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SELECTED MEAT AND FATTENING FEATURES AND SPERM QUALITY IN YOUNG PUREBRED AND HYBRID BOARS

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Abstract. The aim of this study was to investigate the relationship between the selected semen quality features and daily gains and meatiness of boars at the beginning of their reproductive use in one of the animal local artificial insemination centre in Pomerania region, Poland. The study was performed on 158 PLW, PL and Duroc $\times$ Pietrain hybrid boars in the age of 9 to 14 months. The following features were analysed: ejaculate volume (cm^3), sperm concentration ($\times 10^6 \cdot cm^{-3}$), percentage of progressive motility sperm, the total number of sperm in the ejaculate, mean standardised daily gain, intravital meatiness and selection index. The study has shown that the semen from hybrids, in comparison to the purebreds, was characterized by the higher concentration and motility of sperm but the mean volume of ejaculate was lower which resulted in the general lower amount of sperm in ejaculates. The hybrids had also the highest daily gains. With the similar meatiness in all the three groups, the highest selection index was noted for the PLW boars. The positive relationships were found between the ejaculate volume, total number of spermatozoa in the ejaculate and daily gains, meatiness and selection index. The negative relationships were found for these parameters compared to sperm concentration. The results indicate that it is possible to obtain the good quality boar semen simultaneously with maintaining the correct rate of body growth and meatiness.

Key words: boar, semen, daily gain, meatiness

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INTRODUCTION

Quality and quantity of sperm obtained from a boar is a main determinant of its reproductive value, and apart from the breeding aspects, has a crucial influence on the economic efficiency of the insemination facility. This efficiency is expressed, among others, as the number of insemination doses obtained from an ejaculate, which directly depends on the volume of the ejaculate, sperm motility and concentration. These features, especially in young individuals, are highly variable and are influenced by a number of environmental and genetic factors [Kondracki et al. 2003, Szostak and Przykaza 2010, Wilczyńska et al. 2013, Wysokińska and Kondracki 2014]. Therefore, systematic control and analysis of the factors determining sperm quality is of a great importance and decides on the use of artificial insemination in breeding. Due to the mentioned control, as well as other modern biotechnology means, it was possible to achieve undeniable progress in terms of the functional characteristics of pigs in recent years. Insemination makes it possible to use the best males to a wider extent. The intensity of their use, expressed as the quality and quantity of collected sperm and finally as the amount of obtained insemination doses, depends on many factors and varies with a male's age. In general, first ejaculates are of low quality and only 7–8-month old young boars' semen has properties similar to adult boars' semen [Szostak and Przykaza 2010]. The dynamics which reflects the changes in properties of ejaculates before the completion of the first year of life is high, and then stabilizes [Kondracki and Wysokińska 2005, Udała et al. 2005, Kondracki 2006, Kawęcka et al. 2008, Szostak and Przykaza 2010]. Only in boars older than 20 months do the physical properties of ejaculates remain on a constant level [Lasota et al. 2004].

Among numerous genetic and environmental factors affecting the quality of semen, the rate of gain and degree of musculature achieved during the growth may be of great importance. Research conducted on many animal species indicate the complex nature of the relationship between the growth and development features and the male reproductive traits. For both males and females it was shown that the selection targeted to improve the meatiness and growth may affect animal's fertility [Young et al. 1986]. It was found that the rapid growth may negatively affect the length of boars' use and be the cause of fertility problems [Strzeżek 1996, Kawęcka et al. 2008]. A similar effect may be caused by an increase in the intravital assessment index [Kondracki et al. 2003]. Taking this into consideration, a decision was made to investigate the relationship between selected semen quality traits and daily gains and meatiness of boars at the beginning of their reproductive use in one of the animal insemination facilities.

MATERIAL AND METHODS

The research was conducted on 158 Polish Landrace (PL), Polish Large White (PLW) purebred boars and on Duroc x Pietrain hybrids at the age of 9 to 14 months. The animals were used at one of the animal local artificial insemination centre in Pomerania region, Poland. The boars were kept and fed according to principles generally accepted in insemination centre. After the collection and preliminary evaluation the semen was analysed. The assessment included: the volume of the ejaculate (cm^3), sperm concentration ($\times 10^6 \cdot cm^{-3}$) and the percentage of sperm exhibiting progressive motility. Based on these parameters the total sperm count in the ejaculate was determined. The research included ten first ejaculates collected from each of the boars qualified for reproductive use. The data collected from each of the boars included mean standardised daily gain, intravital meatiness and selection index. For the studied properties of the semen quality as well as for the meat and fattening features the mean values and standard deviations were calculated, taking the animals' genotype as a criterion. There were three genetic groups taken into consideration: Group 1 – PLW, Group 2 – PL and Group 3 – Duroc $\times$ Pietrain. The significance of the differences between the groups was estimated with the D-Duncan test. Also, the simple correlation coefficients between the studied features were estimated. The statistical analyses were conducted using the Statistica PL 10 package.

