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PHYSICAL TRAITS OF INSEMINATION BOAR EJACULATES DEPENDING ON THE TIME FROM PREVIOUS EJACULATE COLLECTION

CECHY FIZYCZNE EJAKULATÓW KNURÓW INSEMINACYJNYCH W ZALEŻNOŚCI OD UPŁYWU CZASU OD POBRANIA POPRZEDNIEGO EJAKULATU

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Streszczenie. Obserwacjami objęto 52 805 ejakulatów pobranych od 335 knurów inseminacyjnych. Ejakulaty oceniano na podstawie: objętości ejakulatu, koncentracji plemników, ogólnej liczby plemników o ruchu postępowym i liczby dawek inseminacyjnych możliwych do uzyskania z jednego ejakulatu. Zebrany materiał pogrupowano na osiem podgrup według kryterium czasu upływającego od pobrania poprzedniego ejakulatu. Wykazano, że czas upływający od pobrania poprzedniego ejakulatu w istotny sposób wpływa na cechy fizyczne ejakulatu. W miarę zwiększania czasu upływającego od pobrania poprzedniego ejakulatu wzrasta objętość ejakulatu, koncentracja plemników i ogólna liczba plemników w ejakulacie. Zwiększa się też liczba dawek inseminacyjnych uzyskiwanych z pojedynczego ejakulatu. Największy przyrost liczby plemników w wydalanych ejakulatach oraz liczby dawek inseminacyjnych sporządzanych z ejakulatów następuje przy zwiększaniu czasu od poprzedniego pobrania do czterech, pięciu, sześciu, siedmiu oraz do ośmiu i więcej dni. Częste pobieranie ejakulatów, po upływie trzech lub mniej dni od poprzedniego pobrania, skutkuje małą liczbą plemników w wydalanych ejakulatach i małą liczbą dawek inseminacyjnych sporządzanych z ejakulatów.

Key words: boar, ejaculate, frequency of sperm collection.
Słowa kluczowe: częstość pobrania ejakulatu, ejakulat, knur.

INTRODUCTION

Insemination boars should display considerable sexual urge and produce high-quality semen. The production of high-quality semen depends on the individual predisposition of the boar (Kondracki et al. 2007). However, ejaculate quality also depends on a number of internal and external environmental factors, including the breed and age of the boar, its diet, the upkeep system, room microclimate and season of the year (Strzeżek 2000, Sancho et al. 2004, Wysokińska et al. 2009, Kondracki et al. 2012). The parameters of collected ejaculates can also be affected by the frequency of collection (Bajena et al. 2013, Kowalewski 2013).

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The intensity of the reproduction use of boars is regulated by economic and organisational circumstances. The intensity of semen collection is determined by man, on the one hand, motivated by the demand for the semen of boars of a particular breed and, on the other hand, influenced by the economic efficiency of the insemination use of the boars and their physiology. Some data show that ejaculate collection at an interval of 4–5 days makes it possible for the insemination boar to develop high performance (Kowalewski 2013). It may seem that, with frequent semen collection, more insemination doses will be obtained and the sire's performance will improve. However, shortening the interval between successive ejaculate collections reduces the volumes of the obtained ejaculates and their sperm concentrations (Frangež et al. 2005, Bajena et al. 2014). An excessively intensive use of boars can lead to deterioration of ejaculate quality and, consequently, to a decline in reproduction performance (Pokrywka et al. 2001). Overexploitation can cause numerous disorders, anatomical changes of organs, even leading as a result to a premature discontinuation of boar service. Nevertheless, attempts are being made to increase the intensity of boar service and the frequency of semen collection. Know-how relating to the frequency of ejaculate collection from insemination boars is in high demand, particularly as regards comprehensive examinations to determine the possible extent of effective increases in ejaculate collection frequency. This is highly important for the optimisation of the organisational system of institutions dealing with the collection, laboratory processing and packaging of boar semen.

The present work was aimed at assessing the traits of boar ejaculates obtained in the conditions of an insemination centre in relation to the time elapse between successive ejaculate collections.

