

Age dynamics of some parameters of semen production of Landrace boars with Danish and English origin

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Abstract

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The aim of the study was to analyze the age dynamics of some indicators of semen production of Landrace boars of Danish and English origin. The results show that the boars of Danish Landrace breed surpass the English Landrace with 25% in the volume, with 4% in the concentration, and with 37% in the total concentration. The volume of the semen, the total concentration of sperms, and the number of insemination doses are reliably influenced by the individual, the breed, and the age class of the boars ($p < 0.001$). The individual and its age have influence over the sperm concentration ($p < 0.001$), and its breed, too ($p < 0.01$). In both studied breeds the volume of the semen increases with age as it reaches its highest level with boars at age of over 37 months, and the concentration of sperms in the ejaculate normally decreases with the age of the sirs. It was established that the boars of Danish Landrace breed reach the maximum of sperm production after the age of 37 months, and the breeders with English origin – between the age of 25 and 36 months.

Keywords: age differences; boars; breeds; ejaculate volume; Landrace; concentration; semen parameters; spermatozoa

Introduction

In the last decade, Danish and English Landrace, English Large White and Danube White have been taking the lead in Bulgarian pig farming. Regardless of the fact that the total number of Danish and English Landrace animals under selection control is the highest, the relative proportion of the male breeders for the last year is just 4.6% of all pure-bred boars (EFABIS, 2018), which would lead to rarer cases of insemination with semen of these breeds.

The ejaculates which will be used to the purposes of artificial insemination should be of high quality, which would ensure a good reproductive status and high insemination rate of the female animals.

The ability of the boars to produce quality semen depends on a number of factors, such as breed (Ciereszko et al., 2000), frequency of ejaculate obtaining (Frangez et al., 2005; Malinova & Zapryanova, 2017), age of the

boars (Huang et al., 2010), season of semen obtaining (Savić et al., 2013), testicles size (Huang et al., 1996) and many others.

After the occurrence of sexual maturity, in time, multiple changes occur in the organism, which, to a great extent also define the reproductive characteristics of the breeders in the period of economic use.

In this relation, we have set ourselves a goal to study the age dynamics for some parameters of semen production of Landrace boars with Danish and English origin.

Materials and Methods

The study includes a total of 638 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 age – up to 12 months, from 13 to 24, from 25 to 36, and over the age of 37 months. The ejaculates were obtained with a manual method, collected in a graduated cup for semen collection, covered with sterile gauze. Immediately after the acquisition and filtering, the material was evaluated by quantitative and qualitative semen traits, including:

- ejaculate volume (ml);
- sperm concentration ($\times 10^6/\text{ml}$), measured in sperm densitometer;

- total concentration of the sperms in the ejaculate ($\times 10^9$), 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:

$$Y_{ijk} = \mu + A_i + R_j + CS_{ij} + e_{ijk},$$

where: Y_{ijk} – observation vector; μ – overall average constant; A_i , R_j are fixed effects corresponding to the age class ($i = 4$); the breed of the sirs ($j = 2$); CS_{ij} is random effect of interaction age class*breed of the sirs; e_{ijk} – residual variance.

The statistical processing was done with the program SPSS, v.24, IBM.

Results and Discussion

Table 1 shows the average values (LS \pm SE) of the semen traits, characterizing the quality of the semen, obtained from the boars of both breeds. The results show that the boars from the Danish Landrace breed surpass the boars of the English Landrace breed with 25% in volume, 4% in concentration and 37% in the total concentration. The volume we obtained is similar to the results of Savić & Petrović (2015), who report 237.46 ± 6.50 ml in this semen trait for Swedish Land-

Table 1. Seminal characteristics of Danish and English Landrace boars

Race	Danish Landrace		English Landrace	
	LS	\pm SE	LS	\pm SE
Traits				
Volume, ml	295.86	6.94	236.49	4.45
Concentration, $1 \times 10^6/\text{ml}$	413.29	7.76	386.42	4.95
Total concentration, 1×10^9	117.07	2.00	85.49	1.28
Number of insemination doses	19.57	0.33	14.25	0.21

race boars. Nacu et al. (2011) study breeding boars of several breeds and at different age, for the quality of the ejaculates. In the results, the biggest semen volume is obtained from the Landrace boars, (256 ± 5.3 ml), and the lowest one from the Piétrain boars (183.5 ± 4.88 ml).

