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SEASON-DEPENDENT CHARACTERISTICS OF INSEMINATION BOAR EJACULATES

CECHY EJAKULATÓW KNURÓW INSEMINACYJNYCH W ZALEŻNOŚCI OD PORY ROKU

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Streszczenie. Badania przeprowadzono na ponad 8 tysiącach ejakulatów pobranych od 112 knurów. Badaniami objęto wszystkie ejakulaty pobrane i zakwalifikowane do inseminacji w czteroletnim okresie działania jednej ze stacji unasienniania loch. Nasienie od knurów pobierano dwa razy w tygodniu, metodą manualną, rano po pierwszym karmieniu. Pobrane ejakulaty poddano ocenie według metodyki stosowanej w polskich stacjach unasienniania loch. Zebrane dane podzielono na 12 podgrup obejmujących ejakulaty pobierane w poszczególnych miesiącach roku. Wykazano, że cechy ejakulatów knurów inseminacyjnych zależą od pory roku pobrania. Ejakulaty pozyskiwane w okresie jesienno-zimowym cechują się dużą objętością i zawierają najwięcej plemników o ruchu postępowym. Ejakulaty te cechują się także relatywnie dużą ruchliwością plemników. Ma to związek z dużą liczbą dawek inseminacyjnych wytwarzanych z ejakulatów pobieranych w tym okresie. Ejakulaty pobierane w okresie lata (czerwiec–sierpień) zawierają mniej plemników wykazujących prawidłowy ruch. Uzyskuje się z nich o około 3 dawki inseminacyjne mniej niż z ejakulatów pobieranych w okresie zimowym.

Key words: boar, ejaculate, season, spermatozoa.
Słowa kluczowe: ejakulat, knur, plemnik, pora roku.

INTRODUCTION

Insemination is a progressive technique in commercial pig breeding. The use of insemination offers numerous economic and breeding advantages which are conducive to popularising insemination in mass pig reproduction (Kondracki 2006). The breeding assets include: facilitated commercial crossing, accelerated breeding progress and quick application in commercial production. Moreover, insemination also offers numerous production advantages, consisting in an economical use of boars, curbing the spread of infectious diseases, facilitated organisation of reproduction and the possibility of eliminating infertile animals, as well as those with inferior semen quality from reproduction processes (Kondracki 2006). Rising numbers of inseminated sows and a constant development of insemination techniques

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have contributed to undertaking studies of ejaculate quality (Buczyński et al. 2000). Piglet breeds expect semen that guarantees successful insemination and considerable litter sizes (Kondracki et al. 2003).

Boars should have properly developed reproductive organs, be physically very fit to be able to take the leap, and have a high libido. Insemination boars should produce ejaculates with optimal qualitative and quantitative parameters (Strzeżek 1998; Fiałkowska et al. 2000). Ejaculates can differ in such physical characteristics as sperm volume, concentration and motility, as well as the quality and fertilisation capability of spermatozoa (Kondracki and Wysokińska 2005). Sperm quality can vary under the influence of various genetic and environmental factors (Szostak and Przykaza 2010).

Among the environmental factors, a significant importance is ascribed to seasonal effects (Wysokińska et al. 2009). There is no full consensus as to the reasons for the incidence of seasonal changes in boar semen characteristics. Seasonal effects are generally associated with the influence of ambient temperature variation, daylight duration and lighting intensity. Some researchers relate the incidence of seasonal ejaculate quality changes to air temperature differences. High air temperature can negatively affect spermatogenesis, causing the seminiferous epithelium of testes to degenerate (Malmgren 1989). This limits the production of spermatozoa, which is manifested in diminished sperm concentration in the ejaculates (Kunavongkrit and Prateep 1995). A negative effect of high temperatures on semen production has been demonstrated in numerous studies (Stone 1982; Larsson and Einarsson 1984; Kunavongkrit et al. 2005). Pigs do not tolerate temperature fluctuation well. All the worse if the temperature is high during the day and much lower at night, with the difference between day and night temperatures exceeding 10ºC and humidity above 90% (Kunavongkrit et al. 2005).