MATERIAL AND METHODS

The experimental material consisted of 52 805 ejaculates obtained from 335 boars, including 164 Polish Landrace boars, 38 Polish Large White boars, 16 Pietrain boars, 52 Duroc x Pietrain crossbreds, 39 Pietrain x Duroc crossbreds and 26 Hypor boars kept at the Artificial Insemination Station. The ejaculates were collected using the gloved-hand technique. The studies included ejaculates qualified for insemination from January 1, 2000 to December 31, 2012. Each ejaculate was assessed using standard methods for the following physical traits: volume of ejaculate, sperm concentration, total number of spermatozoa, and number of insemination doses per ejaculate. Ejaculate volume was determined after isolating the gelatinous fraction on the basis of ejaculate weight established on electronic balance. Sperm concentration per ejaculate was determined by the colorimetric method, while spermatozoa motility by means of the microscope under 200x magnification, setting the percentage of spermatozoa seen in the view field. The total number of spermatozoa and the number of insemination doses per ejaculate were determined by the computer programme SYSTEM SUL**.** The collected materials were grouped according to the criterion of the time from previous collection of ejaculates. Eight ejaculate subgroups were distinguished, on the basis of collection at different time intervals from the previous ejaculate collection (group I – collected after one 1 day, group II – collected after two 2 days, group III – collected after three 3 days, group IV – collected after four 4 days, group

V – collected after five 5 days, group VI – collected after six 6 days, group VII – collected after seven 7 days, and group VIII – collected after more than 7 days but no later than 14 days from the previous collection (Table1).

Table 1. Number of examined ejaculates depending on the time from previous ejaculate collection
Tabela 1. Liczba badanych ejakulatów w zależności od upływu czasu od poprzedniego pobrania ejakulatu

Breed Rasa	Time from previous ejaculate collection [days] Czas od poprzedniego pobrania ejakulatu [dni]							
	1	2	3	4	5	6	7	8
Polish Large White Polska biała wielka	171	251	1871	1941	302	388	318	162
Polish Landrace Polska biała zwisłołucha	805	1411	7626	7818	1663	2091	1760	1280
Pietrain	60	111	742	829	296	246	192	123
Duroc x Pietrain	384	538	2755	2691	599	629	476	296
Pietrain x Duroc	265	473	2523	2542	694	577	402	244
Hypor Linia S	76	104	1200	1191	128	151	315	160
Total – Razem	1761	2888	16717	17012	3682	4082	3463	2265

The analysis of the variation of semen traits was carried out using a procedure according to the following model:

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

where:

Y_{ij} – trait value,
μ – population mean,
a_i – effect of the time from previous ejaculate collection,
b_j – effect of boar breed,
ab_{ij} – effect of cooperation of controlled factors,
e_{ij} – error.

Differences between means were evaluated based upon Tukey´s test.

RESULTS

Table 2 contains data that describe selected physical traits of the analysed ejaculates in relation to the lapse of time from the collection of the previous ejaculate. The data show that the traits of insemination boar ejaculates depend on the lapse of time between the successive ejaculate collections. As the time interval from the collection of the previous ejaculate grew, the volume of the obtained ejaculates increased. The lowest volumes were identified in ejaculates collected after one day from the previous ejaculate collection. Increasing the time interval from the previous collection to 2 days resulted in ejaculate volumes growing by 17.5 ml ($P \leq 0.01$). Increasing the interval from the previous collection to 3 days contributed to a further rise in the volumes of the collected ejaculates by additional 6 ml. With a four-day interval from the previous collection, the volume of the obtained ejaculates grew by additional 5.12 ml. Extending the time lapse between the successive ejaculate collections to 5 days was associated with a further increase in ejaculate volumes by additional 2.72 ml. However, continued interval increase between the successive ejaculate collections did not lead to a further rise in the volumes of the obtained ejaculates.

Table 2. Physical traits of ejaculates depending on the time from previous ejaculate collection
Tabela 2. Cechy fizyczne ejakulatów w zależności od upływu czasu upływającego od pobrania poprzedniego ejakulatu

Item Wyszczególnienie		Time from previous ejaculate collection [days] Czas od pobrania poprzedniego ejakulatu [dni]								$NIR_{0.05}$	$NIR_{0.01}$
Group Grupa		1	2	3	4	5	6	7	8		
Number of ejaculates Liczba ejakulatów		1761	2888	16717	17012	3682	4082	3463	2265		
Ejaculate volume [ml] Objętość ejakulatu [ml]	$\bar{x}$	237.84	255.34	261.32	266.44	269.16	274.56	273.77	274.25	14.47	16.76
	sd	90.48	93.15	91.75	94.01	98.53	100.59	104.12	101.52		
Sperm concentration [thous/mm^3] Koncentracja plemników [tys. plemni./mm^3]	$\bar{x}$	344.39	299.01	316.66	352.54	393.81	422.84	438.49	472.44	22.25	25.76
	sd	175.87	133.14	130.62	142.85	158.08	160.69	167.47	180.75		
Total number of spermatozoa [bln] Ogólna liczba plemników w ejakulacie [mld]	$\bar{x}$	51.27	49.17	53.82	61.07	69.19	75.69	78.35	84.86	3.44	3.99
	sd	22.15	19.01	16.69	21.85	25.27	26.49	27.99	30.65		
Number of insemination doses Liczba dawek inseminacyjnych	$\bar{x}$	19.16	19.43	20.89	22.64	24.03	25.59	25.83	26.57	1.07	1.24
	sd	6.86	6.32	6.59	6.97	7.46	7.63	8.14	8.24		

