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# SEASONAL DYNAMICS OF SOME TRAITS OF SEMEN PRODUCTION OF DANISH AND ENGLISH LANDRACE BOARS

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***Abstract***

*The aim of the study was to analyse the seasonal dynamics of some traits of semen production of Danish and English Landrace boars. The concentration of spermatozoa was the highest in spring (412.72±7.72x10⁶/ml) and the lowest in summer (376.28±7.94x10⁶/ml). The volume of the semen (274.38±8.76 ml), the total concentration of sperms, (101.07±2.58x10⁹) and the number of insemination doses (16.89 ± 0.43) were the lowest in summer and the highest in winter (319.9±8.21 ml, 119.4±2.42x10⁹ and 19.94±0.43, resp.). The boars' race and the season of obtaining the ejaculates have a significant influence on the analysed semen traits. The Danish Landrace race surpass the English Landrace boars by all studied characteristics of semen production. The priority of the Danish Landrace in semen volume is between 3% and 19%, and in sperm concentration is between 1% and 14%. About the total concentration of sperms and the number of insemination doses, English Landrace boars give up with 29% during the different seasons.*

***Key words****: boars, ejaculate, Landrace, season, spermatozoa*

## INTRODUCTION

Purebred animals on which an intensive selection of important reproductive, fattening, and slaughtering qualities is applied are a small part of pig-farming. Artificial insemination stations, as well as the nucleus herds of the hybrid pyramid where ejaculates of breeding animals are collected, have a significant influence on the economic efficiency of the branch. According to Kunowska-Slósarz & Makowska (2011), this can be achieved by insemination with ejaculates from boars with high-quality sperm and excellent reproductive potential. According to the same authors, pigs are a species which does have a season for its reproduction due to the fact that they are polycyclic.

Despite these species and physiological feature, the potential of the boars to produce quality sperm depends of a number of factors, like breed, frequency of collection of the ejaculates, age of the breeding animals, season of collection of the sperm, size of the testicles, and many others (Frangez et al., 2005; Ugwu et al., 2009; Huang et al., 2010; Marchev and Szostak, 2013; Knecht et al., 2014; Kowalewski et al., 2016; Malinova and Zapryanova, 2017).

In connection to this, we set our goal to study the seasonal dynamics of some traits of semen production of Danish and English Landrace boars.

## MATERIALS AND METHODS

The study includes a total of 750 ejaculates, obtained from Landrace boars with Danish and English origin, in the period from September 2004 to July 2015, bred at the artificial insemination station at the Executive Agency for Selection and Reproduction, the town of Sliven. To achieve the goal, the semen production of boars of both breeds was studied at different seasons – spring (March, April, May), summer (June, July, August), autumn (September October, November,) and winter (December January, February).

The ejaculates were obtained with a manual method, collected in a graduated cup for semen collection, covered with a sterile gauze. Immediately after the acquisition and filtering, the material was evaluated by quantitative and qualitative semen traits, including:

- ejaculate volume (ml);
- sperm concentration ($x10^6$/ml), measured in sperm densitometer;
- total concentration of the sperms in the ejaculate ($x10^9$), calculated by multiplying the concentration of the sperms by the volume of the ejaculate;

When processing the data and establishment of the influence of some factors on the studied traits we used multifactor dispersion analysis as the linear model had the following statistical type:
Yijk=μ+Ai+Rj+eij (Model 1);
Yijk=μ+Ai+Rk+eik (Model 2);
Yijk=μ+Ai+Rj+CSij+eijk (Model 3); where: Yijkl – observation vector; μ- overall average constant; Ai, Rj are fixed effects corresponding to the season (i=4); the race of the sires (j=2); the individual (k = 8); CSij is random effect of interaction season*breed of the sires; eijk..- residual variance.

