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ASSESSMENT OF THE RELATIONSHIP BETWEEN PHYSICAL EJACULATE PARAMETERS AND THE SEXUAL ACTIVITY OF LANDRACE BOARS

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Abstract

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The study involved 11 Landrace boars, aged 8-9 months and used for insemination purposes. Each boar was assessed four times for its sexual activity: at the beginning of breeding service and after 3, 6 and 9 months of service. Ejaculates were collected for the assessment of sexual activity parameters. Physical parameters of the ejaculates were subsequently analysed. Pearson's linear correlation was used to calculate coefficients of phenotypic correlation between sexual activity levels and physical parameters of the ejaculates. Ejaculate parameters were shown to depend on the sexual activity of boars, as identified after 3, 6 and 9 months of insemination service. Moreover, it was determined that the degree of this interrelation increases along with age and development. After 3 months of service a correlation was identified between the sperm count in the ejaculate and the number of times the boar mounted the phantom, as well as a correlation between sperm motility and the time necessary for effectively mounting the phantom. After 6 months of service a correlation was observed between sperm concentration and both the time of ejaculation and total semen collection time. After 9 months of service the interrelation between ejaculatory efficiency and the level of sexual urge was the most prominent and was expressed in a high coefficient of correlation between ejaculation duration and the total semen collection time and both the volume of the ejaculate and sperm concentration.

Key words: ejaculate, sexual activity, Landrace, boars

Introduction

Artificial insemination plays a very important role in massive breeding of pigs. The already widespread practice of pig insemination contributed to the development of research relating to the efficiency of boar insemination service.

The chief criterion of insemination fitness of boars is the quality of obtained semen and libido levels. Such parameters are determined both by genetic parameters, connected with the breed of the boar, cross-breeding variant or genetic line, and environmental factors (Kondracki, 2010; Knecht et al., 2014). Boars of different breeds were found to provide ejaculates that differ in qualitative and quantitative parameters (Ciereszko et al., 2000; Wolf and Smital, 2009; Kondracki et al., 2012).

A serious technical and organisational problem connected with the insemination service of boars is varying sexual activity and facility in producing semen. The degree of sexual excitement prior to semen yielding can affect the ejaculatory efficiency of the boar. There are boars that produce a lot of high-quality semen and those that quickly and easily develop sexual reflexes. Such animals are particularly useful for insemination service (Bertani et al., 2002; Foote, 2003; Kondracki, 2010).

It may be possible to use libido measurements for the assessment of the insemination fitness of boars by drawing conclusions about the quality of obtained ejaculates on the basis of the correlation between ejaculate parameters and the sexual activity of the boars. No conclusive data, however, exist to support this view.

The present work was aimed at assessing the correlations between sexual activity parameters of Landrace boars and the physical traits of ejaculates yielded by them.

Materials and Methods

The experiments were carried out on 11 Landrace boars in insemination service. At the start of the study all the boars

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were 8-9 months of age. The study of the sexual activity of each boar was performed four times at three-month intervals at the following times: - investigation 1; in the first week of insemination service, - investigation 2; after 3 months from the start of insemination service, - investigation 3; after 6 months from the start of insemination service, - investigation 4; after 9 months from the start of insemination service.

The assessment of sexual activity was based on measurements of the time necessary for the development of copulation reflexes. The release time of particular copulation reflexes was determined using a stop-watch precise to one second. The measurements were carried out in the morning between 6:15 and 8:00 am at the service site. Each investigation involved following measurements: time from entering the arena until mounting the phantom, time from mounting the phantom until developing erection, time from developing full erection until the start of ejaculation, the time of ejaculation, semen collection time (the time of copulation), i.e. the total time from effective mounting until disengagement from the phantom following completed ejaculation, the necessary number of times the boar mounted the phantom to yield semen.

In parallel to the study of sexual activity we collected ejaculates. Ejaculates were manually collected into germ-free plastic bags placed in heat-insulating dish plugged with a disposable viscose filter. This made it possible to isolate the gelatinous fraction. Directly after collection, the ejaculates were examined macro- and microscopically analysed to determine the following physical parameters: ejaculate volume (in ml), sperm concentration (in thousands/mm^3), percentage of correctly motile spermatozoa (in %), overall sperm count in the ejaculate (in bn), number of insemination doses obtained from one ejaculate (its).