$\bar{x}$ – mean – średnia arytmetyczna.
sd – standard deviation – odchylenie standardowe.

The ejaculates collected after six, seven and eight days from the previous sampling had similar volumes of approximately 274 ml. Thus, the data reveal that ejaculate volumes increase with growing time intervals between the successive ejaculate collections but the dynamics of these changes diminishes as the time lapse from the previous collection grows longer (Fig.1).

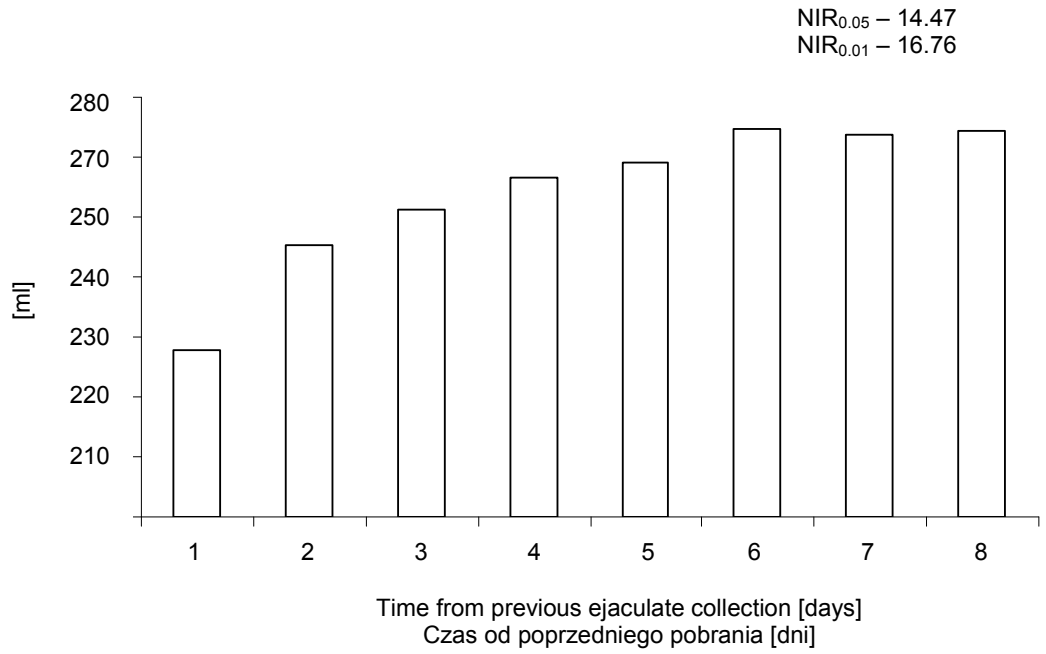

Fig. 1. Volume of ejaculate depending on the time from previous ejaculate collection
Rys. 1. Objętość ejakulatu w zależności od czasu upływającego od pobrania poprzedniego ejakulatu

The data in Table 2 show that the lapse of time from the previous ejaculate collection also affected sperm concentration in the ejaculates. The lowest sperm concentration was identified in ejaculates collected at two-day intervals (299.01 thou./mm^3). Increasing the time interval from the previous collection with each additional day resulted in a gradual rise in sperm concentration in the obtained ejaculates. Sperm concentration increased by 17.65 thou./mm^3 in the ejaculates collected after three days from the previous collection, by 53.53 thou./mm^3 after 4 days, by almost 95 thou./mm^3 after 5 days. Sperm concentration in the ejaculates collected after six days from the previous collection increased by 123.83 thou./mm^3, and after seven days by almost 139 thou./mm^3. The highest sperm concentration (472.44 thou./mm^3) was identified in the ejaculates obtained after 8–14 from the previous collection. The conclusion to be drawn from the data is that growing intervals between the successive ejaculate collections are accompanied with increasing ejaculate sperm concentrations, which was statistically confirmed ($P \leq 0.01$).

