

SEMEN QUALITY ASSESSMENT OF DUROC X PIETRAIN CROSSES IN A SIX DEGREE SPERMIOGRAM CLASSIFICATION SCALE

Stanisław Kondracki, Joanna Wysokińska, Anna Wysokińska

Siedlce University of Natural Sciences and Humanities, Siedlce, Poland

Abstract. The experimental material was constituted by 200 ejaculates manually collected from 20 boars maintained at three insemination stations of the Masovian Centre for Animal Breeding and Reproduction in Łowicz. The assessment concerned ejaculates collected from each boar at the frequency of one month. Each boar provided 10 ejaculates and each ejaculate was assessed for sperm morphology. 500 spermatozoa in each sample were analysed for their morphology. Well-formed and morphologically altered spermatozoa were counted and the modified sperms were differentiated into those with primary and secondary changes, following Blom's classification. In order to compare sperm morphology of particular males, a spermogram quality classification was devised using a six-degree scale that assessed the ejaculates under analysis from 0 (for ejaculates with the worst sperm morphology) up to 5 (for those with the best sperm morphology). The assessment based on classifying a number of boar spermograms was found to make it possible to determine what proportion of the ejaculates was highly useful for insemination and how many of them were not fit for the purpose.

Keywords: boar, semen, spermogram

INTRODUCTION

The fertility and reproductive performance of females largely depend on semen quality. That is why boars should be tested for their reproduction aptitude. It is essential to analyse ejaculate quality, including such parameters as: ejaculate volume, semen fraction volume, colour, sperm concentration and percentage of spermatozoa with correct motility. Mating efficiency depends on ejaculate sperm count and concentration as well as the incidence of particular morphological forms. The presence of morphologically altered spermatozoa may be due to the effect of numerous exo- and endogenic factors [Jaczewski and Kruszyński 1995, Banaszewska et al. 2007]. Spermigenetic or spermatogenetic disorders cause temporary or lasting deterioration of the biological value and insemination capacity of semen [Kondracki and Wysokińska 2005]. Results of sperm morphology tests are

Corresponding author – Adres do korespondencji: prof. dr hab. Stanisław Kondracki, Department of Animal Reproduction and Hygiene, Siedlce University of Natural Sciences and Humanities, Bolesława Prusa 14, 08-110 Siedlce, Poland, e-mail: sk@uph.edu.pl

highly variable. Better results are produced by assessments of sperm morphology based on several boar ejaculates. Particular boars have been found to differ in ejaculate quality [Gadea and Matas 2000, Johnson et al. 2000, Thurston et al. 2001, Foote 2003] and the incidence of morphologically modified spermatozoa [Pinart et al. 1998].

The present work was aimed at assessing the morphological sperm quality of Duroc x Pietrain boar crosses in a six-degree scale devised at the Department of Animal Reproduction and Hygiene of the University of Natural Sciences and Humanities [Kondracki et al. 2007].

MATERIAL AND METHODS

The study involved 20 Duroc x Pietrain hybrids kept at three insemination stations of the Masovian Centre for Animal Breeding and Reproduction in Łowicz (Table 1).

Table 1. Number of boars and ejaculates included into the investigations of semen morphology
Tabela 1. Liczba knurów i liczba ejakulatów objętych badaniami morfologii nasienia

Item – Wyszczególnienie	Sow Insemination Station – Stacja Unasieniania Loch						Total Łącznie
	Gostków		Łowicz		Ciechanów		
	license number of boar numer licencyjny knura	number of ejaculates liczba ejakulatów	license number of boar numer licencyjny knura	number of ejaculates liczba ejakulatów	license number of boar numer licencyjny knura	number of ejaculates liczba ejakulatów	
R 3147 PL	10	R 610 OL	10	R 1134 OL	10		
R 3146 PL	10	R 611 OL	10	R 1044 OL	10		
R 2819 PZ	10	R 1924 PZ	10	R 1040 OL	10		
R/ 17/26	10	23/80/04	10	R 1045 OL	10		
R /17/27	10	38/80/04	10	R 1423 OL	10		
R 69026/04	10	364/70/04	10	R 1577 OL	10		
R 2635 PZ	10			R 1579 OL	10		
Number of boars Liczba knurów	7		6		7	20	
Number of ejaculates Liczba ejakulatów	70		60		70	200	

