DEPENDENCIES BETWEEN SOME TRAITS OF SPERM PRODUCTION OF BOARS AT DIFFERENT AGE

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Abstract: The aim of the study was to establish correlation and regression dependencies between some traits of sperm production of terminal boars (Large White x Pietrain). The analyzed material consisted of 347 ejaculates, received in the period from 2011 to 2014. The boars were divided in three groups according to the age the ejaculate was obtained at (up to 12 months, from 12 to 24 months, and above 36 months). A moderate and negative correlation was established (r_p=-0.34, p<0.001) between the volume of the ejaculate and the concentration of the sperms in the second age group. With the youngest boars we established poor and positive correlation (r_p=0.29, p<0.05) between the volume of the semen and the motility of the sperm. The correlations between the traits concentration and motility are poor in the third (r_p=0.18, p<0.05), and moderate in the second age group (r_p=0.49, p<0.001). Between the motility from one side and the agglutinated and dead sperms from the other, they are within the range of r_p =-0.46 to r_p=-0.87, p<0.001. The correlations between the agglutinated and dead sperms are positive, from moderate to high and reliable (p<0.001) in all three age classes. The regression trend between the traits of sperm production are almost the same in all three age groups with the exception of volume of the ejaculate to the concentration of sperms.

Key words: boars, semen traits, correlations, regression, age class

Introduction

Artificial insemination (AI) has large economic importance in pig-breeding and in the past twenty years there has been a significant increase in its use. The results of AI depends mostly on quantitative and qualitative properties of the sperm *(Savić et al., 2015)*. According to *Ciereszko et al. (2000)* cross-bred boars are frequently used for reproduction. Numerous authors have determined that

ejaculates, received from cross-bred boars have better quantitative and qualitative semen traits in comparison with the pure-bred animals – *(Kondracki et al., 2003; Wysokińska and Kondracki, 2004) on Szostak and Przykaza (2016).* On the other hand, the establishment of the correlation and regression regularities appear as a reliable factor for the effective performance of the selection of farm animals *(Gerzilov, 2004).*

All of the above gave us reason to establish the correlation and regression dependencies between some of the sperm production traits of terminal boars (Large White x Pietrain), grouped in three age classes.

Materials and Methods

The study includes a total of 347 ejaculates, obtained in the period from January 2011 to May 2014, from 11 breeding boars (Large White x Pietrain), bred in a pig farm located in the region around the town of Plovdiv. The animals were divided in three groups according to the age the semen was obtained at (up to 12 months, from 12 to 24 months, and above 36 months).

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

-          volume of the ejaculate (cm^3),

-          concentration of the sperms ($x10^6$ sperm/cm^3), measured in a sperm densitometer

-          motility (%), determined by a routine method, under microscope with standard magnification *(Nikolov et al., 2012).*

-          Agglutinated and dead sperms (%) - determined by a routine method under light microscope, with magnification x400 *(Nikolov et al., 2012).*

Linear regression and Pearson's coefficient of correlation was used for bivariate correlation analysis, and were performed with SPSS software product version 19.

Results and Discussion

The average values of the studied traits of sperm production at the different age classes are shown in Table 1.

Table 1. Seminal characteristics of terminal boars

Traits	1-st age class		2-nd age class		3-th age class	
	n	LS±SD	n	LS±SD	n	LS±SD
Volume, (cm^3)	43	237.67±71.9	172	330.47±107.8	132	301.8±90.6
Concentration, (x10^6 sperm/cm^3),	43	468.84±82.9	171	393.86±109.8	131	436.6±73.6
Motility, (%)	43	74.88±8.34	169	73.05±8.4	132	71.06±3.4
Agglutinated spermatozoa, (%)	37	7.03±6.06	133	6.82±3.5	91	6.81±2.7
Dead spermatozoa, (%)	37	6.62±3.1	134	9.22±6.7	91	9.23±2.9

LS Mean; SD- Standard deviation

According to *Savić et al. (2013)* the volume and progressive motility of sperm are significant characteristics that determine the reproductive ability of semen. Based on a previous publication of ours *(Zapryanova and Hristev, unpublished data)*, whose aim was to make an analysis of the influence of the year, season and age when collecting semen from hybrid imported boars on the volume and concentration of the ejaculate, and the motility of the sperms, we determined that the age of the boar when collecting the ejaculate has a significant effect on the volume and concentration of the semen ($p < 0.001$), and on the motility of the sperms ($p < 0.05$). Boars below the age of 12 months have the smallest semen volume and the highest sperms motility. The breeding boars from the third age group are characterized with the lowest motility (Table 1). The largest percentage of abnormal sperms are found in the semen of the youngest boars, which is with the highest concentration as well. In the other two age classes the percentage of agglutinated sperms is practically the same. The results of our study are in unison with the information established by *Kondracki et al., (2013)*, who also report the highest presence of abnormal sperms in the semen with highest concentration. The group of up to 18 months of age have the smallest fraction of dead sperms, while the second and the third have almost identical values in this trait.

