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SEASON'S INFLUENCE ON THE PROPERTIES OF MALE DOMESTIC PIG SEMEN

Key words: pig boar, ejaculate, season

Introduction

Proper reproduction is fundamental for the profitability of slaughter pig production, the effectiveness of which depends mainly on the appropriate use of pig sows and pig boars. The important factor in using the potential fertility of sows is to use for reproduction boars characterized by a high-level sexual activity and the appropriate quantity and quality of semen (Czarnecki et al. 2000). The economic factor is of high significance in the utilization of boars employed for insemination, including the production of sperm with a high number of sperm cells and the associated number of the prepared insemination doses. The process of semen production varies over time and depends on various endo- and exogenous factors. The exogenous factors having strong effect on live organisms are, among others, the seasonal factors. Beside the breed effect and the crossbreeding effect, season of the year is an important factor influencing boar fertility (Smital et al. 2004). A relationship has been revealed between the environmental factors associated with season, such as ambient temperature (Suriyasomboon et al. 2004), daylight duration (Sancho et al. 2004), radiation intensity (Weiler et al. 1996) and the properties of semen. Elevated ambient temperature in connection with the reduced ability for temperature regulation in pigs suppresses the reproductive functions in males, reducing their sexual activity (Owsianny et al. 2004). Claus and Weiler (1985) report that changes of the daylight duration occurring over a year are the main reason for the seasonal variations of testicle functions and the changes of testosterone concentration in blood. Despite numerous studies regarding the influence of seasonal factors on sperm properties, there is no unanimity on the direct reasons for season's influence on the properties of the ejaculate of boars utilized for insemination.

The aim of this work was to determine the influence of season on the physical properties of the ejaculate collected from boars used for insemination.

Material and methods

The material for the analyses comprised 30,160 ejaculate samples collected from 81 boars of the Polish Large White breed (Polish abbrev. *wbp*) and 182 boars of the Polish Landrace (*pbz*) used in the Zielkowice Sow Insemination Station, a branch of the Mazowieckie Centre for Breeding and Reproduction of Animals in Łowicz. The ejaculate was collected manually (King and Macpherson 1973) in the time intervals of 4-5 days. The examined ejaculate was taken from boars utilized for at least 6 months and qualified for insemination in the period from 01.01.1992 to 31.12.2007. All ejaculate samples were assessed with respect the following physical criteria:

- ejaculate volume,
- sperm cells concentration,
- percentage of sperm cells exhibiting proper movement,
- total number of sperm cells in ejaculate,
- number of insemination doses obtained from one ejaculate.

The ejaculate volume was determined after separation of the gelatinous fraction, by weighing the ejaculate mass on electronic scales. The concentration of sperm cells in the ejaculate was determined by colorimetry, using a spectrophotometer. This method is based on the measurement of the light intensity transmitted through the sperm cells suspension in isotonic to sperm solution containing sodium chloride or sodium citrate. The percentage of properly moving sperm cells was determined by microscopic examination. Determined under about 200-fold magnification was the per cent content of the properly moving sperm cells in the total number of sperm cells visible in the field of view. The total number of mobile sperm cells and the number of insemination doses obtained from one ejaculate were calculated using the SYSTEM SUL software.

The collected data were grouped in 12 sub-groups containing the ejaculate collected in the individual months of the year (Tab. 1).

Tab. 1. Number of the ejaculate samples collected from pig boars in the individual months.

Month	Breed		Total
	wbp	pbz	
I	850	1819	2669
II	717	1672	2389
III	839	1794	2633
IV	878	1903	2781
V	825	1803	2628
VI	844	1744	2588
VII	822	1656	2478
VIII	755	1628	2383
IX	727	1569	2296
X	757	1583	2340
XI	764	1656	2420
XII	830	1725	2555
Total	9608	20552	30160

The variability analysis of the examined sperm properties has been carried out using the following mathematical model:

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

where

Y_{ijk} – value of the examined feature,

μ – population average,

a_i – boar breed's effect,

b_j – season's effect,

ab_{ij} – effect of the controlled factors' co-operation,

e_{ijk} – error.

The significant differences between the groups were found by means of the Tukey test.

Results and discussion

Table 2 presents data that characterize the physical properties of the ejaculate collected from the pig boars of the wbp and pbz breeds in the individual months. The data reveal that the season exerts an effect on most of the physical features of the ejaculate. In the insemination practice the total number of sperm cells is of major importance, as it determines the number of insemination doses prepared from the ejaculate and eventually, the economic usefulness of the boar used for insemination. The least sperm cells were determined in the ejaculate collected in May (84.68 billion on average) while in the following months an increase was observed until

December, when the number reached the value exceeding 100 billion sperm cells in the ejaculate. The patterns of the sperm cells number variations in the ejaculate for both examined boar breeds were similar (Fig. 1).