The assessment concerned ejaculates collected from each boar with the frequency of one month. Each boar provided 10 ejaculates and each ejaculate was assessed for sperm

morphology. The semen quality assessments for each boar were carried out using the results of microscopic analysis of fresh ejaculate preparations. The ejaculate samples served to prepare microscopic preparations. Each preparation was analysed for the morphological structure of 500 spermatozoa contained therein. The incidence of well-formed and morphologically altered sperms was determined. Moreover, forms with primary and secondary defects were differentiated according to Blom's classification [Blom 1981].

The results of the sperm morphology assessment were classified in a six-degree scale established by the Department of Animal Reproduction and Hygiene [Kondracki et al. 2007]. Following that classification, the ejaculates were assigned classes ranging from 0 to 5 with regard to the following criteria:

- class 5 (very good semen) was assigned to ejaculates containing at least 90% spermatozoa with correct morphology and up to 3% spermatozoa with primary changes;
- class 4 (correct semen) was assigned to ejaculates containing at least 90% morphologically well-formed spermatozoa and 3–5% spermatozoa with primary defects or to ejaculates with 85–90% well-formed sperms but not more than 3% sperms with primary changes;
- class 3 (satisfactory semen) was assigned to ejaculates that contained 73–90% spermatozoa with correct morphology and up to 9% spermatozoa with primary defects;
- class 2 (poor-quality semen) was assigned to ejaculates that contained 10–15% spermatozoa with primary changes but at least 73% sperms with correct morphology;
- class 1 (low-quality semen) was assigned to ejaculates with 15–20% spermatozoa with primary changes or 65–73% morphologically well-formed sperms;
- class 0 (morphologically substandard semen) was assigned to ejaculates that contained more than 20% spermatozoa with primary defects or fewer than 65% well-formed spermatozoa.

The spermograms of the ejaculates under analysis were classified by putting them in one of the above six categories.

Study results were statistically processed using the analysis of variance according to the following mathematical model:

$$Y_{ij} = \mu + a_i + e_{ij}$$

where: Y_{ij} – trait value, μ – population mean, a_i – boar breed effect, e_{ij} – error. Significance of between-group differences was verified by means of Tukey's test.

RESULTS AND DISCUSSION

Table 2 shows the frequency of morphological changes in the spermatozoa contained in the semen of the analysed Duroc x Pietrain crosses.

Table 2. Frequency of occurrence of spermatozoa morphological changes in the crossbred Duroc x Pietrain boars semen

Tabela 2. Częstość występowania zmian morfologicznych plemników w nasieniu badanych knurów mieszańców duroc x pietrain