Table 2. Phenotypic correlations (r_p) between some indices of semen

Traits	Concentration	Motility	Agglutinated	Dead
Volume				
I age class	-0.06	0.29*	-0.08	-0.13
II age class	-0.34***	0.06	-0.03	-0.06
III age class	-0.03	0.06	0.01	-0.08
Concentration				
I age class		0.13	0.08	-0.13
II age class		0.49***	0.01	-0.26**
III age class		0.18*	-0.03	-0.04
Motility				
I age class			-0.65***	-0.77***
II age class			-0.56***	-0.77***
III age class			-0.46***	-0.64***
Agglutinated				
I age class				0.27
II age class				0.51***
III age class				0.41***

The correlations between the volume of the ejaculate and the sperms concentration are poor and unproven in age classes I and III, and moderate ($r_p=$-0.34, p<0.001) in the breeding boars from 12 to 24 months old (Table 2). For different grade phenotype correlations between the volume of the semen and the concentration of sperms of boars is also reported by *Buranawit and Imboonta (2016) and Wolf (2009)*, in whose experiments the values of the correlation coefficient is within the range of $r_p=$-0.20 to $r_p=$-0.6. In their own study of Duroc x Pietrain boars and their reciprocal crosses, *Szostak and Przykaz (2016)* establish strong correlations between the volume and the concentration of the sperms in the

semen depending of the season of collection of the ejaculate. The correlations between the volume and the motility are also poor, but positive and reliable (p<0.05) and they are only in the first group. The correlations between the motility and the concentration of the sperms in the second and third age class are poor to moderate r_p =0.49 (p<0.001) and r_p=0.18 (p<0.05) respectively. Between the traits of ejaculate volume and sperms concentration from one side, and the percentage of dead sperms from the other, there is a poor negative correlation, and only the connection between the sperms concentration and the percentage of dead sperms of boars below the age of two years is statistically proven (p<0.001).
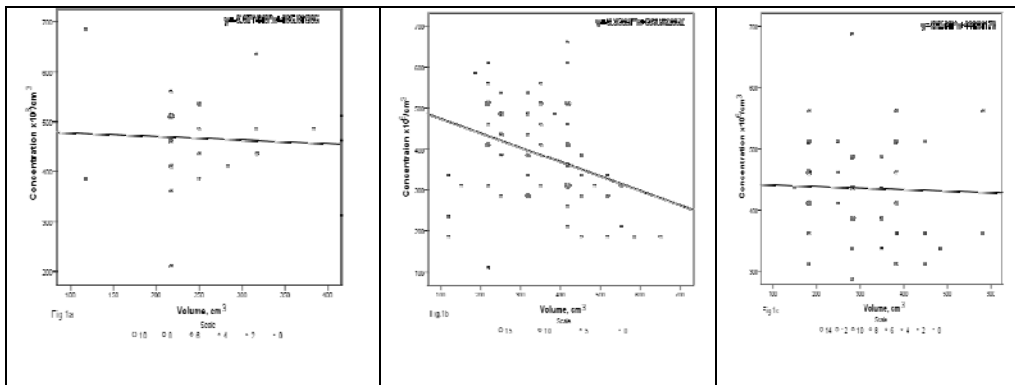