Spermatogenesis, and consequently the quantity and quality of produced semen, are not only affected by seasonal ambient temperature changes but also by daylight duration. The influence of factors connected with the effect of light varies according to sire breed, geographical location and degree of adaptation of the animal to different climatic conditions. The scale of reaction of animals to daylight duration is highly variable and largely determined by the origin of the animals. Generally, the farther north from the equator a given pig breed has been created, the more sensitive it is to the effect of the photoperiod (Sonderman and Luebbe 2008). A study of sheep revealed an effect of daylight duration on the sexual activity of the males (Aguirre et al. 2007). Higher testis weights and perimeters were identified in them during short daylight as compared with long daylight. Ejaculates with the highest sperm volumes and concentrations, as well as elevated motility, were obtained in autumn months (Gündogan 2007). In their analysis of the influence of the photoperiod on the quality of Landrace boar semen, Sancho et al. (2004) found that short daylight duration is associated with diminished ejaculate volumes, sperm concentrations, total ejaculate sperm counts and lower numbers of obtained insemination doses. This study also revealed that the number of morphologically well-formed spermatozoa rises with increasing daylight duration. Rivera et al. (2005) claim that variation in daylight duration is an important factor that affects mammalian reproduction. These researchers did not identify a significant effect of this phenomenon on semen quality. However, decreasing daylight duration was found to be

accompanied with a slightly lower sperm motility and higher numbers of morphologically altered spermatozoa than in the case of growing daylight duration. According to the scientists, air temperature and humidity are more important factors that affect semen quality.

Other opinions as to the reasons of seasonal variation in pig reproduction have also been reported. Kondracki et al. (1997) have indicated that the causes of seasonal changes in boar semen characteristics are not only to be looked for in the effect of ambient temperature and daylight duration but also in the natural, atavistic predisposition of contemporary domestic pigs to display a more intensive reproductive activity during the natural reproductive period of the European wild boar (*sus scrofa ferus*) which is the ancestor of the majority of modern pig breeds.

Domestic pigs are polyoestrous animals, sexually active year round. However, the reports presented above lead to the conclusion that reproduction efficiency of sows and boars displays seasonal variation. The seasonal fluctuations in reproduction efficiency are largely determined by variation in the quantitative and qualitative ejaculate characteristics and the sexual activity of sires. The sensitivity of different breeds or hybrids to the influence of seasonal factors can, however, vary, and there are diverse claims put forward in this regard.

The present investigation was an attempt at assessing the influence the season of the year exerts on the physical characteristics of insemination boar ejaculates.

MATERIAL AND METHODS

We investigated more than 8 thousand ejaculates collected from 112 boars, including: 39 Polish Large White (wbp) boars, 43 Polish Landrace (pbz) boars, 13 Pietrain boars, 4 Duroc boars, 2 Hampshire boars, 4 Line 990 boars, 4 Duroc x Pietrain hybrids and 3 Hampshire x Pietrain crosses (Table 1).

Table 1. Number of boars examined for physical characteristics
Tabela 1. Liczba knurów poddanych ocenie cech fizycznych

Breed Rasa	Number of boars Liczba knurów
Wbp	39
Pbz	43
Hampshire	2
Hampshire x Pietrain	3
Duroc	4
Duroc x Pietrain	4
Pietrain	13
Linia 990	4
Total – Razem	112

The investigation involved all the ejaculates collected and qualified for insemination during a four-year period at a sow insemination centre. Semen was manually collected from the boars twice weekly, in the morning, after the first feeding. The collected ejaculates were evaluated according to a methodology used at Polish sow insemination centres. The following ejaculate characteristics were examined:

– ejaculate volume without the gelatinous fraction [ml],
– sperm concentration [thou./mm^3],

– percentage of progressively motile spermatozoa [%],
– overall ejaculate sperm count [bn],
– number of insemination doses obtained from a single ejaculate [it.].

Ejaculate volumes were determined after draining off the gelatinous fraction. Ejaculate sperm concentrations were identified with the colorimetric method using a spectrophotometer. This method consists in measuring the intensity of light passing through a suspension of spermatozoa in an isotonic sodium chloride solution. The percentages of correctly motile spermatozoa were identified microscopically. A 200-fold zoom was applied to determine the share of correctly motile sperms in the overall number of spermatozoa noticeable in the field of vision. The overall number of motile spermatozoa and the number of insemination doses obtained from a single ejaculate were calculated using SYSTEM SUL software.

The data we gathered were divided into 12 subgroups comprising ejaculates collected in particular seasons of the year (Table 2).