As the time from the previous ejaculate collection increased, the total numbers of spermatozoa in the obtained ejaculates and the number of insemination doses prepared from these ejaculates rose as well. It should be however noted that an extension of the interval until the next collection from 1 to 3 days only slightly reduced the number of spermatozoa in

the ejaculates and the number of insemination doses prepared from them. The ejaculates collected after 1, 2 and 3 days from the previous collection contained similar numbers of spermatozoa, with the observed differences statistically unconfirmed. We also observed only slight differences in the numbers of insemination doses prepared from the ejaculates collected after one, two and three days from the previous ejaculate collection. Further extending the interval from the previous collection, i.e. to 4, 5, 6, 7 and 8 and more days**,** led to a dynamic growth in the number of spermatozoa in the produced ejaculates (Fig. 2) and the number of insemination doses prepared from these ejaculates.

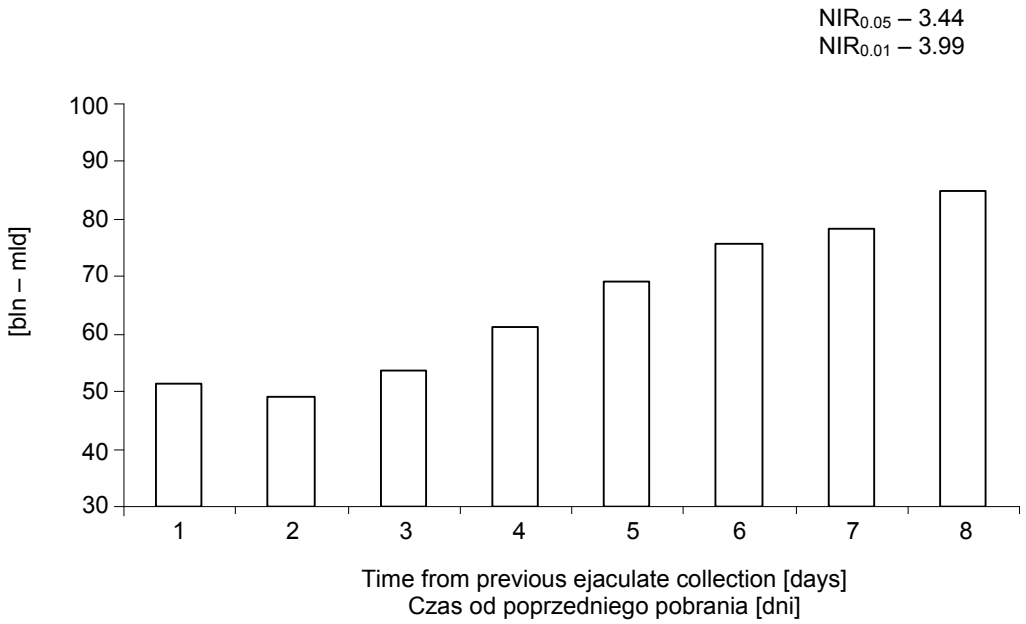

Fig. 2. Total number of spermatozoa in ejaculate depending on the time from previous ejaculate collection
Rys. 2. Ogólna liczba plemników w ejakulacie w zależności od czasu upływającego od pobrania poprzedniego ejakulatu

DISCUSSION

The presented data permit the conclusion that the lapse of time from the previous collection affects the physical traits of boar ejaculates. Increasing time intervals from previous collections were accompanied with rising ejaculate volumes, and to a lesser degree with rising sperm concentrations in the ejaculates. This led to a rise in the overall number of spermatozoa in the ejaculates and, consequently, to a rise in the number of insemination doses possible to be prepared from a single ejaculate. The influence of semen collection frequency on ejaculate traits has been identified in studies of various animal species. Magistrini et al. (1987) proved the relationship between ejaculate characteristics and the intensity of insemination use of stallions. Ritar et al. (1992) documented the existence of such interrelationship in their study of goats. There are also observations available that reveal correlations between ejaculate traits and boar use frequency (Pokrywka et al. 2001, Janicki et al. 2004, Miclea et al. 2007). According to Strzeżek et al. (1995) and Bonet et al. (1991),

high ejaculate collection frequency leads to a fall in the concentration and the total number of spermatozoa in boar ejaculates, as well as lowering sperm motility and increasing the percentage of sperms with morphological defects.