Figure 1. Regression between sperm volume and sperm concentration
1a-1-st age class, 1b- 2-nd age class, 1c- 3-th age class
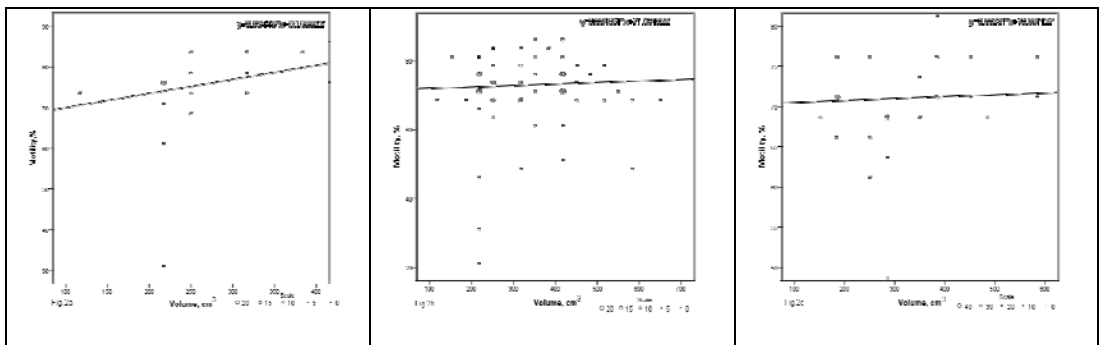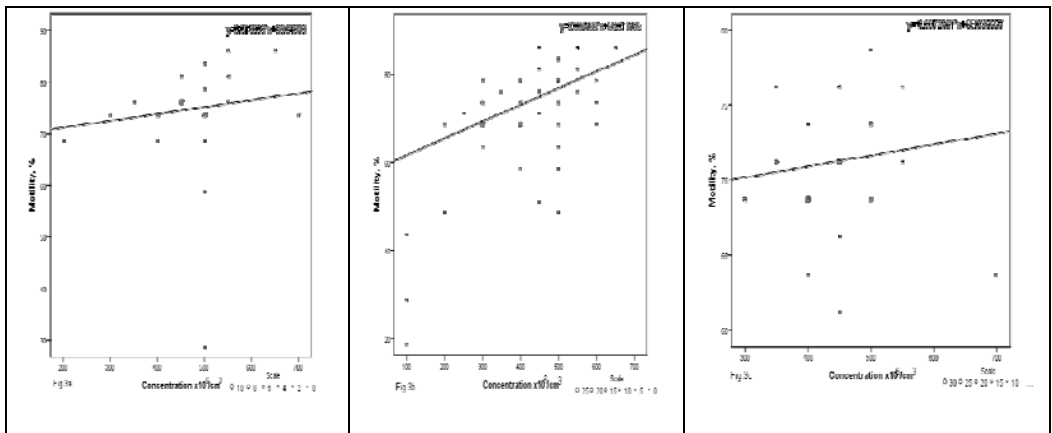

Figure 2 a, b, c. Regression between sperm volume and sperm motility
2a-1-st age class, 2b- 2-nd age class, 2c- 3-th age class

We have a moderate to strong correlation between the sperms motility and the percentage of agglutinated and dead sperms in all three age classes (p<0.001). The correlation between dead and agglutinated sperms is reliable (p<0.001) and positive in the second (r_p=0.51) and third (r_p=0.41) age class. Similar results are achieved with other animal species *(Gerzilov, 2004)*. The author establishes a

coefficient of phenotype correlation between the motility of the semen and the percentage of dead sperms (r_p=-0.430÷-0.440), during trials with Muscovy drakes in first and second reproductive season.

The regression dependencies between some of the studies traits of sperm production of boars are presented on figures 1-5. From figure 1a, c it is clear that the trend to a decrease of the volume of the ejaculate and the sperms concentration of the first and third age class is almost the same and quite slanting, while the regression line is a lot steeper for the boars from 12 to 24 months old (Fig. 1b)

With the exception of the first age group, where we have a reliable increase of the sperms motility in a larger volume of ejaculate (Fig.2a), the inclination of the other two groups is insignificant (Fig. 2b, c). In the conditions of our study we report increase in the sperms motility with increase of their concentration. This is especially noticeable with breeding boars before the age of 2 years (Fig. 3b), while in the youngest boars the positive dependency is the most poorly expressed (Fig. 3a).

Figure 3 a, b, c. Regression between sperm concentration and sperm motility
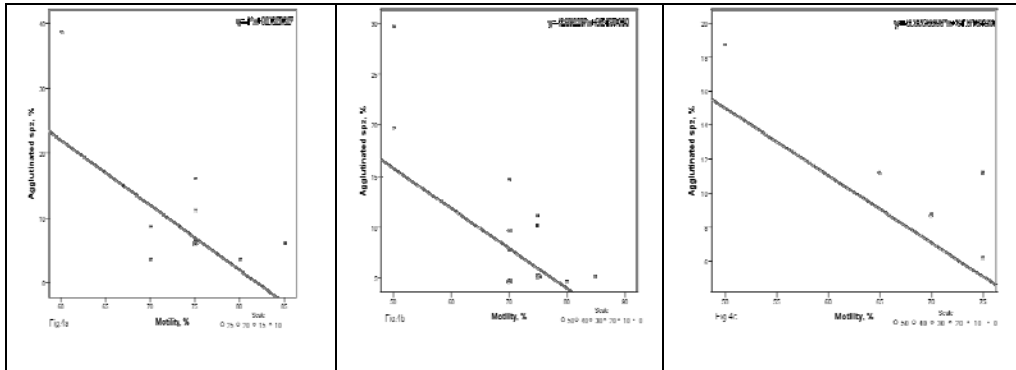**3a-1-st age class, 3b- 2-nd age class, 3c- 3-th age class**