Table 2. Number of ejaculates examined in different months
Tabela 2. Liczba ejakulatów badanych w poszczególnych miesiącach

Month – Miesiąc												Total Razem
I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	
845	732	624	640	650	637	656	641	623	650	634	699	8031

Variance analysis of the semen characteristics in question was carried out according to the following mathematical model:

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

where:

Y_{ijk} – value of a given characteristic,
μ – populational mean,
a_i – season of the year effect,
b_j – boar breed effect,
ab_{ij} – controlled factor interaction effects,
e_{ijk} – error.

The significance of the differences between the groups was established on the basis of Tukey's test.

RESULTS

Table 3 contains a juxtaposition of data relating to the characteristics of the ejaculates collected from the boars in different months of the year. We found the physical ejaculate characteristics to be dependent on the month of collection. The highest volume was identified in the ejaculates collected between November and February (over 270 ml), whereas the ejaculates collected in August had a significantly lower volume (254.1 ml, on average) ($P \leq 0.05$). We observed a gradual increase in ejaculate volume from September. Ejaculate sperm concentration also changed depending on the season of the year.

Table 3. Physical properties of the analysed ejaculates in different months
Tabela 3. Cechy ejakulatów poddanych ocenie w poszczególnych miesiącach

Item Wyszczególnienie		Month Miesiąc													
		I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII	$NIR_{0.05}$ $LSD_{0.05}$	$NIR_{0.05}$ $LSD_{0.01}$
Number of ejaculates Liczba ejakulatów		845	732	624	640	650	637	656	641	623	650	634	699		
Ejaculate volume Objętość ejakulatu [ml]	$\bar{x}$	279.1	271.9	258.1	257.8	259.4	260.2	259.6	254.1	260.1	265.7	281.8	293.4	15.1	17.2
	sd	87.5	83.0	80.9	82.2	82.1	85.6	81.0	73.6	82.4	89.7	92.7	874		
Sperm concentration [thous/mm^3] Koncentracja plemników [tys. plemników/1mm^3]	$\bar{x}$	632.7	627.9	661.0	681.0	648.0	643.0	627.3	639.0	648.0	667.7	642.7	634.5	32.5	37.2
	sd	1842	180.5	182.0	192.2	188.6	187.8	178.2	170.2	181.9	184.7	173.0	179.5		
Percentage of spermatozoa with progressive motility Odsetek plemników o ruchu postępowym [%]	$\bar{x}$	68.1	68.1	68.2	68.0	67.9	67.4	67.7	68.0	67.9	67.5	67.0	67.6	0.8	0.9
	sd	45	43	4.2	4.3	4.6	4.7	4.6	4.6	4.8	5.2	5.1	5.0		
Total number of spermatozoa per ejakulateejaculate [bln] Ogólna liczba plemników w ejakulacie [mld]	$\bar{x}$	115.7	111.0	111.6	114.4	108.5	107.6	105.6	106.9	110.2	114.5	116.4	121.0	6.3	7.2
	sd	38.7	33.8	34.4	34.4	32.3	34.9	32.2	32.9	35.8	37.6	37.9	38.4		
Number of insemination doses Liczba dawek inseminacyjnych	$\bar{x}$	30.5	30.0	29.8	29.3	28.9	27.8	27.5	27.8	27.8	28.1	29.9	31.2	1.5	1.8
	sd	9.6	8.9	8.8	8.7	8.2	8.4	8.1	7.7	8.2	9.0	9.5	9.4		

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

The highest sperm concentration was identified in the ejaculates collected in March and April, and in October (over 660 thou. sperms/1mm^3). The ejaculates collected in July had the lowest concentration. A high percentage of progressively motile spermatozoa persisted in the ejaculates between January and April (on average: 68.0–68.2%), and in August (with a mean of 68.0%), while a significant decline in sperm motility was observed in November. At that time, the percentage of progressively motile spermatozoa fell down to 67.0% ($P \leq 0.01$).

The ejaculates collected between October and January, and in April contained the highest numbers of spermatozoa. The mean numbers of spermatozoa in these ejaculates ranged from 114 bn to 121 bn. The ejaculates collected at the time provided the most insemination doses (over 29 doses per 1 ejaculate). The ejaculates collected between May and August contained significantly fewer spermatozoa (105.6 bn – 108.5 bn). Fewer insemination doses were prepared from these ejaculates. The data presented here show that the characteristics of insemination boar semen depend on the season of the year. The highest volume characterised the ejaculates obtained in the winter period. The spring and autumn periods were the time at which the ejaculates had the highest sperm concentration, with the highest motility observed in the spermatozoa in the ejaculates collected in winter and spring.