License number of boar Numer licencyjny knura	Number of ejaculates Liczba ejakulatów	Percentage of normal spermatozoa, % Plemniki o prawidłowej budowie, %		Sperm with morphological abnormalities, % Plemniki morfologicznie zmienione, %			
				with major abnormalities z wadami głównymi		with minor abnormalities z wadami podrzędnymi	
		\bar{x}	Sd	\bar{x}	Sd	\bar{x}	Sd
R 3147 PL	10	97.02	1.82	0.08	0.10	2.92	1.85
R 3146 PL	10	96.80	1.25	0.26	0.36	2.94	1.32
R 610 OL	10	96.32	1.27	0.50	0.89	3.18	0.95
R 611 OL	10	97.36	1.04	0.04	0.08	2.56	1.16
R 1924 PZ	10	97.94	1.17	0.32	0.28	1.74	1.36
23/80/04	10	98.58	1.00	0.54	0.69	1.12	1.11
38/80/04	10	96.86	3.34	0.48	0.43	2.66	3.14
364/70/04	10	95.44	3.76	1.46	1.85	3.12	2.64
R 1134 OL	10	95.28	3.11	0.78	0.74	3.94	3.18
R 1044 OL	10	96.16	2.80	0.34	0.34	3.50	2.75
R 1040 OL	10	96.08	2.22	0.26	0.25	3.66	2.23
R 1045 OL	10	97.92	1.90	0.12	1.16	1.96	1.95
R 1423 OL	10	93.52	4.28	0.88	1.22	5.60	3.86
R 1577 OL	10	97.44	1.88	1.06	1.08	1.50	0.98
R 1579 OL	10	97.50	3.84	0.34	0.21	2.16	3.96
R 2819 PZ	10	98.34	1.37	0.30	0.19	1.36	1.31
R /17/26	10	95.62	2.03	0.18	0.23	4.18	2.09
R /17 /27	10	97.90	1.05	0.34	0.40	1.76	1.10
R 69026/04	10	97.24	1.77	0.34	0.32	2.42	1.72
R 2635 PZ	10	86.84	13.24	0.58	0.97	12.58	13.45
LSD _{0.01}		6.57		1.12		5.92	
LSD _{0.05}		5.81		0.97		5.13	

The ejaculates obtained from the Duroc x Pietrain hybrids were generally of good quality. The mean percentage of well-formed spermatozoa in the semen of the particular boars used at the three pig insemination stations of the Masovian Centre for Animal Breeding and Reproduction in Łowicz ranged from 86.84% for the semen of the R 2635 PZ boar to 98.58% for the ejaculates of the animal designated as 23/80/04. The lowest percentage of well-formed spermatozoa in the semen of the R 2635 PZ boar resulted from the high count and, simultaneously, highest percentage share of spermatozoa with secondary defects (12.58%). The mean incidence of spermatozoa with secondary changes ranged from 1.12%

in the semen of the 23/80/04 boar to 12.58% in that of the R 2635 PZ boar. The highest mean percentage of spermatozoa with primary changes (1.46%) was found in the semen of the 364/70/04 boar. It was 1.42% higher than the mean percentage in the ejaculates of R 611 OL. The other breeders provided ejaculates in which the mean percentage of spermatozoa with primary changes did not exceed 1.1%. Blom [1981] accepts as normal the level of 15% of spermatozoa with primary changes 10–15% of those with secondary defects. Based on the mean frequency of the morphological sperm defects, it was shown that the analysed Duroc x Pietrain hybrids provided ejaculates adequate for insemination. The number of anomalous spermatozoa did not exceed 25% of the standard recommended by [Bronicka and Dembiński 1999]. A high percentage of spermatozoa with primary and secondary changes may seriously affect the insemination capacity of boars and may serve as a benchmark for boar fertility [Wysokińska et al. 2008].

Table 3 shows the quantitative and percentage share of the particular ejaculate quality categories for the analysed boars, based on spermogram classification. Among the analysed Duroc x Pietrain breeders, only three spermogram classes were observed. Among the 200 morphologically analysed ejaculates, the most (over 90%) spermatozoa were classified as category 5 in the adopted spermogram classification. On the other hand 6% qualified for category 4 in the spermogram classification. These categories include high-quality ejaculates which may be unconditionally used for insemination. Among the analysed ejaculates, none were evaluated as cat. 3 (satisfactory semen quality), 2 (poor semen quality) or 1 (low-quality semen). Only one ejaculate (0.50% of all those under analysis) was classified as morphologically substandard (class 0).