RESULTS AND DISCUSSION

The conducted research showed that the mean ejaculate volume reached 223.3 cm^3 and the ejaculates with the highest volume (242.9 cm^3, on average) were collected from PLW boars (Table 1). Less semen was collected from PL boars (229.4 cm^3) and the least from the hybrids (182.2 cm^3). The differences in ejaculate volumes were statistically significant. The results point to variability of this feature development depending on the environmental conditions. The same analysis conducted by Adamiak et al. [2010] showed that the ejaculates with the highest volume were collected from PL boars. Similar results were obtained by Pokrywka and Ruda [2001] and Szostak [2003]. The highest sperm concentration was observed in the hybrid group (473.8 $\times 10^6 \cdot cm^{-3}$) whilst PL and PLW boars groups had lower concentration (433.2 $\times 10^6 \cdot cm^{-3}$ and 423.5 $\times 10^6 \cdot cm^{-3}$, respectively). The differences between purebred and hybrid boars were statistically significant. Muczyńska et al. [2010] demonstrated that the Duroc boars' ejaculates have low volume but high sperm concentration. These features are genetically determined in this breed and are passed also to hybrids as a result of paternal heterosis [Pokrywka and Ruda 2001, Knecht et al. 2004, Wysokińska and Kondracki

2013]. These results were confirmed by the research by Kondracki et al. [2000] as well as Szostak and Przykaza [2010], who showed that the PLW boars had the lowest sperm concentration in ejaculates compared to other breeds.

Table. 1. The properties of semen in the studied boar groups

Tabela. 1. Wartości badanych cech nasienia knurów w grupach badawczych

Grupa Group	n	Trait – Cecha			
		Ejaculate volume, cm^3 Objętość ejakulatu, cm^3	Sperm concentration, $\times 10^6 \cdot cm^{-3}$ Koncentracja plemników, $\times 10^6 \cdot cm^{-3}$	Percentage of spermatozoa with progressive motility, % Ruch postępowy plemników, %	Total number of spermatozoa, $\times 10^9$ Liczba plemników w ejakulacie, $\times 10^9$
1. PLW – wbp	586	242.9 ±91.2 ^{Aa}	423.5 ±116.6 ^{A}	79.47 ±4.85 ^{A}	80.45 ±23.10 ^{A}
2. PL – pbz	586	229.4 ±76.0 ^{Ab}	433.2 ±108.9 ^{A}	77.67 ±5.30 ^{BC}	76.16 ±22.14 ^{BC}
D × P	366	182.2 ±74.3 ^{Bbc}	473.8 ±173.7 ^{B}	80.67 ±7.31 ^{B}	68.05 ±26.95 ^{B}
Total – Ogółem	1538	223.3 ±85.1	438.8 ±130.8	79.07 ±5.81	75.95 ±24.12

a, b, c, A, B, C – the means labelled with different letters differ significantly at $P \leq 0.05$ and $P \leq 0.01$, respectively.

a, b, c, A, B, C – średnie oznaczone różnymi literami różnią się statystycznie istotnie, odpowiednio przy $P \leq 0{,}05$ i $P \leq 0{,}01$.

Table 2. The values of fattening and meat performance boars in study groups

Tabela 2. Wartości badanych cech użytkowości tucznej i mięsnej knurów w grupach

Grupa Group	n	Trait – Cecha		
		Daily gain, g Przyrost dzienny, g	Meatiness, % Mięsność, %	Index Indeks
1. PLW – wbp	59	824.6 ±36.9 ^{A}	62.17 ±1.33 ^{A}	142.9 ±9.58 ^{Aa}
2. PL – pbz	60	813.7 ±41.9 ^{BC}	61.58 ±1.80 ^{C}	141.0 ±12.41 ^{Ab}
3. D × P	39	834.4 ±44.8 ^{B}	62.11 ±0.98 ^{AB}	131.9 ±22.91 ^{B}
Total – Ogółem	158	822.8 ±41.6	61.93 ±1.49	139.6 ±15.41

a, b, A, B, C – the means labelled with different letters differ significantly at $P \leq 0.05$ and $P \leq 0.01$, respectively.

a, b, A, B, C – średnie oznaczone różnymi literami różnią się statystycznie istotnie, odpowiednio przy $P \leq 0{,}05$ i $P \leq 0{,}01$.