The highest number of the insemination doses was prepared from the ejaculate collected in December (nearly 30 doses from one ejaculate). The least doses were obtained from the ejaculate collected in the springtime (March, April, May). From May to December, the number of the insemination doses obtained from the ejaculate gradually increased. The highest numbers of insemination doses from the ejaculate of the pbz pig boars were obtained in November, December and January whereas the highest numbers of insemination doses from the wpb pig boars were prepared in October, November and December (Fig. 2).

Data presented in Tab. 2 show also that the season influences the volume of the ejaculate. The lowest volume ejaculate was obtained in the springtime (March through May) and was about 40 ml less than the ejaculate volume obtained in November and December ($P \leq 0.01$). In the summer months (June through September), the ejaculate doses were of similar volume, containing in the range from about 273 ml to about 277 ml and showing an increasing tendency in the following months. The patterns of the ejaculate volume changes regarding both breeds, *i.e.* the wbp and pbz, were similar (Fig. 3).

Ejaculate with the highest concentration of sperm cells was collected between December and April. May through November the concentration of sperm cells in the ejaculate was considerably lower. Seasonal variations of the sperm cells concentration in the ejaculate from both examined breeds were similar (Fig. 4).

On the basis of the data presented in this study, it may be concluded that the best ejaculate, *i.e.* having the largest volume and containing the highest number of sperm cells, can be collected from male domestic pig in the autumn and winter months (November, December). The ejaculate collected in that period yields the highest number of insemination doses. The favourable properties of the ejaculate collected in the autumn and winter months have also been described in other Polish and foreign papers (Łyczyński 1991, Kunavongkrit et al. 1995, Liao et al. 1996, Kondracki et al. 1997, Ciereszko et al. 2000, Kozdrowski and Dubiel 2004a, Pokrywka and Ruda 2004). However, there is no agreement upon the reasons differentiating the ejaculate properties with relation to the season. Some authors connect the seasonal changes in semen with the seasonal variations of the ambient temperature and air humidity (Stone 1982, Larsson and Einarsson 1984, Kunavongkrit et al. 2005), others claim that the daytime duration and the intensity of radiation are the critical factors determining ejaculate properties (Zaicev 1995, Ciereszko et al. 2000, Sancho et al. 2004, Rivera et al. 2005).

Nonetheless, the influence of those factors on the sperm quality is not explicit. Weiler et al. (1996), employing a light reverse programme in May and June have observed an increased testosterone secretion in the pig boars, reaching the values typical for autumn thus, for the period when the ejaculate usually bears the most favourable properties. Claus et al. (1985) obtained similar results. They observed an increase of the sex hormones in blood and sperm plasma of the pig boars subjected to the influence of a short daytime. Likewise, the studies by Borga et al. (1993) conducted on pig boars of various breeds revealed an increase of the testosterone concentration in blood when the daytime shortened whereas Andersson et al. (1998) reported a reduction in the testosterone concentration in the pig boars utilized for insemination kept in the conditions of a shortening daytime. When shortening the duration of daytime in the summer, a larger volume ejaculate, containing more sperm cells (Zaicev 1995) and with higher sperm cells concentration (Ciereszko et al. 2000) may be obtained than in the long daytime period. In the autumn and winter period when daytime is short the ejaculate volume is usually the largest with high sperm cells concentration (Pokrywka and Ruda 2001, Wysokińska et al. 2005). In the present study, the most suitable ejaculate, *i.e.* the largest volume and with the highest number of sperm cells, was obtained in November and December. Therefore, a hypothesis has been formulated that the seasonal changes in the sexual activity of pigs may result from the close relationship between the domestic pig and the European wild boar (Kondracki et al. 1997). The European wild boar (*Sus scrofa ferus*) is regarded one of the main ancestors of the contemporary domestic pig; biologically they are the same species. Crossbreeding of the domestic pig and the European wild boar can be successful, with fertile offspring. The wild boar is monoestrous, with a short period of sexual activity. According to Kondracki et al. (1997), one of the important reasons for the seasonal changeability of the sperm properties is the atavistic predisposition for higher sexual activity during the natural to the wild boar rut and to the lower sexual activity in the period unfavourable to the species reproduction. Polyestrousness of the domestic pig is unnatural and has developed as a result of the domestication. The peak of the reproduction period for the wild boar occurs in autumn and winter (November-December) that is when most females enter the heat period and males' libido is elevated. In autumn, male testicles grow considerably and the level of testosterone in blood increases, reaching the highest values in late autumn and in winter (Mauget and Boissin 1987), that is when the best ejaculate can be collected from the pig boar. Likewise, in the hybrids of the wild boar and the domestic pig in that period, the peak of the sexual activity can be observed, indicated by the production of the largest volume sperm, containing the