Ejaculate volumes were determined after isolating the gelatinous fraction on the basis of measurements of ejaculate weights by means of electronic scales. Sperm concentration in the ejaculates was determined with a photometric method, using a spectrophotometer. This method consists in measuring the intensity of light passing through a suspension of spermatozoa in an isotonic sodium chloride solution. Sperm motility was assessed under a microscope. A drop of fresh semen was placed on a preheated slide and covered with a slip-glass that had also been preheated to approximately 37°C. With a 200-fold zoom we determined the percentage of correctly motile spermatozoa in the overall number of sperms present in the field of vision of the microscope. The total number of spermatozoa in the ejaculate and the number of insemination doses obtained from one ejaculate were determined with SYSTEM SUL software.

Pearson's linear correlation was used to calculate coefficients of phenotypic correlation between sexual activity levels and the physical parameters of the ejaculates.

Results

Table 1 contains a juxtaposition of the coefficients of phenotypic correlation between the analysed sexual activity parameters and ejaculate volumes.

The data contained in the table show that ejaculate volume mostly depends on the duration of ejaculation and the overall semen collection time. The coefficients of phenotypic correlation indicating the interconnection between ejaculate volume and the duration of semen evacuation (duration of ejaculation) were relatively high, ranging from r = 0.32 to r = 0.88. The coefficients assumed positive values that mean

Table 1
Coefficients of phenotypic correlation between ejaculate volume and the sexual activity parameters of the boars at the beginning and after 3, 6 and 9 months of breeding service

Sexual activity parameters	At the start of service	After 3 months of service	After 6 months of service	After 9 months of service
Time from entering the arena until mounting the phantom	0.56	-0.19	-0.03	0.36
Time from mounting the phantom until developing erection	0.06	0.22	0.11	0.23
Time from developing full erection until the start of ejaculation	0.20	-0.27	-0.19	-0.01
Duration of ejaculation	0.34	0.32	0.47	0.88*
Semen collection time	0.53	0.19	0.31	0.85*
Necessary number of times the boar mounted the phantom to yield semen	0.09	-0.06	0.47	0.11

*- significant differences at $P \leq 0.05$

the volume of the ejaculates increased along with the time of ejaculation. It should be noted that the degree of this correlation rose along with breeding service duration. At the start of service and after 3 months this interrelation was relatively weak (r = 0.32 – 0.34). After six months of service, the correlation coefficient showing the relationship between ejaculate volume and the duration of ejaculation increased to the level of 0.47, and after 9 months it was already very high at 0.88 (P≤0.05). The correlation between ejaculate volume and the level of the other sexual activity parameters was not proved. The correlation coefficients for these parameters were generally relatively low, often close to zero and indicated variable trends of correlation.

The correlation coefficients showing the connection between sperm concentration in the ejaculate and the analysed sexual urge parameters are presented in Table 2.

The data in Table 2 show a significant correlation between sperm concentration in the ejaculate and both the duration of ejaculation and the overall semen collection time, though only in older boars. After 6 months of insemination service, the correlation was relatively low and amounted to r = - 0.66 (P ≤ 0.05) and r = - 0.70 (P ≤ 0.05) for the duration of ejaculation and for the overall semen collection time, respectively. After 9 months of service, the correlation even increased to the level of r = - 0.87 (P ≤ 0.05) and r = - 0.88 (P ≤ 0.05), respectively. The correlation coefficients assumed high and negative values, which show a strong and inversely proportional relationship between sperm concentration in the ejaculate and both the duration of ejaculation and the total semen collection time. This means that sperm concentration fell along with the time of ejaculation and the overall semen collection time. The other analysed sexual urge parameters were only slightly connected with sperm concentration in the ejaculate.

Table 3 contains data that reveal the degree of interrelation between sperm motility in the ejaculate and the sexual activity parameters.