Statistically significant, although relatively low variation was recorded for the percentage of the sperm exhibiting progressive motility. It was highest in the hybrid boars (80.67%) and lowest in PL boars (77.67%) and reached the mean of 79.07% for all of the boars. Overal, the highest sperm content in an ejaculate was found in PLW boars (80.45×10^9), whilst PL and hybrid boars had lower sperm count (76.16×10^9 and 68.05×10^9, respectively).

The determined daily gains for boars during the examination period reached 822.8 g on average. The highest daily gains were observed in the hybrid boars (834.4 g), PLW boars showed daily gains lower by ca. 10 g and the lowest gains were observed in PL boars (813.7 g). These boars also had the lowest meatiness

(61.58%) compared to the mean of the whole population (61.93%). The hybrids and PLW boars showed similar meatiness (62.17% and 62.11%, respectively). The highest selection index was observed in the PLW group (142.9), which was significantly ($P \leq 0.01$) higher than the index of the hybrids (131.9) and significantly ($P \leq 0.05$) higher than the PL group (141.0).

The mean results for particular features are close to the results presented by other authors (Eckert and Szyndler-Nędza, 2014), which indicate the accurate growth and development of the tested animals.

Table 3. Correlation coefficients between the studied traits

Tabela 3. Wartości współczynników korelacji między badanymi cechami

Trait – Cecha		1	2	3	4	5	6	7
1	Ejaculate volume, cm^3 Objętość ejakulatu, cm^3	–						
2	Sperm concentration, $\times 10^6 \cdot cm^{-3}$ Koncentracja plemników, $\times 10^6 \cdot cm^{-3}$	–0.418**	–					
3	Progressive motility, % Ruch postępowy, %	0.091	–0.121**	–				
4	Total numer of spermatozoa, $\times 10^9$ Liczba plemników w ejakulacie, $\times 10^9$	0.593**	–0.297**	0.168**	–			
5	Daily gain, g Przyrost dzienny, g	0.075*	–0.030	0.002	0.031	–		
6	Meatiness, % Mięsność, %	0.118**	–0.085*	0.055*	0.010	–0.007	–	
7	Index Indeks	0.106**	–0.006	–0.088*	0.085*	0.580**	0.206	–

*, ** – significance of the correlation coefficient (r) at P = 0.05 and 0.01 respectively.
*, ** – istotność współczynnika korelacji (r) odpowiednio przy P = 0,05 i 0,01.

A correlation was found between the analysed sperm assessment factors and the meat and fattening use properties, which confirms the complex nature of the research problem. The coefficient of the correlation between the volume of ejaculate and daily gain, meatiness and selection index ranged between 0.075 to 0.118 and was statistically significant (Table 3). Different results were however recorded for the sperm concentration. The estimated correlation coefficients were negative and statistically insignificant, apart from meatiness (–0.085, $P \leq 0.05$). It can be speculated that the relationship between the volume and the sperm concentration of an ejaculate and boars' daily gain, meatiness and selection index are a result of commonly known negative relationships between the mentioned semen features, which also found its confirmation in the present study ($r = –0.418$, $P \leq 0.01$). It can also be speculated that such distinct relationships may have arisen from the differences in the gonads development intensity and additional sex glands in young boars (Strzeżek 2007). The results of the present research suggested that in the studied animals the gonads development was not proportional to the animal

development and the seminiferous tubules' epithelium was not yet fully efficient in the young animals. It confirms the results of other authors (Kondracki et al. 2000, Lasota et al. 2004]) demonstrating that semen quality and quantity increase with the age of a boar and stabilises around the second year of life. The correlation coefficient for the percentage of sperm exhibiting progressive motility was variable with positive values for meatiness and daily gain and negative for the selection index. Positive relationships were observed between the number of sperm exhibiting progressive motility in ejaculates and the three analysed meat and fattening traits of boars. The relations were statistically significant for the selection index 0.085 ($P \leq 0.05$, Table 3).