The sperm concentration in ejaculate we established ($413.29 \pm 7.76 \times 10^6/\text{ml}$ and $386.42 \pm 4.95 \times 10^6/\text{ml}$, respectively for Danish and English Landrace) is higher than the one established by Tăpăloagă et al. (2013), but is in unison with the results of Wolf & Smital. (2009).

The factors included in the study have a significant influence on the analyzed semen traits (Table 2). The individual appears as a reliable source of variation for the volume of the ejaculate, the concentration, the total concentration and the number of doses for insemination ($p < 0.001$). The age class, which the breeders fall in when obtaining the semen, has a significant influence on all studied traits ($p < 0.01$; < 0.001).

The breed of the sirs has a significant effect on the volume of the ejaculate, the total sperm concentration and the number of doses for insemination ($p < 0.001$), as well as on the concentration of sex cells in the ejaculates ($p < 0.01$). Savić et al. (2013) establish significant influence of the breed, the individual within the breed and the season on the ejaculate volume and sperm motility. The authors make the conclusion that the two studied characteristics of semen production are of exceptional importance when determining

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

Model	Factor	F-criterion and degree of reliability			
		Traits			
		Volume, ml	Concentration, $1 \times 10^6/\text{ml}$	Total concentration, 1×10^9	Number of insemination doses
1	Age class	14.14***	12.43***	7.98***	8.13***
	Individual	38.58***	23.91***	49.06***	49.75***
2	Age class	26.02***	25.91***	9.62***	9.75***
	Breed	67.84***	7.33**	216.23***	220.48***
3	Age class	15.49***	4.01**	15.21***	15.66***
	Breed	20.17***	0.35	57.08***	58.08***
	Age class*Breed	2.06	2.06	8.4***	8.74***

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

the number of doses, which is obtained from one ejaculate, as well as for the fertilization ability of the semen. Nacu et al. (2011), Savić & Petrović (2015), Kamanová et al. (2017) and others also report a significant effect of factors, such as breed, age, season of semen obtaining and the individual, etc., on the quality of the ejaculate.

After reaching sexual maturity, the quality and quantity of the semen of boars constantly increases with the rise of the levels of testosterone, the libido and the development of the testicles to the age of 6-8 months, and then at a slower rate until reaching the levels of adults animals (Rothschild & Ruvinsky, 2011). According to Kamanová et al. (2017), the changes which occur in the ejaculate with the age of the boars refer mainly to an increase of the volume of seminal fluid and the total concentration of the sperms, but along with that, the percentage of abnormal sperms also increases. In the same publication, the authors recommend the age from 13 to 36 months as the most suitable for the boars, used in the artificial insemination stations. According to Smital (2009) data, semen production of boars increases with age, and it reaches its maximum at a relatively late stage – the age of 42 months.

Gradual increase of the semen volume is observed with the Danish Landrace boars (Figure 1). The ejaculate volume is the smallest for the boars under the age of 12 months (190.0 ± 31.9 ml) and it is the biggest for the oldest animals (370.0 ± 34.5 ml), which is in unison with the trend of this parameter in previous our studies of (Zapryanova & Hristev, 2018). The increase of the volume of the semen with the increase of the age of the breeders, according to Savić et al. (2013) is due to an increase in the mass and size of the testicles.

The concentration of sperm in the semen of the boars at the age between 13 and 24 months ($409.7 \pm 8.63 \times 10^6/\text{ml}$) is just 4% higher than the value of this parameter of the boars of first age class. With time, the level of the studied parameter decreases, reaching its lowest level from $359.9 \pm 38.8 \times 10^6/\text{ml}$ for boars over the age of 37 months.

Obtaining the necessary number of doses for insemination is in direct dependence with the high quality of the semen (Kamanová et al., 2017). Malinova (2016) defines the total concentration as an important indicator, used to assess the semen production of sirs and more specifically the number of doses, obtained from one ejaculate. According to data from Wolf & Smital (2009), the total concentration of sperms, reaches its maximum at the age of 21 months, and then it starts to decrease.

In the condition of our study, the boars over the age of 37 months have the highest total concentration ($131.3 \pm 9.7 \times 10^9$), and highest number of doses, obtained from one ejaculate

(22 ± 1.6 pieces). The differences in these parameters with the boars from the other groups are 50.4%, 12.2% and 1.8%, compared, respectively with the first, second and third age class.