The phenotypic correlation coefficients presented in the table reveal a low correlation between sperm motility in the ejaculate and the sexual activity parameters of the boars. It was observed, however, that the time measured from the moment of mounting the phantom until developing erection was related with the percentage of progressively motile spermatozoa. Nevertheless, this correlation was only significant in the case of relatively young boars, after 3 months of insemination service, for which the relevant correlation coefficient amounted to r = - 0.66 (P ≤ 0.05). Negative values of this coefficient indicate an inversely proportional relationship between the percentage of motile spermatozoa and the necessary time until developing erection. The negative values assumed by the correlation show that the boars that needed more time to develop erection yielded ejaculates with a lower percentage of correctly motile spermatozoa.

Table 4 contains a juxtaposition of the coefficients of phenotypic correlation between the analysed sexual activity parameters and the total ejaculate sperm count.

The data in Table 4 reveal that the relationship between the overall sperm count in the ejaculate and the speed of developing sexual reflexes by the boars is not very consistent. Nevertheless, we proved that the boars that needed to take more leaps also produced fewer spermatozoa per ejaculate. Such correlation was confirmed in the boars analysed after 3 (r = - 0.64) and 9 months of insemination service (r = - 0.63). On the other hand, the ejaculate sperm count was not significantly correlated with the other libido parameters under analysis.

The data in Table 5 show that the sexual urge of the boar only slightly translates into the number of insemination dos-

Table 2
Coefficients of phenotypic correlation between sperm concentration in the ejaculate and the sexual activity parameters of the boars at the beginning and after 3, 6 and 9 months of breeding service

Sexual activity parameters	At the start of service	After 3 months of service	After 6 months of service	After 9 months of service
Time from entering the arena until mounting the phantom	-0.22	0.20	-0.24	0.18
Time from mounting the phantom until developing erection	-0.22	-0.29	-0.42	-0.19
Time from developing full erection until the start of ejaculation	-0.30	0.51	-0.48	-0.46
Duration of ejaculation	-0.02	-0.35	-0.66*	-0.87*
Semen collection time	-0.30	-0.13	-0.70*	-0.88*
Necessary number of times the boar mounted the phantom to yield semen	-0.43	-0.31	-0.73	0.25

*- significant differences at P≤0.05

Table 3
Coefficients of phenotypic correlation between sperm motility in the ejaculate and the sexual activity parameters of the boars at the beginning and after 3, 6 and 9 months of breeding service

Sexual activity parameters	At the start of service	After 3 months of service	After 6 months of service	After 9 months of service
Time from entering the arena until mounting the phantom	0.01	0.22	0.31	-0.28
Time from mounting the phantom until developing erection	-0.34	-0.66*	-0.56	-0.29
Time from developing full erection until the start of ejaculation	-0.13	0.38	-0.11	-0.33
Duration of ejaculation	-0.02	0.03	0.39	-0.08
Semen collection time	-0.27	0.06	0.17	-0.03
Necessary number of times the boar mounted the phantom to yield semen	0.15	0.05	-0.07	-0.43

*- significant differences at P≤0.05

Table 4
Coefficients of phenotypic correlation between the ejaculate sperm count and the sexual activity parameters of the boars at the beginning and after 3, 6 and 9 months of breeding service

Sexual activity parameters	At the start of service	After 3 months of service	After 6 months of service	After 9 months of service
Time from entering the arena until mounting the phantom	0.24	-0.37	-0.16	-0.51
Time from mounting the phantom until developing erection	-0.22	0.18	-0.61	0.33
Time from developing full erection until the start of ejaculation	-0.10	0.21	-0.54	0.22
Duration of ejaculation	0.45	0.30	0.03	0.52
Semen collection time	0.23	0.37	-0.23	0.57
Necessary number of times the boar mounted the phantom to yield semen	0.21	-0.64*	-0.27	-0.63*

*- significant differences at P≤0.05

Table 5
Coefficients of phenotypic correlation between the number of insemination doses prepared from one ejaculate and the sexual activity parameters of the boars at the beginning and after 3. 6 and 9 months of breeding service

Sexual activity parameters	At the start of service	After 3 months of service	After 6 months of service	After 9 months of service
Time from entering the arena until mounting the phantom	0.65*	-0.40	-0.14	-0.34
Time from mounting the phantom until developing erection	0.06	0.16	-0.53	-0.20
Time from developing full erection until the start of ejaculation	0.20	0.32	-0.38	0.29
Duration of ejaculation	0.34	0.27	0.15	0.25
Semen collection time	0.53	0.38	0.09	0.21
Necessary number of times the boar mounted the phantom to yield semen	0.09	-0.75*	0.07	-0.45

*- significant differences at P≤0.05

es. The number of insemination doses prepared from one ejaculate rose along with the time passing from entering the arena by the boar until it mounted the phantom (r = 0.65). After 3 months of service an inversely proportional relationship was identified between the number of insemination doses prepared from one ejaculate and the necessary number of times the boar mounted the phantom to effectively ejaculate (r = - 0.75).