Due to the genetic diversity of the studied boars, also the relationships between the semen quality traits and meat and fattening properties of boars were analysed with respect to the three groups. In general, the correlation coefficients had values similar to the coefficients of the whole boar population and the differences between the three groups were usually significant.

CONCLUSIONS

The results of the research have demonstrated the variable nature of the semen traits development in various genetic groups of boars. The ejaculates collected from the hybrid boars had the smallest volume but highest sperm concentration as well as the highest content of the sperm exhibiting progressive motility. However, in these ejaculates the total sperm count was lowest.

In general, the results indicate differential relationships between the volume of ejaculate and sperm concentration and daily gains, meatiness and selection index. These differences may have arisen from negative relationships between the mentioned sperm features as well as from the variable intensity of gonads development or presence of additional sex glands in boars. However, the positive relationships between the analysed meat and fattening traits and the ejaculate volume together with the total sperm count indicate that it is possible to collect good quality sperm from boars, providing that the appropriate weight and meatiness gain intensity is ensured.

REFERENCES

Adamiak, A., Kondracki, S., Wysokińska, A. (2010). Wpływ pory roku na właściwości fizyczne ejakulatu knurów ras wbp i pbz [Influence of season of the year on physical properties of ejaculates from Polish Large White and Polish Landrace boars]. Rocz. Nauk. Zootech., 37(2), 159–167 [in Polish].

Eckert, R., Szyndler-Nędza, M. (2014). Ocena przyżyciowa młodych knurów. [W:] Stan hodowli i wyniki oceny świń w roku 2013 [Results of performance tested boars]. Inst. Zootech. PIB, Kraków, 32, 19–33 [In Polish].

Kawęcka, M., Pietruszka, A., Jacyno, E., Czarnecki, R., Kamyczek, M. (2008). Quality of semen of young boars of the breeds Pietrain and Duroc and their reciprocal crosses. Arch. Tierz., Dummerstorf, 51, 42–54.

Knecht, D., Jasek, S., Procak, A., Krzyżewski, P. (2004). Skuteczność unasieniania loch knurami czystej rasy i mieszańcami [Efficiency of inseminating sows with pure breed and crossbreed boars]. Med. Weter., 60(11), 1208–1211 [in Polish].

Kondracki, S. (2006). Znaczenie inseminacji jako podstawowej biotechniki w rozrodzie świń. [The importance of artificial insemination as the basic reproductive biotechnology in the pigs' reproduction]. Rocz. Nauk. PTZ, 2(1), 71–101 [in Polish].

Kondracki, S., Wysokińska, A. (2005). Characterization of sperm abnormalites of boars with regard of age and breed. Folia Univ. Agric. Stetin., Zootechnica, 243(47), 96–103.

Kondracki, S., Wysokińska, A., Kowalczyk, Z. (2003). The effect of crossing of Duroc and Pietrain breeds semen quality of crossbred boars. Anim. Prod. Rev., App. Sci. Rep., Pig Production and Breeding., Warszawa, 68(2), 105–111.

Kondracki, S., Wysokińska, A., Paplińska, A. (2000). Wpływ wieku na cechy nasienia młodych knurów rasy wielkiej białej polskiej [The effect of age on semen traits of young Polish Large White boars]. Zesz. Nauk. Prz. Hod. 48, 103–110 [in Polish].

Lasota, B., Błaszczyk, B., Seremak, B., Udała, J. (2004). Selenium status and GSH-Px activity in semen and blood of boars at different ages used for artificial insemination. Reprod. Dom. Anim., 39, 309–314.

Muczyńska, E., Kondracki, S., Wysokińska, A. (2010). Zmienność międzyrasowa cech fizycznych ejakulatów knurów użytkowanych w stacji unasienniania loch [Between-breed variation in physical characteristics of ejaculates from boars used in Sow Insemination Station]. Rocz. Nauk. Zootech., 37(2), 151–157 [in Polish].

Pokrywka, K., Ruda, M. (2001). The quality of selected features of boar ejaculators on the basis of intervals of sperm collection and season of the year. Mat. XXXI Konf., Zesz. Nauk. AR Wrocław, 405, 211–221.

Strzeżek, J. (1996). Nasienie i użytkowanie rozpłodowe knura. (W:) Andrologia, Red. S. Wierzbowski [Semen and reproductive exploitation of the boar. (In:) Andrology, Ed. Wierzbowski, S.]. Platan – Kryspinów, Kraków, 201–246 [in Polish].

