Livestock Science 157 (2013) 364–371

Contents lists available at ScienceDirect

Livestock Science

journal homepage: www.elsevier.com/locate/livsci

The effect of photoperiod on selected parameters of boar semen

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ARTICLE INFO

Article history:
Received 5 April 2013
Received in revised form
10 June 2013
Accepted 22 June 2013

Keywords:
Photoperiod
Boars
Breed
Semen quality

ABSTRACT

The objective of the present research was to determine the effect of increasing and decreasing natural photoperiods on selected parameters of boar ejaculates. The study material consisted of 17 boars: six Polish Large White (PLW) breed, five Polish Landrace (PL) breed, and six Duroc × Pietrain (D × P) crossbreed, all aged between 8 and 12 months at the beginning of the research. Analyses were conducted on 612 ejaculates, which were collected in two experimental periods: an increasing photoperiod (IP) (January–June) and a decreasing photoperiod (DP) (July–December). A statistically proven impact of photoperiod on the volume of semen was observed in all the studied breeds ($P=0.004$). During the decreasing photoperiod the mean volume of semen was 261.16 ± 75.20 ml and this was almost 17 ml higher than that for the increasing period. For boars involved in the experiment, day length also had a significant impact on the total number of motile spermatozoa ($P=0.037$). In the increasing photoperiod the mean number was 3.26×10^9 lower. A decreasing photoperiod has a positive affect on both boars and the parameters of the collected ejaculates, which were observed in the higher number of insemination doses per ejaculate. Between the different breeds, the reactions of boars to photoperiod differed and the most significant influence of photoperiod on semen parameters was noted among D × P breed boars. Least susceptible to changes in day length were PLW breed boars.

1. Introduction

The process of the domestication of animals has not completely eliminated traces characterizing the behavior of their ancestors. Semen production is year-round and the wild boar is a short-day breeder, whose reproduction activity takes place in winter and early spring, while suppression is in summer and early autumn (Claus et al., 1985). The seasonality of the quality and quantity of boar semen is often observed (Ciereszko et al., 2000; Corcuera et al., 2002; Sancho et al., 2004; Smital, 2009), although boars are widely recognized as a aseasonal.

In temperate climates it seems important to take into account the complex of external environment factors, among which daylight rhythm and temperature show the most important effect on pigs (Kozdrowski and Dubiel, 2004a; Nardone et al., 2010; Popiołek et al., 2010; Rivera et al., 2005). Colenbrander and Kemp (1990) estimated that quantitative changes in the composition of boar semen can vary in the range of 25–30% during the calendar year. Daylight length determines the process of spermatogenesis in boars, although experimental results are inconclusive (Rivera et al., 2005). Photoperiod is a known modulator of sperm production in mammals as an effect of the mechanism of the regulation of melatonin. This hormone is synthesized and secreted during the dark and light inhibits the process or reduces its concentration, but it is also dependent on the duration or intensity of the light (Tast et al., 2001). Andersson (2000) stated that for

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http://dx.doi.org/10.1016/j.livsci.2013.06.027

boars short days stimulated spermatogenesis and long days caused worse results. It is suggested that photoperiod may play an important role, particularly in temperate climates, due to significant differences in the day length over the months (Kunavongkrit et al., 2005).

The development of artificial insemination has been based on the constant production of high parameter semen doses, which can be used in the mass production of pigs (Knecht et al., 2004). The quality and quantity of ejaculate are determined by means of key parameters, such as volume, concentration, percentage of motile spermatozoa and number of insemination doses which can be obtained in the case of dilution of the ejaculate. Monitoring of ejaculate parameters has a very important economic significance (Smital, 2009), especially for artificial insemination centers. The elimination of differential sperm quality factors contributes to a more efficient organization of propagation via an increase in the production of insemination doses. Genetic improvements in pigs mean that further research is required in order to determine whether the production of semen by modern breed boars is still affected by seasonality.

The aim of the present study was to determine the effect of increasing and decreasing photoperiods on selected parameters of boar semen in relation to months and breeds.

2. Material and methods

2.1. Experimental location and design

The study was carried out on an industrial pig farm located in the Opole region, Poland (51.0431°N, 17.8583°E), in two separate periods. The first was from January 2012 to June 2012, and the second from July 2012 to December 2012. Temperate climates are characterized by increasing day length from 22 December (2nd astronomical winter day) to 21 June (1st astronomical summer day) and decreasing day length from 22 June (2nd astronomical summer day) to 21 December (1st astronomical winter day). On this basis, the semen collected for analysis in the first period came from an increasing photoperiod, and in the second period from a decreasing photoperiod. The mean value for day length in each month of the study is shown in Table 1.

2.2. Collection of samples

Semen was collected throughout the calendar year from all boars included in the study. Analyses were performed on 612 ejaculates. Three semen samples were taken per boar each month over the 12-month experiment (at the beginning, middle and end of the month). The period between the collections semen was at least 7 days. Semen samples were divided into two groups: increasing photoperiod (IP) January–June, and decreasing photoperiod (DP) July–December.

Within the experimental groups defined subgroups were characterized by months: Month 1 (January for group IP, July for group DP), Month 2 (February for group IP, August for group DP), Month 3 (March for group IP, September for group DP), Month 4 (April for group IP, October for group DP), Month 5 (May for group IP, November for group DP), and Month 6 (June for group IP, December for group DP).

2.3. Semen analysis

The analyzed numerical material focused on five features: semen volume (ml), spermatozoa concentration ($\times 10^6$ ml^{-1}), total number of spermatozoa ($\times 10^9$), total number of motile spermatozoa ($\times 10^9$) and number of insemination doses obtained from one ejaculate (n).

Semen was collected from boars via the hand method (King and Macpherson, 1973), using a container with a filter. Only sperm-rich fractions were analyzed. The gelatinous fraction was separated using a special filter. Immediately after collection the volume of semen was measured using a scalar cylinder. The concentration of spermatozoa was evaluated using a SpermaCue device, Model 12300/0500, Minitube International, Verona, USA. Based on the semen volume and spermatozoa concentration, the total number of spermatozoa in the ejaculate was calculated. In native semen, the percentage of motile spermatozoa was determined microscopically (200× magnification). Then, the percentage of motile spermatozoa and the total number of spermatozoa were multiplied to achieve the total number of motile spermatozoa in the ejaculate. Immediately after assessment, the semen dilution was effected using a short-term BTS boar semen extender, Version 13525/0100 Antibiotic free, Minitube International, Verona, USA.

2.4. Experimental animals

The research material consisted of 17 boars: six Polish Large White (PLW), five Polish Landrace (PL), six Duroc × Pietrain (D × P), all aged between 8 and 12 months at the beginning of the experiment. Boars were kept in individual pens (10 m^2/boar, with a concrete floor) in natural light conditions. The external lighting was obtained from nine uniformly distributed windows. The microclimate of the pen was adapted to the requirements of the animals in accordance with welfare principles. The air temperature in all the boar pens was 15 °C (averaged min 13 °C, max 18 °C). Relative humidity was close to 75% (min 70%, max 80%). The air circulation inside the building was equal to 0.15 m/s in winter and 0.20 m/s in the

Table 1
day length in increasing and decreasing photoperiods in the study period 01.01.2012–31.12.2012.

Month	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Period	Increasing photoperiod						Decreasing photoperiod					
Month	I	II	III	IV	V	VI	I	II	III	IV	V	VI
Day (h)	8	10	11	13	15	16	16	14	12	10	8	8
Length (min)	30	4	57	51	34	38	2	20	36	43	57	00