Discussion

The existence of a correlation between sexual activity parameters and ejaculate characteristics and sire fertility gives rise to a certain controversy. Some researchers think that such relationship does not exist. However, the data presented herein show that the physical characteristics of the ejaculate are to a certain degree determined by the sexual activity of the boar. After 6 and 9 months of service the older boars were found to take more time to ejaculate and more time to copulate, which was in correlation with larger volumes of yielded ejaculate. Simultaneously, ejaculate sperm concentration decreased along with extended ejaculation and overall copulation time. On the other hand, the number of insemination doses prepared from ejaculates collected from the boars after 3 months of service remained significantly correlated with the time elapsing from the entry in the arena until mounting the phantom. The results show thus a relationship between sexual activity levels and ejaculatory efficiency. The effect of the level of sexual activity prior to semen collection on semen quality had been demonstrated by Signoret (1962) and Łyczyński (1988). Basic ejaculate parameters, such as: ejaculate volume, sperm concentration and motility in pure-bred boars mainly depend on the duration of ejaculation and the overall copulation time, whereas in two-breed boar hybrids these parameters are to a greater degree connected with the time passing from the moment the boar mounts the phantom until the start of ejaculation (Wysokińska and Kondracki, 2014). A slightly different view is held by Levis and Reicks (2005) who have reported that the sexual behaviour of boars has little effect on the ejaculatory efficiency and semen quality. LeAmaster and DuPonte (2007) as well as Walker et al. (2009) are of the same opinion. They claim that there is no significant connection between bull libido and semen quality and the level of sexual urge only improves the course of copulation and facilitates semen collection. Semen collection is not affected by bull behaviour either (Adamczyk et al., 2013).

Boar libido is conditioned by a complex interaction between the internal reaction of the organism and the environment. The development of sexual reactions in young boars is on the other hand, highly determined by the element of fun and the social relations within the herd (Williams, 2009). The exploration of sexual behaviour control in boars is important with regard to optimising the breeding value of sires (Hemsworth and Tilbrook, 2007). Sires intended for insemination purposes are initially trained to yield semen using a phantom. Correct sexual urge is ascertained when the time necessary to effectively mount the phantom does not exceed 15 minutes (Leidl, 1983).

The efficiency of breeding service by boar sires is determined by quantitative and qualitative ejaculate parameters. Their economic measure is the number of insemination doses (Borg et al., 1993). One ejaculate collected form a boar hybrid usually provides more insemination doses than one ejaculate obtained from a pure-bred sire (Wysokińska and Kondracki, 2004; Wysokińska et al., 2009). Hybrid boars produce ejaculates containing highly motile spermatozoa (Wysokińska et al., 2009), which ensures higher impregnation rates.

The overall number of spermatozoa in the ejaculate is usually higher in boars with a strong sexual urge, as confirmed by our own results. More active boars yield ejaculates with a higher percentage of progressively motile spermatozoa (Dziadek et al., 1998). Ejaculates of greater volume and sperm concentration are obtained from cross-bred boars (Głogowski et al., 1997; Wysokińska and Kondracki, 2013) that also exhibit higher libido and produce semen of better quality (Ciereszko et al., 2000; Wysokińska and Kondracki, 2014).