Sutkeviciene, N., Andersson, M.A., Zilinskas, H., Andersson, M. (2005). Assessment of boar semen quality in relation to fertility with special reference to methanol stress. Theriogenology, 63, 739–747.

Szostak, B. (2003). Wpływ genotypu, wieku knura i sezonu eksploatacji na wybrane cechy ejakulatów [The influence of genotype and age of boar, and exploitation season on selected traits of ejaculates]. Zesz. Nauk. Prz. Hod., 68(2), 147–155 [in Polish].

Szostak, B., Przykaza, Ł. (2010). Wpływ rasy i wieku młodych knurów na wybrane cechy ich nasienia [The influence of breed and age of young boars on the selected traits of their semen]. Acta Sci. Pol., Zootechnica 9(3), 93–100 [in Polish].

Udała, J., Gączarzewicz, D., Lasota, B., Błaszczyk, B., Seremak, B., Stankiewicz, T. (2005). Charakterystyka zmian budowy morfologicznej plemników knurów użytkowanych w inseminacji [Characterization of changes in the morphology of spermatozoa of boars used in artificial insemination]. Folia Univ. Agric. Stetin, Zootechnica, 243(47), 161–172 [in Pollish].

Wilczyńska, E., Kondracki, S., Wysokińska, A., Kowalewski, D., Gajownik, K. (2013). Jakość nasienia knurów ras wbp, pbz, duroc i pietrain w poszczególnych miesiącach roku [The quality of boar semen of Polish Large White, Polish Landrace, Duroc and Pietrain breeds in different months of the year]. Rocz. Nauk. PTZ, 9(1), 49–56 [in Polish].

Wysokińska, A., Kondracki, S. (2013). Assessment of the effect of heterosis on semen parameters of two-breed crosses of Duroc, Hampshire and Pietrain boars. Arch. Tierzucht, 56(7), 65–74.

Wysokińska, A., Kondracki, S. (2014). Assessment of changes in sperm cel membranę integrity occurring during the storage of semen from genetically different males using two diagnostic methods. Can. J. Anim. Sci., 94, 1–6.

Young, L.D., Johnson, R.K., Omtvedt, I.T., Walters, L.E. (1976). Postweaning performance and carcass merit purebred and two-bred cross pigs. J. Anim. Sci., 42, 1124––1132.

WYBRANE CECHY UŻYTKOWOŚCI TUCZNEJ I MIĘSNEJ A JAKOŚĆ NASIENIA U MŁODYCH KNURÓW RAS CZYSTYCH I MIESZAŃCÓW

Streszczenie. Celem pracy było zbadanie związków między wybranymi cechami jakości nasienia a cechami użytkowości tucznej i mięsnej knurów na początku ich użytkowania rozpłodowego w jednym z zakładów unasienniania zwierząt na Pomorzu. Badania wykonano na 158 knurach ras pbz, wbp i mieszańcach duroc $\times$ pietrain w wieku od 9 do 14 miesięcy. Analizowano następujące cechy: objętość ejakulatu (cm^3), koncentrację plemników ($\times 10^6 \cdot cm^{-3}$), procent plemników o ruchu postępowym, ogólną liczbę plemników w ejakulacie, średni standaryzowany przyrost dzienny (g), oszacowaną przyżyciowo mięsność (%) i indeks selekcyjny. Wykazano, że nasienie knurów mieszańców w porównaniu do ras czystych odznaczało się większą koncentracją i ruchliwością plemników ale mniejszą objętością ejakulatu w efekcie czego ogólnie istotnie mniej było w nich plemników. Mieszańce osiągały również największe przyrosty dzienne. Przy podobnej mięsności w trzech grupach, najwyższym indeksem selekcyjnym charakteryzowały się knury wbp. Między objętością ejakulatu i ogólną liczbą plemników w ejakulacie a przyrostami dobowymi, mięsnością i indeksem selekcyjnym wystąpiły zależności dodatnie, natomiast między koncentracją plemników a wymienionymi cechami ujemne. Uzyskane wyniki wskazują, że przy zachowaniu odpowiedniego tempa wzrostu masy ciała i mięsności, możliwe jest pozyskanie od knurów nasienia charakteryzującego się dobrą jakością.

Słowa kluczowe: knur, nasienie, przyrost dzienny, mięsność

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