The influence of semen collection frequency on the physical traits of ejaculates seems then rather obvious and has been also documented in the results of the present work. There is no doubt as to the direction of this influence: the parameters of collected ejaculates improve as the intensity of insemination use diminishes. However, there is no consensus as to the course of the observed changes and the optimal ejaculate collection frequency. A study of Large White boars has revealed that ejaculates collected at four-day intervals are characterised with larger volumes, and greater numbers and higher motility of spermatozoa than ejaculates obtained at one-day intervals (Umesiobi 2010). Frangež et al. (2005) found the collection frequency of 2–3 times a week to be optimal, claiming that ejaculates collected at three-day intervals contain three times more spermatozoa than ejaculates collected at one-day intervals. According to Levis (1997), ejaculate collection with the frequency of three times a fortnight or every other 4–5 days ensures the highest reproductive performance of the boar. Janicki et al. (2004) are in favour of collecting ejaculates once a week, since ejaculate volumes and total ejaculate sperm counts decrease with rising collection frequency. Rising ejaculate collection frequency is accompanied with significant differences in the physical traits of boar ejaculates (Janicki et al. 2004).

The overall number of spermatozoa with progressive motility is considered to be the most important ejaculate parameter, since it determines the number of insemination doses that can be obtained from the ejaculate (Kondracki et al. 2014). The data presented in this work show that the numbers of spermatozoa in the ejaculates rose when extending the time from the previous ejaculate collection but a significant increase in the numbers of spermatozoa in the ejaculates was observed only after more than three days from the previous collection. These observations are confirmed in the study by Pruneda et al. (2005) who found that increasing the frequency of ejaculate collection leads to a fall in the number of spermatozoa in the ejaculates. This can result from a depletion in sperm reserves stored in the epididymides, leading to smaller litter sizes (Frangež et al. 2005). This hypothesis is backed by the results of the study by Umesiobi (2010) who observed that sows inseminated with semen collected every 96 hours give birth to 30% more piglets than sows inseminated with sperm collected every 24 hours. The deterioration in fertilisation efficiency is brought about by a decline in the quality of produced spermatozoa, stemming from anomalies in the process of sperm maturation (Bonet et al. 1991) due to spermatozoa spending less time in the epididymal duct (Pruneda et al. 2005), as a result of frequent ejaculation (Bonet et al. 1991).

Many of the study results published to date indicate improvements in the physical traits of ejaculates associated with extending intervals between the successive collections. With an ejaculation frequency of more than 7 days, ejaculates are characterised with the highest volumes and sperm concentrations and contain the highest numbers of progressively motile spermatozoa (Pokrywka et al. 2001, Miclea et al. 2007, Milewska 2008, Kowalewski 2013, Bajena et al. 2014).

CONCLUSIONS

The time elapsed from the collection of the previous ejaculate significantly affects the physical traits of ejaculates. Ejaculate volumes, sperm concentrations and the total numbers of spermatozoa in the ejaculates rise along with increasing time intervals from previous ejaculate collections. The numbers of insemination doses prepared from a single ejaculate also rise. The highest increase in the numbers of spermatozoa in the produced ejaculates and in the numbers of insemination doses prepared from the ejaculates is observed after extending the time interval from the previous collection to 4, 5, 6, 7 and 8 and more days. After three or fewer days from the previous collection, high ejaculate collection frequency results in low numbers of spermatozoa in the produced ejaculates and low numbers of insemination doses prepared from the ejaculates.

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Abstract. The experimental material consisted of 52 805 ejaculates obtained from 335 boars. The ejaculates were collected using the gloved-hand technique. Each ejaculate was assessed using standard methods for the following physical traits: volume, sperm concentration, total number of spermatozoa, and number of insemination doses per ejaculate. The collected materials were grouped according to the criterion of the time from previous collection of ejaculates. The time elapsed from the collection of the previous ejaculate significantly affects the physical traits of ejaculates. Ejaculate volumes, sperm concentrations and the total numbers of spermatozoa in the ejaculates rise along with increasing time intervals from previous ejaculate collections. The numbers of insemination doses prepared from a single ejaculate also rise. The highest increase in the numbers of spermatozoa in the produced ejaculates and in the numbers of insemination doses prepared from the ejaculates is observed after extending the time interval from the previous collection to 4, 5, 6, 7 and 8 and more days. After three or fewer days from the previous collection, high ejaculate collection frequency results in low numbers of spermatozoa in the produced ejaculates and low numbers of insemination doses prepared from the ejaculates.