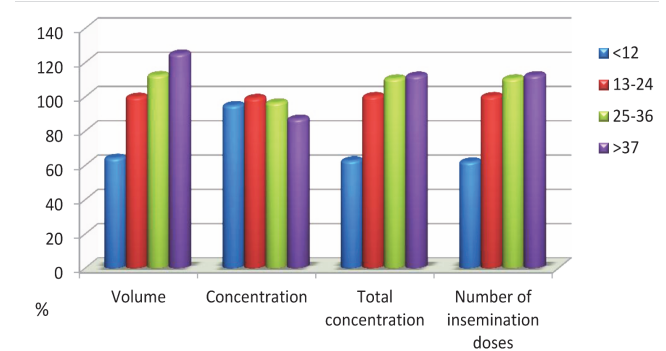


Fig. 1. The age dynamic of semen parameters in Danish Landrace boars (like deviation of mean, %)

The parameters of semen production for the English Landrace boars are presented in Figure 2. The smallest volume of ejaculate is of the breeders below the age of 12 months – 178.69 ± 9.2 ml, with a clear trend towards increasing to 280 ± 11.8 ml for animals after the age of 37 months. Quite normally, the concentration of sperms in the semen of the boars gradually decreases with age – it is highest for the youngest breeders ($458.6 \pm 10.4 \times 10^6/\text{ml}$), and reaches its minimum for the boars over the age of 37 months ($311.7 \pm 13.3 \times 10^6/\text{ml}$).

In both studied breeds, the total sperm concentration is higher with 8.5 to 40×10^6 compared to what was established by Tăpăloagă et al. (2013), lower with up to 86×10^6 (Pearodwong & Tummaruk, 2016), and relatively equal to what was

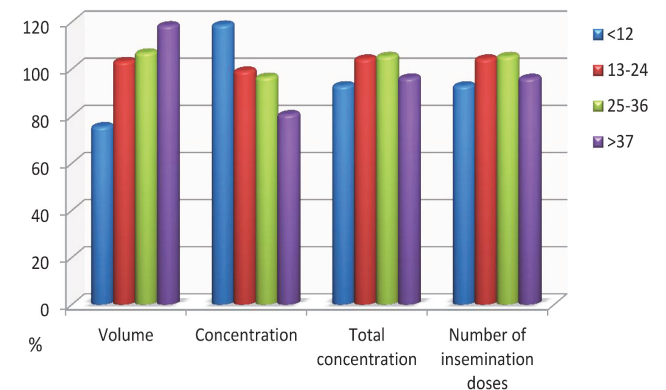


Fig. 2. The age dynamic of semen parameters in English Landrace boars (like deviation of mean, %)

established by Wolf and Smital (2009) at experiments with Czech Landrace boars.

On the basis of lower levels of volume and concentration, the number of the obtained doses from one ejaculate for the English Landrace boars is lower, compared to those with Danish origin. In that way for the studied breed, the lowest number of doses is obtained from the smallest age group for (13.2±0.4 pieces), and the highest number – from the semen of the boars at the age between 25 and 36 months (15.0±0.4 pieces).

Conclusions

In the condition of our study we established that the average values for ejaculate volume – 295.86±6.94ml and 236.49±4.45ml; sperm concentration – 413.29±7.76x10⁶/ml and 386.422±4.98x10⁶/ml; total concentration of the sperms in the ejaculate – 117.07±2.00x10⁹ and 85.49±1.28x10⁹; and number of insemination doses – 9.57±0.33 and 14.25±0.21 for Danish and English Landrace, respectively.

The volume of the semen, the total concentration of sperms, and the number of insemination doses are reliably influenced by the individual, the breed, and the age class of the boars ($p < 0.001$). The individual and its age have influence over the sperm concentration ($p < 0.001$), and its breed, too ($p < 0.01$).

In both studied breeds, the volume of the semen increases with age as it reaches its highest level with boars at age of over 37 months, and the concentration of sperms in the ejaculate normally decreases with the age of the sirs.

On the basis of the results of our study of total concentration of sperms in the ejaculate, we establish that the Danish Landrace boars reach the maximum of their sperm production after the age of 37 months, and the English origin boars – between the age of 25 and 36 months.

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