The maintenance of an adequate level of sexual activity in male mammals requires steroid hormones, among which testosterone plays a crucial role. Castrated males do not exhibit interest in sexual activity (Williams, 2009). The maintenance of an optimal level of sexual urge requires an appropriate concentration of androgens and oestrogens (Levis and Ford, 1989). Boar testes can be stimulated to secrete steroid hormones by the effect of prostaglandins (Estienne et al., 2004). Some researchers have reported that prostaglandins can be a tool to stimulate libido in young boars (Estienne et al., 2001; Szurop et al., 1985). Not all scientists are. However, on the same opinion are Wettemann et al. (1992). Experiments performed on older sires have demonstrated that prostaglandin administration can have a positive effect, if such breeders have to be used for insemination (Estienne and Harper, 2000). Prostaglandin injections do not impinge on semen parameters (Estienne and Harper, 2004). Sexual behaviour stimulation can be taken advantage of to modify semen quality (Pound et al., 2002). A natural factor that stimulates male sexual activity

and does not involve hormonal interference is the observation of another sire directly before entering the arena (Levis and Reicks, 2005). The purpose of this procedure is to stimulate the transport of spermatozoa and. Consequently, increase their overall number in spermatic duct ampullas from where they are transferred into the urethra directly prior to ejaculation. The boars in the present study were given an opportunity to observe and even come in contact with another male, which could have a strong stimulant effect on ejaculatory performance.

Conclusion

The sexual urge level affects ejaculatory efficiency of boars. The correlation is however not very consistent and varies as the boar develops. Advancing age and development of a boar is accompanied with a growing correlation between physical ejaculate parameters and sexual urge. At the start of breeding service ejaculatory performance is only slightly affected by the level of sexual urge. After 3 months of service the correlation between the sperm count in the ejaculate and the number of times the boar mounts the phantom becomes visible. An analogous correlation is observed then between sperm motility and the time necessary for effectively mounting the phantom. After 6 months of service a correlation was observed between sperm concentration and both the time of ejaculation and total semen collection time (duration of copulation). After 9 months of service the interrelation between ejaculatory efficiency and the level of sexual urge was the most prominent and was expressed in a high coefficient of correlation between ejaculation duration and the total semen collection time and both the volume of the ejaculate and sperm concentration.

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References

Adamczyk, K., A. Makowska, J. Jędraszczyk, L. Hebda and Z. Gil, 2013. Effect of behaviour of Holstein-Friesian and Simmental bulls on semen quality. *J. Cent. Eur. Agr.*, **2**: 22-34.

Bertani, G., L. Scheid, R. Irgang, W. Barioni, I. Wentz and S. Afonso, 2002. Gonadal sperm reserve in purebred Landrace and Large White boars of high average daily gain. *Theriogenology*, **57**: 859-867.

Borg, K., D. Lunstra and R. Christenson, 1993. Semen characteristics. testicular size and reproductive hormone concentrations in mature Duroc. Meishan. Fengjing and Minzhu boars. *Biol. Reprod.*, **49**: 515-521.

Ciereszko, A., J. Ottobre and J. Głogowski, 2000. Effects of season and breed on sperm acrosin activity and semen quality of boars. *Anim. Reprod. Sci.*, **64**: 89-96.

Dziadek, K., R. Czarnecki and J. Owsianny, 1998. The relationship between sexual activity line 990 boars and their semen traits. *Rocz. Nauk. Zoot.*, **25** (3): 73-82 (Pl).

Estienne, M. J. and A. F. Harper, 2000. $PGF_{2\alpha}$ facilitates the training of sexually active boars for semen collection. *Theriogenology*, **54**: 1087-1092.

Estienne, M. J. and A. F. Harper, 2004. Semen characteristics and libido in boars treated repeatedly with PGF2? *J. Anim. Sci.*, **82**, 1494-1498.

Estienne, M. J., A. F. Harper and C. E. Babb, 2001. Lutalyse enhances libido in boars being trained to mount an artificial sow for semen collection. *J. Anim. Sci.*, **79**: 21.

Estienne, M. J., A. F. Harper, J. W. Knight, C. R. Barb and G. B. Rampacek, 2004. Sexual behavior after treatment with $PGF_{2\alpha}$ in boars with suppressed concentrations of gonadal steroids. *Appl. Anim. Behav. Sci.*, **89**: 53-57.

Foote, R., 2003. Fertility estimation: a review of past experience and future prospects. *An. Reprod. Sci.*, **75**: 119-139.

Glogowski, J., J. Falkowski and T. Rotkiewicz, 1997. Phosphatase activity in seminal plasma of boars on an annual basis and their relationship with the fundamental determinants of quality ejaculates. *Rocz. Nauk. Zoot.*, **24**: 85-95 (Pl).