highest total number of sperm cells, with a high percentage of motile sperm cells (Kozdrowki and Dubiel 2004b) and with the maximum concentration of testosterone in blood (Gromadzka-Ostrowska et al. 1999). The mechanisms controlling the seasonal reproduction in the wild boar may be related to the changes of the daytime and darkness duration over a year, having effect on the secretory activity of the hypothalamus-hypophysis-gonads axis through the pineal gland and the produced melatonin hormone (Kozdrowski and Dubiel 2004c). The analysis of the seasonal changes of the male domestic pig ejaculate properties allowed a conclusion that these properties have a genetic background and reflect an atavistic relationship between the domestic pig and its wild kin (Kondracki et al. 1997). In summer time, when the wild boars reveal diminished sexual activity, the pig boars reveal unfavourable ejaculate properties indicated by smaller volumes of the obtained ejaculate and a smaller number of sperm cells in the ejaculate and eventually by the lower number of the prepared insemination doses. The present study has also revealed that ejaculate collected in the spring time was characterized by a smaller volume and a lower number of motile sperm cells than in the other seasons.

Concluding, it should be stated that ejaculate of the male domestic pig exhibits the most favourable properties in November and December whereas March, April and May are characteristic for the lowered parameters of the ejaculate. More insemination doses can be prepared from the ejaculate collected in autumn and winter than from those collected in spring and summer. Pig boars of the wbp and pbz breeds reveal similar susceptibility to the influence of the seasonal factors.

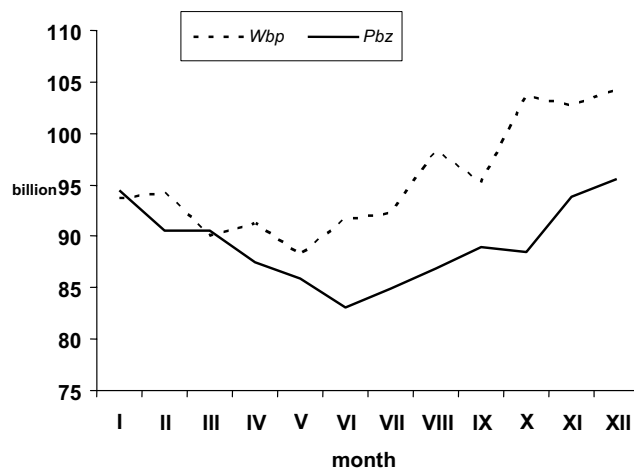


Fig. 1. Total number of sperm cells with relation to the season.

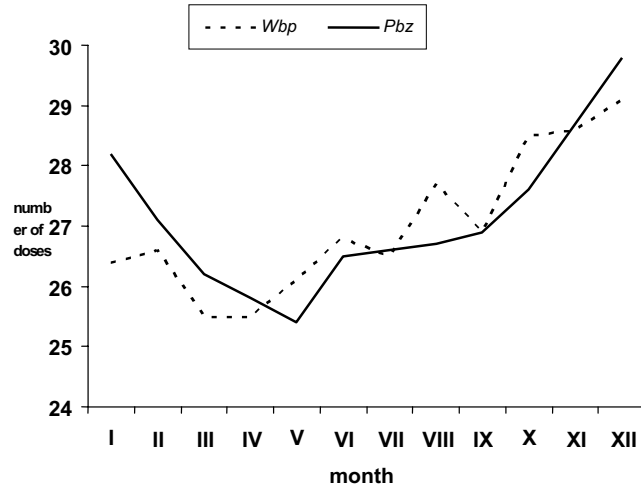


Fig. 2. Number of insemination doses with relation to the season.

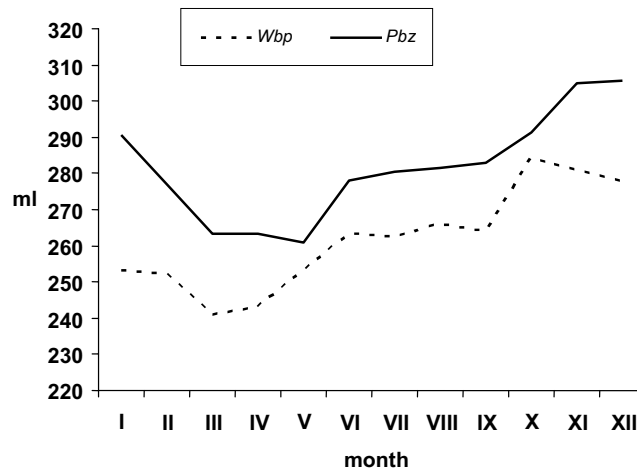


Fig. 3. Ejaculate volume with relation to the season.