## RESULTS AND DISCUSSIONS

Table 1 shows the average values (LS±SE) of the indicators of sperm production of boars in the different seasons. The lowest features of all the studies were reported in summer (274.38±8.76 ml for sperm volume, 376.28±7.94x10⁶/ml for sperm concentration, 101.07±2.58x10⁹ for total concentration, and 16.89±0.43 for number of doses).
Szostak et al., (2015) also discovered that during summer months, the collected ejaculates were with reliably lower values for volume, concentration, and total concentration than the other seasons.
In our study, the highest volume of the ejaculate (319.9±8.21 ml), the highest total concentration (119.4±2.42x10⁹), and the highest number of doses for insemination (19.94±0.43), were monitored during the winter period, except the highest sperm concentration (412.72± 7.72x10⁶/ml) which was registered in spring.

Table 1. Seminal characteristics of boars during different seasons (LS± SE) (N=750)

| Season | Spring | | Summer | | Autumn | | Winter | |
|---|---|---|---|---|---|---|---|---|
| **Traits** | LS | ± SE | LS | ± SE | LS | ± SE | LS | ± SE |
| **Volume, ml** | 281.26 | 8.52 | 274.38 | 8.76 | 286.1 | 8.48 | 319.9 | 8.21 |
| **Concentration, 1x10⁶/ml** | 412.72 | 7.72 | 376.28 | 7.94 | 385.6 | 7.69 | 390.5 | 7.44 |
| **Total concentration, 1x10⁹** | 113.18 | 2.51 | 101.07 | 2.58 | 104.7 | 2.5 | 119.4 | 2.42 |
| **Number of insemination doses** | 18.90 | 0.42 | 16.89 | 0.43 | 17.44 | 0.42 | 19.94 | 0.43 |

The factors which are object of the analysis have a reliable effect on the studied indications of the sperm (Table 2). The individual appears to be a reliable source of variation in all the features of sperm production (p<0.001). The season of collecting the ejaculates has a reliable effect not only on the volume of the ejaculate and the sperm concentration (p<0.01) but also on the total concentration and the number of doses for insemination (p<0.001). The race of the breeding animals within the season has an analogical on the reviewed features as well.

Table 2. The effect of the season, race and the individual on the quality of sperm

| | | F-criterion and degree of reliability | | | |
|---|---|---|---|---|---|
| | | Traits | | | |
| **Model** | Factor | Volume, ml | Concentration, 1x10⁶/ml | Total concentration, 1x10⁹ | Number of insemination doses |
| **1** | Race | 14.267*** | 9.789** | 71.803*** | 74.248*** |
| | Season | 4.973** | 3.285* | 13.297*** | 13.446*** |
| **2** | Individual | 99.080*** | 35.462*** | 104.930*** | 105.202*** |
| | Season | 12.029*** | 6.596*** | 23.886*** | 24.056*** |
| **3** | Season | 5.881** | 3.944** | 11.065*** | 11.209*** |
| | Race*Season | 5.023** | 3.938** | 18.583*** | 19.129*** |

***P<0.05; **P<0.01; ***P<0.001**

While analyzing the age dynamics of sperm production in our previous publications (Zapryanova and Malinova, 2019), we discovered that the breed of sires has a significant effect on the volume of the ejaculate, the total sperm concentration, the number of doses for insemination (p<0.001), as well as on the concentration of reproductive cells in the ejaculates (p<0.01).

There are a number of other authors who come to similar conclusions about the influence of the breed, the individual, and the season of collection of the ejaculate, and who express the importance of the volume of the ejaculate and the sperm concentration in it, for specifying the number of doses of insemination as well as for the reproductive potential of the sperm (Nacu et al., 2011; Savić et al., 2013; Savić and Petrović, 2015; Kamanová et al., 2017).

Season is an interaction of multiple dynamic factors of the environment such as temperature, humidity, duration of daylight, air movement, etc. (Hristev and Zapryanova, 2018). The data provided by the same authors shows that during the periods characterized with more significant deviations of the temperature and light factors, when the organism aims to reach homeostasis, some changes are observed which concern the quantitative and qualitative indications of sperm.