Table 3. The spermogram classification of examined crossbred Duroc x Pietrain boars on the basis of the classification in the 6-degree Scale

Tabela 3. Klasyfikacja spermogramów badanych knurów mieszańców ras duroc x pietrain na podstawie przyjętej klasyfikacji sześciostopniowej

License number of boar Numer licencyjny knura	Number of ejaculates Liczba ocenionych ejakulatów	Number of ejaculates in particular classes Liczba ejakulatów w poszczególnych klasach											
		class 5 ocena 5		class 4 ocena 4		class 3 ocena 3		class 2 ocena 2		class 1 ocena 1		class 0 ocena 0	
		n	%	n	%	n	%	n	%	n	%	n	%
R 3147 PL	10	10	100.00	–	–	–	–	–	–	–	–	–	–
R 3146 PL	10	10	100.00	–	–	–	–	–	–	–	–	–	–
R 6100 L	10	10	100.00	–	–	–	–	–	–	–	–	–	–
R 611 OL	10	10	100.00	–	–	–	–	–	–	–	–	–	–
R 1924 PZ	10	10	100.00	–	–	–	–	–	–	–	–	–	–
23/80/04	10	10	100.00	–	–	–	–	–	–	–	–	–	–
38/80/04	10	10	100.00	–	–	–	–	–	–	–	–	–	–
364/70/04	10	9	90.00	1	10.00	–	–	–	–	–	–	–	–
R 1134 OL	10	9	90.00	1	10.00	–	–	–	–	–	–	–	–
R 1044 OL	10	9	90.00	1	10.00	–	–	–	–	–	–	–	–
R 1040 OL	10	10	100.00	–	–	–	–	–	–	–	–	–	–
R 1045 OL	10	10	100.00	–	–	–	–	–	–	–	–	–	–

cont. Table 3 – cd. tab. 3

R 1423 OL	10	8	80.00	2	20.00	–	–	–	–	–	–	–
R 1577 OL	10	9	90.00	1	10.00	–	–	–	–	–	–	–
R 1579 OL	10	9	90.00	1	10.00	–	–	–	–	–	–	–
R 2819 PZ	10	10	100.00	–	–	–	–	–	–	–	–	–
R /17/26	10	10	100.00	–	–	–	–	–	–	–	–	–
R /17/27	10	10	100.00	–	–	–	–	–	–	–	–	–
R 69026/04	10	10	100.00	–	–	–	–	–	–	–	–	–
R 2635 PZ	10	5	50.00	4	40.00	–	–	–	–	–	1	10.00

CONCLUSIONS

1. Ejaculates of Duroc x Pietrain boar hybrids are generally of high quality. The share of morphologically well-formed spermatozoa in the semen of the particular boars was high and ranged from 86.84% in the semen of the R 2635 PZ boar to 98.58% in the semen of the boar designated as 23/80/04.
2. Over 90% of the analysed ejaculates of the Duroc x Pietrain crosses were classified as belonging to the highest spermogram category (class 5). 6% of the total ejaculates were evaluated as category 4, i.e. correct semen. The lowest grade according to the adopted spermogram classification (class 0) was obtained by 0.50% of the ejaculates.
3. The spermogram classification employed in the present study made it possible to accurately analyse the ejaculates of each breeder and determine which ejaculates provided by a given boar were absolutely fit for insemination and how many were inadequate for the purpose. The results are of capital importance for artificial insemination practice.

REFERENCES

- Banaszewska D., Kondracki S., Wysokińska A., 2007. Wpływ sezonu na zmiany w budowie morfologicznej plemników wybranych ras knurów inseminacyjnych [The influence of the season on the sperm morphology young boars used for insemination]. *Acta Sci. Pol., Zootechnica* 6 (2), 3–14 [in Polish].
- Blom E., 1981. Ocena morfologiczna wad plemników buhaja. I. Zmiany patologiczne plemników w świetle wyników nowych badań [The morphological estimation of the spermatozoa defects of bull II. The proposal of new classification of spermatozoa defects]. *Med. Weter.* 37 (3), 104–106 [in Polish].
- Bronicka A., Dembiński Z., 1999. Aktualne kryteria oceny oraz uwarunkowania jakości nasienia knura [Current criteria and conditions influencing the quality of boar semen]. *Med. Weter.* 55 (7), 436–439 [in Polish].
- Foote R.H., 2003. Fertility estimation: a review of past experience and future prospects. *Anim. Reprod. Sci.* 75, 119–139.
- Gadea J., Matas C., 2000. Sperm factors related to *in vitro* penetration of porcine oocytes. *Theriogenology* 54, 1343–1357.

