*, **24**(6): 1649-1654.
- Szostak, B.**, 2003. Wpływ genotypu, wieku knura i sezonu eksploatacji na wybrane cechy ejakulatów. *Zeszyty Naukowe Przeglądu Hodowlanego*, 68, pp. 147-155.
- Szostak, B., Ł. Przykaza and A. Stasiak**, 2015. The effect of growth rate and lean meat content In polish Large White boars on their semen characteristics. *Polish J. Natural Sci.*, **30**(4): 359-366
- Szostak, B., Ł. Przykaza and V. Katsarov**, 2016. The effect of growth rate and lean meat content in Pietrain x Duroc and Duroc x Pietrain hybrid boars on their semen characteristics. *Bulg. J. of Vet. Med.*, **19**(2): 145-152
- Udała, J., E. Kwita, D. Gączarzewicz, J. Kuba, T. Stankiewicz, B. Błaszczyk, B. Pilarczyk, A. Tomza-Marciniak and M. Bąkowska**, 2015. Selected meat and fattening features and sperm quality in young purebred and hybrid boars. *Acta Sci. Pol. Zootechnica*, **14** (2): 165-174
- Wolf, J.**, 2009. Genetic correlations between production and semen traits in pig. *Animal*, **3**(8): 1094-1099
- Weeb, A. J., P. R. Hampton and A. D. Hall**, 1998. Crossbreeding strategies to break genetic antagonisms in pig breeding. Proc 49th Annual Meeting EAAP, Warsaw, pp. 1-8
- Wysokińska, A. and S. Kondracki**, 2005. Częstość występowania zmian w budowie morfologicznej plemników knurów mieszańców duroc x pietrain i hampshire x pietrain oraz czystorasowych knurów duroc, hampshire i pietrain. *Folia Universitatis Agriculturae Stetinensis, Zootechnica*, **243**(47): 191-198.