According to Gorski et al., (2017), domestic pigs, like their wild predecessors, show higher sexual activity during the season which is natural for their reproduction, as, at the same time, their reproductive potential decreases when the environmental factors are not favorable for reproduction in natural conditions. The highest volume of ejaculates in our current analysis in both monitored breeds is detected in winter, as the prevalence of Danish Landrace boars (347.33±13.44 ml) compared to those of English origin (292.46±9.42 ml) is 19% (Figure 1).

The difference between these two breeds is a percent less in autumn, and in spring this distance melts to 3% (278.00±14.72 ml and 270.75±9.50 ml, respectively).

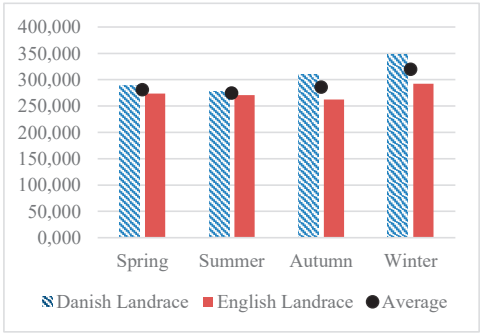


Figure 1. Dynamics of volume of the ejaculate (ml), depending on the season and breed

Kunowska-Slósarz and Makowska (2011) reach to similar results in their experiments to prove the seasonal effect on sperm production in different breeds and hybrid pigs. The authors find out reliably higher values of the volume of the ejaculate collected in winter and autumn, which is explained by the length of daylight, environment, and seasonal fluctuation in the sexual activity of male breeding animals. The lowest volume of ejaculates in the same study is in the period from March to June, which is explained with the reduced activity of boars. As for the seasonal variation of Danish Landrace, the highest volume is reported in winter (347.33±13.44 ml), which is 69.33 ml more than the lowest value of this indicator in summer.

The value of the quantitative feature of ejaculates of English boars is also highest in winter (292.46±9.42 ml), reaching its lowest levels in September, October, and November (262.23±7.87 ml).

Considering the seasonal dynamics of concentration of spermatozoa in the semen, we report prevalence of Danish Landrace sirs over the ones of English origin again (Figure 2).

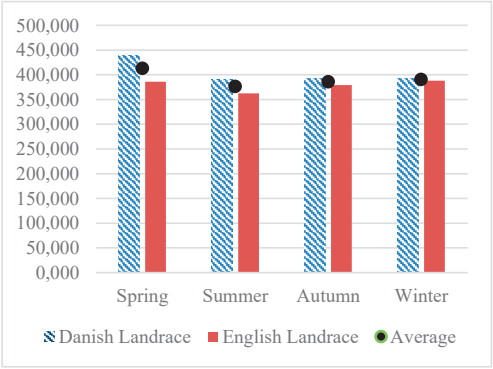


Figure 2. Dynamics of concentration of spermatozoa (x10⁶/ml), depending on the season and breed

The highest difference between these breeds is in spring – 21%, followed by the one collected in the months of summer (8%), and the difference is 1% in winter. In connection to the movement of the reviewed indicator of the breed, the highest detected values of concentration of spermatozoa in Danish breeding animals is in spring (439.45±12.84x10⁶/ml), while with the English ones, the highest concentration is in winter (388.19±8.54x10⁶/ml). In the other two seasons,

the direction of change in the studied indicator is equal, reaching its minimum in summer.

Our results are supported by those of Kunowska-Slósarz and Makowska (2011), who report the highest concentration of reproductive cells in the semen collected in the periods of winter-spring. In their studies, Gorski et al., (2017) find out that the longer the daylight, the lower the sperm concentration in ejaculates, and the shorter it is, the higher the sperm production becomes, which also leads to increased number of insemination doses.