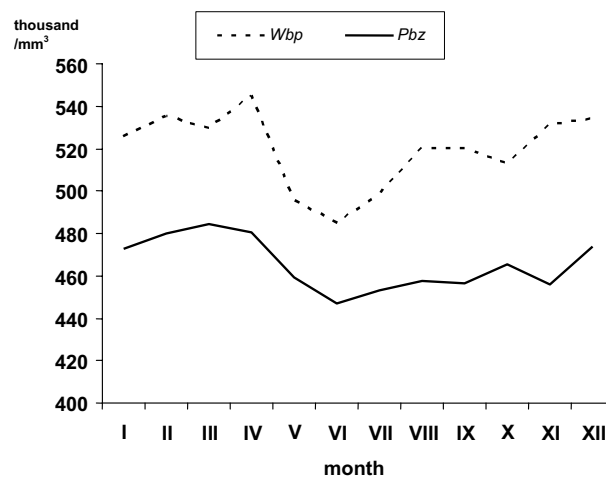


Fig. 4. Sperm cells concentration with relation to the season.

Tab. 2. Physical properties of the assessed ejaculate in the individual months of the year (average for pig boars of the wbp and pbz breeds).

Specification	Month												NIR _{0.05}	NIR _{0.01}	
	I	II	III	IV	V	VI	VII	VIII	IX	X	XI	XII			
Number of ejaculates	2669	2389	2633	2781	2628	2588	2478	2383	2296	2340	2420	2555			
Volume of the ejaculate (ml)	\bar{X}	278.85	269.59	256.15	256.83	258.46	273.29	274.57	276.58	277.08	289.13	297.34	296.78	8.30	9.50
	sd	96.78	93.13	89.02	89.74	89.11	91.85	93.86	92.73	93.75	96.18	101.61	100.32		
Sperm cells concentration (thousand/mm ³)	\bar{X}	489.86	496.64	498.73	500.93	470.93	459.59	468.34	477.32	476.86	480.79	479.84	493.50	15.89	18.17
	sd	180.97	183.85	183.05	182.36	167.68	160.92	176.06	183.22	186.18	177.58	190.39	186.59		
Percentage of sperm cells exhibiting progressive movement	\bar{X}	71.86	71.71	72.10	71.74	72.64	72.93	72.50	72.10	72.20	72.20	72.32	72.70	0.70	0.79
	sd	7.99	8.10	8.03	7.78	7.79	7.53	7.60	7.82	7.80	7.86	7.94	7.86		
Total number of sperm cells in ejaculate (billion)	\bar{X}	94.26	91.62	88.35	87.60	84.68	87.14	88.70	91.89	90.66	97.04	97.81	101.92	2.87	3.29
	sd	33.18	31.63	32.23	30.45	29.76	30.36	30.44	38.34	31.57	35.21	33.92	33.43		
Number of insemination doses (piece)	\bar{X}	27.66	26.94	26.04	25.69	25.64	26.61	26.56	27.04	26.94	27.87	28.68	29.58	0.76	0.87
	sd	8.92	8.70	8.42	8.12	8.04	8.33	8.29	8.74	8.87	8.84	9.31	9.29		

Abstract

A study was carried out of 30,160 ejaculate samples collected from 81 boars of the wbp (Polish Large White) breed and 182 boars of the pbz (Polish Landrace) breed. The ejaculate was collected manually with the sampling frequency of 4-5 days. An assessment of the ejaculate has been done with regard to the following physical properties: ejaculate volume, sperm cells concentration, percentage of sperm cells exhibiting proper motility, total number of sperm cells in the ejaculate and number of insemination doses obtained from one ejaculate. The collected data have been analyzed according to the season criterion with indication of the ejaculate collected in the individual months. It has been revealed that the most suitable ejaculate was collected from the domestic pig boars in November and December whereas in March, April and May the parameters lowered. The ejaculate collected in the springtime is characterized by a lower volume and a lower number of the motile sperm cells than in the other seasons. From the ejaculate collected in the autumn and winter period more insemination doses can be prepared than from those collected in spring and summer. No difference has been found between the boars of the wbp and pbz breeds with regard to their susceptibility to the seasonal factors' influence.

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