Hemsworth, P. and A. Tilbrook, 2007. Sexual behavior of male pigs. *Horm. Behav.*, **52**: 39-44.

Knecht, D., S. Środoń and K. Duziński, 2014. The influence of breed and season on semen parameters. *S. Afr. J. Anim. Sci.*, **44**: 1-9.

Kondracki, S., 2010. The importance of artificial insemination in breeding and production pigs. *Rocz Nauk Zoot Monografie i Rozprawy*, **44**: 55-64 (Pl).

Kondracki, S., M. Iwanina, A. Wysokińska and M. Huszno, 2012. Comparative analysis of Duroc and Pietrain boar sperm morphology. *Acta Vet. Brno*, **81**: 195-199.

LeaMaster, B. R. and M. W. DuPonte, 2007. Bull power: examination of beef cattle bulls for breeding soundness. The Cooperative Extension Service of the USDA. *Livestock Management*, LM-17.

Leidl, W., 1983. Fortpflanzzungsstörungen beim Pferd. In: Fortpflanzzungsstörungen bei den Haustieren. *Ferdinand Enke Verlag.*, Stuuttgart, pp. 247-287.

Levis, D. G. and J. J. Ford, 1989. The influence of androgenic and estrogenic hormones on sexual behavior in castrated adult male pigs. *Horm. Behav.*, **23**: 393-411.

Levis, D. and D. Reicks, 2005. Assessment of sexual behavior and effect of semen collection pen design and sexual stimulation of boars on behavior and sperm output-a review. *Theriogenology*, **63**, 630-642.

Łyczyński, A., 1998. The effect of duration of sexual arousal on the basis of sexual activity on semen characteristics. *Biul. Inf. ART Olsztyn*, **25**: 145-149 (Pl).

Pound, N., M. H. Javed, C. Ruberto, M. Anis Shaikh and A. P. Del Valle, 2002. Duration of sexual arousal predicts semen parameters for masturbatory ejaculates. *Physiol. Behav.*, **76**: 685-689.

Signoret, J., 1962. Etude de l'influence de divers elements du comportement sexual du taureaur sur les caractéristiques du sperme. *Ann. Zoot.*, **11**: 93-101.

Szurop, A., A. Nagy and W. Jochle, 1985. Stimulation of libido in pubertal and mature Boars with prostaglandin F2? analogs: clinical observations. *Zuchthygiene*, **20**: 83-86.

Walker, J., G. Perry, R. Daly and K. Olson, 2009. Bull management and nutrition. In: Proc. of the Range Beef Cow Symposium, XXI Casper, WY, pp. 1-10.

Wettemann, R. P., S. Welty and D. K. Bishop, 1992. An attempt to stimulate sexual behavior of boars. *Anim. Sci. Res. Report*, 410-412.

Wiliams, S., 2009. Assessment of the boar reproductive effciency: physiodogy and implications. *Rev. Bvas Reprod. Anim. Supl. Belo Horizonte*, **6**: 194-198.

Wolf, J. and J. Smital, 2009. Quantification of factors affecting semen traits in artifical insemination boars from animal model analyses. *J. Anim. Sci.*, **87**: 1620-1627.

Wysokińska, A. and S. Kondracki, 2004. Heterosis effects on physical traits of ejaculate in Duroc×Pietrain and Hampshire x Pietrain crossbred boars. *Anim. Sci. Pap. Rep.,* **22**: 595-601 (Pl).

Wysokińska, A. and S. Kondracki, 2013. Assessment of the effect of heterosis on semen parameters of two-breed crosses of Duroc. Hampshire and Pietrain boars. *Archiv Tierz.*, **56**: 1-11.

Wysokińska, A. and S. Kondracki, 2014. Assessment of sexual activity levels and their association with ejaculate parameters in two-breed hybrids and pure-bred Duroc and Pietrain boars. *Ann. Anim. Sci.*, **14** (3): 559-572.

Wysokińska, A., S. Kondracki, D. Kowalewski, A. Adamiak and E. Muczyńska, 2009. Effect of seasonal factors on the ejaculate properties of crossbred Duroc x pietrain and pietrain x duroc boars as well as purebred duroc and pietrain boars. *Bull. Vet. Inst. Pulawy*, **53**: 677-685.