The reported prevalence of the volume of ejaculates and concentration of spermatozoa of Danish Landrace boars, reasonably leads to the summary that the breeding animals from this breed have higher total concentration and collected number of insemination doses than the animals of English origin collected in the different seasons. The highest difference in the total concentration between the two breeds is in autumn – 29%, and the lowest one is in summer – 16%, in favor of the Danish genotype (Figure 3).

The values of the studied indicator in both monitored breeds are highest in winter and spring.

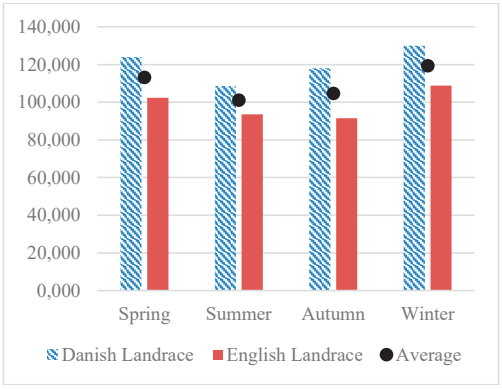


Figure 3. Dynamics of total concentration (x10⁹), depending on the season and breed

Danish Landrace boars reach the minimum of sperm production in summer (108.58±4.33x10⁹), while the breeding animals of the other race reach it in autumn (91.45±2.32x10⁹).

According to Kowalewski et al., (2016), the crucial factor of efficiency in the use of boars is the number of insemination doses. Malinova (2016) states that the total concentration is an important indicator which helps for the judgment of sperm production of breeding animals, and, more precisely, of the number of doses collected by one ejaculate.

In the conditions of the experiment we conducted, the values of this parameter in both studied breeds are the highest in winter (21.73±0.66 and 18.14±0.46, in Danish and English Landrace boars, respectively) (Figure 4).

The most significant difference between both genotypes is in autumn, when 29% more insemination doses were collected from the Danish boars than from the breeding animals of the English Landrace. The lowest contrast between the studied breeds is in summer (17%), but, again, in favor of the Danish genotype (18.18±0.72 against 15.59±0.47 numbers).

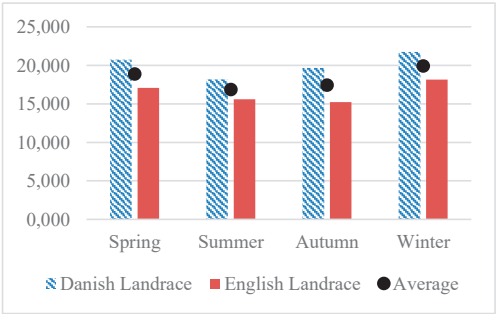


Figure 4. Dynamics of number of insemination doses, depending on the season and breed

## CONCLUSIONS

The lowest features of all the studies were reported in summer (274.38±8.76 ml for volume, 376.28±7.94x10⁶/ml for sperm concentration, 101.07±2.58x10⁹ for total concentration, and 16.89±0.43 number of doses). In our study, the highest volume of the ejaculate (319.9±8.21 ml), the highest total concentration (119.4±2.42x10⁹), and the highest number of doses for insemination (19.94±0.43), were monitored during the winter period, except the highest sperm concentration (412.72± 7.72x10⁶/ml) which was registered in spring.

The boars' race and the season of obtaining the ejaculates have a significant influence on the analysed semen traits, as the Danish Landrace

boars surpass the English Landrace origin by all studied characteristics of semen production.

The highest volume of ejaculates in both monitored breeds is detected in winter, as the prevalence of Danish Landrace boars (347.33±13.44 ml) compared to those of English origin (292.46±9.42 ml) is 19%.

The highest detected values of concentration of spermatozoa in Danish boars is in spring (439.45±12.84x$10^6$/ml), while with the English ones, the highest concentration is in winter (388.19±8.54x$10^6$/ml).

And both studied breeds reach the maximum of their sperm production in winter and spring. Danish Landrace boars reach the minimum of sperm production in summer (108.58±4.33x$10^9$), while the breeding animals of the other breed reach it in autumn (91.45±2.32x$10^9$).

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