DISCUSSION

On the basis of the gathered data, it can be concluded that the physical characteristics of boar ejaculates vary with the season of the year. The season of the year is a significant factor that affects the quality of the obtained ejaculates. This is probably connected with changes in ambient temperature, daylight duration and lighting intensity (Sancho et al. 2004). The data demonstrated in the present paper reveal that the best-quality ejaculates were obtained in the autumn and winter periods. At that time, the most voluminous and concentrated ejaculates were gathered. Similar observations can be found in a study by Pokrywka and Ruda (2001). The hypothesis concerning the effect of the season of the year on the quality of boar semen is confirmed by investigations of Wilczyńska et al. (2013). They demonstrated that ejaculates obtianed in summer months have lower volumes and contain fewer spermatozoa than ejaculates collected in autumn and winter. Other studies indicate that ejaculates collected in winter are characterised with the greatest volume, though sperm concentration in the ejaculates collected at that time proved the lowest (Pokrywka and Ruda 2004). A study by Adamiak et al. (2010) also demonstrated the highest volume in ejaculates obtained in autumn and winter. Wysokińska et al. (2008) observed a connection between ejaculate characteristics and the time of the year and boar breed.

The data presented in Tabele 3 prove that ejaculates collected in autumn and winter months are characterised with higher volumes and greater sperm numbers, thus providing higher numbers of insemination doses at the time. Similar results were obtained by Kondracki et al. (1997), Ciereszko et al. (2000), and Kozdrowski and Dubiel (2004).

The spring and autumn periods were the time when the highest concentrations were identified in the analysed ejaculates, whereas ejaculate sperm concentration was slightly lower in winter. Kondracki et al. (1997) observed rising sperm concentration in ejaculates collected between August and November.

The highest percentage of progressively motile spermatozoa was found in ejaculates collected in winter and spring. High summer temperatures are not favourable to semen generation (Stone 1982; Larsson and Einarsson 1984; Kunavongkrit et al. 2005). Ejaculates collected in the summer and early autumn contain more spermatozoa with morphological alterations than those collected in the other seasons of the year (Banaszewska et al. 2007). Ejaculates collected in winter and spring contain more spermatozoa with a correct morphological structure, in comparison with ejaculates collected during the summer (Wysokińska and Kondracki 2004). The present investigation proved that ejaculates gathered in the summer period are characterised with lower volumes and contain fewer progressively motile spermatozoa. The ejaculatory efficiency of boars can be disadvantaged by high summer heat temperatures. Boars exhibit a lower libido then and can produce less semen (Kozdrowski and Dubiel 2004).

CONCLUSIONS

The characteristics of insemination boar ejaculates depend on the season in which the ejaculates are collected. Ejaculates obtained in the autumn-winter period are characterised with a high volume and contain the greatest number of progressively motile spermatozoa. These ejaculates also contain relatively highly mobile sperms. This results in obtaining a high number of insemination doses prepared from ejaculates collected at the time. Ejaculates collected in the summer (June-August) contain fewer correctly motile spermatozoa. Roughly, they produce 3 insemination doses fewer than the ejaculates collected in the winter period.

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Abstract. We investigated more than 8 thousand ejaculates collected from 112 boars. The investigation involved all the ejaculates collected and qualified for insemination during a four--year period at a sow insemination centre. Semen was manually collected from the boars twice weekly, in the morning, after the first feeding. The collected ejaculates were evaluated according to a methodology used at Polish sow insemination centres. The data we gathered were divided into 12 subgroups comprising ejaculates collected in particular seasons of the year. We found the characteristics of insemination boar ejaculates to be dependant on the season in which the ejaculates were collected. Ejaculates obtained in the autumn-winter period are characterised with a high volume and contain the greatest number of progressively motile spermatozoa. These ejaculates also contain relatively highly mobile sperms. This results in obtaining a high number of insemination doses prepared from ejaculates collected at the time. Ejaculates gathered in the summer (June-August) contain fewer correctly motile spermatozoa. Roughly, they produce 3 insemination doses fewer than the ejaculates collected in the autumn-winter period.