Figure 4 a, b, c. Regression between sperm motility and agglutinated spermatozoa
4a-1-st age class, 4b- 2-nd age class, 4c- 3-th age class

For the rest of the studied traits of sperm production – percentage agglutinated (Fig. 4a, b, c) and dead (Fig. 5a, b, c) sperms to the sperms motility trait, the regression trend is almost identical in all three age groups.
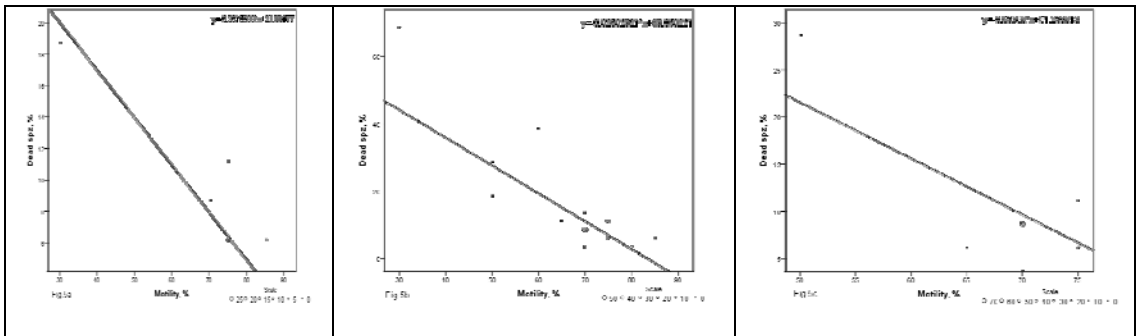

Figure 5 a, b, c. Regression between sperm motility and dead spermatozoa
5a-1-st age class, 5b- 2-nd age class, 5c- 3-th age class

Conclusion

The correlation between the volume of the ejaculate and the concentration of the sperms is negative and proven to be moderate for boars from the second age class (r_p=-0.34, p<0.001). Between the volume of the ejaculate and the motility of the sperms we have poor, positive and reliable correlation for the youngest breeding boars. The correlation links between the concentration and motility of the sperms are positive by trend, poor to moderate by grade for the second and third age class. Between the sperm motility from one side, and the agglutinated and dead

sperms from the other, we established reliable (p<0.001), moderate to strong and negative correlations in all three age classes.

The regression trend for the volume of the ejaculate to the concentration of the sperms is more clearly expressed for breeding boars up to the age of 2 years. The variation direction for the traits of volume and concentration towards the sperms motility as well as of the motility to the percentage of agglutinated and dead sperms is almost the same. There is an exception in the group from 18 to 24 months old regarding the traits of semen volume from one side towards the concentration and motility of the sperms from the other, where the regression dependencies are expressed more clearly.

Proizvodnja spermatozoida nerastova različitog uzrasta

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Rezime

Cilj istraživanja je bio da se utvrdi korelacija i regresione zavisnosti između nekih osobina u proizvodnji semena terminalnih nerastova (jorkšir x pijetren). Analizirani materijal se sastojao od 347 ejakulata, primljenih u periodu od 2011. do 2014. godine. Nerastovi su bili podeljeni u tri grupe, prema uzrastu nerastova u trenutku uzimanja ejakulata (do 12 meseci, od 12 do 24 meseci, iznad 36 meseci). Umerena i negativna korelacija ustanovljena je (r_p=-0.34, p<0.001) između zapremine ejakulata i koncentracije sperme u drugoj starosnoj grupi. Kod najmlađih nerastova ustanovili smo slabu i pozitivnu korelaciju (r_p=0.29, p<0.05) između zapremine semena i pokretljivosti sperme. Korelacije između osobina koncentracija i pokretljivosti su slabe u trećoj (r_p=0.18, p<0.05), odnosno umerene u drugoj starosnoj grupi (r_p=0.49, p<0.001). Između motiliteta, sa jedne strane, i aglutiniranih i mrtvih spermatozoida, sa druge, oni su u rasponu od r_p =-0.46 do r_p=-0.87, p<0.001. Korelacije između aglutiniranih i mrtvih spermatozoida su pozitivne, od umerenih do visokih i pouzdanih (p<0,001) u sve tri starosne grupe. Regresioni trend između osobina proizvodnje sperme je skoro isti u sve tri starosne grupe, sa izuzetkom zapremine ejakulata u odnosu na koncentraciju spermatozoida.

Ključne reči: nerastovi, osobine semena, korelacije, regresija, starosna klasa

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