- Johnson L.A., Weitze K.F., Fiser P., Maxwell W.M.C., 2000. Storage of boar semen. *Anim. Reprod. Sci.* 62, 143–172.
- Jaczewski S., Kruszyński W., 1995. *Rozród zwierząt gospodarskich [Reproduction in Farm Animals]*. Ed. J. Monkiewicz. Wydaw. AR, Wrocław [in Polish].
- Kondracki S., Wysokińska A., 2005. Charakterystyka zmian w budowie morfologicznej plemników knura z uwzględnieniem wieku i rasy rozplodnika [Characterization of sperm abnormalities of boars with regard of age and breed]. *Folia Univer. Agric. Stetin., ser. Zootech.* 243 (47), 97–104 [in Polish].
- Kondracki S., Wysokińska A., Banaszewska D., Iwanina M., 2007. Zastosowanie metody klasyfikacji spermogramów do oceny jakości morfologicznej nasienia knura lub grupy knurów [Application of spermogram classification for evaluation of the semen morphology of a boar or a group of Boars]. *Rocz. Nauk. PTZ* 3 (1), 79–89 [in Polish].
- Pinart E., Camps R., Briz M.O., Bonet S., Egozcue J., 1998. Unilateral spontaneous abdominal cryptorchidism: structural and ultrastructural study of sperm morphology. *Anim. Reprod. Sci.* 49, 247–268.
- Thurston L.M., Watson P.F., Mileham A.J., Holt W.V., 2001. Morphologically distinct sperm subpopulations defined by Fourier Shape Descriptor in fresh ejaculates correlate with variation in boar semen quality following cryopreservation. *J. Androl.* 22, 382 – 394.
- Wysokińska A., Kondracki S., Banaszewska D., 2008. Ocena przydatności inseminacyjnej ejakulatów pozyskiwanych od knurów mieszańców dwurasowych [An assessment of artificial insemination usefulness of the ejaculates gained from crossbred and purebred boars]. *Postępy Nauk. Rol.* 4–5, 65–72 [in Polish].

OCENA JAKOŚCI NASIENIA KNURÓW MIESZAŃCÓW DUROC X PIETRAIN WEDŁUG SZEŚCIOSTOPNIOWEJ SKALI KLASYFIKACJI SPERMIOGRAMU

Streszczenie. Materiał badawczy stanowiło 200 ejakulatów pobranych metodą manualną od 20 knurów użytkowanych w trzech stacjach unasienniania loch należących do Mazowieckiego Centrum Hodowli i Rozrodu Zwierząt w Łowiczu. Ocenie poddano ejakulatory pobierane od każdego knura w odstępach jednego miesiąca. Od każdego knura pobrano 10 ejakulatów i w każdym z nich przeprowadzono ocenę budowy morfologicznej plemników. W każdym preparacie oceniono budowę morfologiczną 500 plemników, ze wskazaniem liczby plemników o prawidłowej budowie i morfologicznie zmienionych, wyróżniając formy ze zmianami głównymi i podrzędnymi według klasyfikacji Bloma. W celu porównania morfologii plemników poszczególnych samców opracowano klasyfikację jakości spermogramu w sześciostopniowej skali, umożliwiającą przyznanie badanym ejakulatom oceny od 0 (dla ejakulatów o najgorszej morfologii plemników) do 5 (dla ejakulatów o najlepszej morfologii plemników). Stwierdzono, że ocena na podstawie klasyfikacji wielu spermogramów knurów pozwala określić, jak duża część ejakulatów ma wysoką przydatność do inseminacji, a ile z nich nie nadaje się do unasienniania.

Słowa kluczowe: knur, nasienie, spermogram

Accepted for print – Zaakceptowano do druku: 2.12.2011