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Post-mortem evaluation of genital organs from sows with reproductive disturbances

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ABSTRACT

The purpose of our research was to define changes in sows culled due to reproductive disturbances of genital organs, to evaluate functional condition of the ovaries and the stage of reproductive cycle. In order to study these parameters, 60 sows with disturbed reproductive cycles, Lithuanian White × Danish Landrace (LWxDL) and purebred Danish Landrace (DLxDL) were slaughtered. After slaughtering, the reproductive organs of all the sows were evaluated and it was concluded that 80% of the culled sows' ovaries continued to be active and an anoestrus stage was defined in 20% of the sows. Multiple follicular cysts were found in 3.33% of all culled sows. It was defined that the total count of follicles in both ovaries had no statistically reliable effect on the weight of genital organs, while the CL count greatly affected not only the weight of the genital organs but the stage of the sexual cycle ($P \leq 0.001$), the consistency of the cervix ($P \leq 0.01$) and vice versa. The average weight of the genital organs varied, depending on the sexual stage ($P \leq 0.05$) Our experiments proved that post-mortem examination of genital organs in sows and palpation of the uterus cervix are effective methods of defining the stage of sexual cycle and important diagnostic tools in the evaluation of reproductive disturbances.

Key words: reproductive disturbances, uterus, ovaries, oestrus cycle, anoestrus, sow

Introduction

Oestrus of the sows becomes unidentified, "silent", and can cause repeated oestrus after insemination and infertility. A sow which has been inseminated two or more times using high quality sperm, but which experiences failure, is culled, although the function of its ovaries is not disturbed. Such disturbances of the reproductive cycle in sows can be provoked not only by the disturbances of ovaries, but by exogenous factors and hormonal disbalance in the organism, caused in addition by poor management. Hormones produced by the hypophysis and gonads circulate in the blood and control cycles of the genital organs and uterus, ensuring the normal reproductive functions of sows. If neuroendocrine

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coordination is disturbed, the normal reproductive cycle undergoes changes as well (CHUNG et al., 2002).

Disturbed reproduction of sows is considered to be one of the main reasons for culling. These reasons may vary on different farms: late manifestation of the oestrus after weaning piglets, repeated oestrus, a small number of piglets in the hatch, or their low weight. The successful correction of reproduction and regulation of functions can be ensured by synchronising the oestrus, ovulation and farrowing, and by modern, precise methods for estimating hormone levels, their relationship and properly organised management. However, despite all the new methods for the regulation of reproductive disturbances of genital functions in sows and new diagnostic methods, reproductive disturbances in sows still remain one of the most urgent problems on pig farms. The main reason for this situation is the difficulty of studying sows' reproductive functions while the pigs are alive. Consequently, post-mortem examination of the genital organs of sows is one of the main methods for investigating reproductive disturbances. There seems to be little purpose in investigating the genital organs of all slaughtered sows, but only those sows from the herd which show various reproductive disturbances before slaughtering. Such investigations were carried out among randomly selected and slaughtered cyclic sows (DALIN et al., 1997; HEINOEN et al., 1998), however ,we failed to obtain any similar data about sows with reproductive disturbances in research data in Lithuania.

The purpose of this research was to identify changes in the genital organs of sows culled due to reproductive disturbances, to evaluate the functional state of their ovaries and the stage of oestrus cycle.

Materials and methods

The investigations were carried out in the autumn. Sixty sows of 3-4 farrowing Lithuanian White × Danish Landrace (LWxDL) and purebred Danish Landrace (DLxDL) with disturbed reproductive cycles were slaughtered. Before slaughtering, the data on breed, farrowing and reasons for culling were collected. According to the reasons for culling, they were divided into two groups. The first group consisted of 27 individuals (45%) culled due to the absence of signs of oestrus lasting longer than 45 days after weaning piglets and the second group consisted of 33 sows (55%) culled due to infertility after a third insemination.

Post-mortem examination of the genital organs was carried out immediately after slaughtering at the slaughter-house and the stage of oestrus cycle was defined.

The uterus (its body and horns) and ovaries were weighed, the follicles in the ovaries, corpora lutea (CL), were counted, the diameter of follicles and CL was measured, the consistency of the cervix was evaluated by grades and the functional condition of the ovaries was observed. The stages of sexual cycle was defined, if the ovaries were active

(the diameters of follicles were 5-10 mm and CL observed, as follows: pro-oestrus (from 19 to 21 days), oestrus, early dioestrus (2-7 days), dioestrus (8-12 days), and late dioestrus (16-18 days). Sows' ovaries which were inactive (no CL, size of the follicles less than 4 mm or none found at all) were considered anoestrus. Follicles in these anoestrus sows were not calculated. The stage of oestrus cycle and the reason for reproductive disturbances were defined according to the Dalin method (DALIN et al., 1997) and Meredith method (MEREDITH., 1977) for the evaluation of cervix consistency. This parameter was rated according to the following system of grades: 0-1G -very soft, 2G - soft, 3G - medium hard, 4G - hard, 5G - very hard.

Statistical analysis was carried out using version No. 9 of the SPSS statistical package (SPSS for Windows 9.0, SPSS Inc., Chicago, IL, USA, 1989-1995). The descriptive and monofactorial statistical analysis was used to analyse the data (ANOVA) and the Post Hoc Test (LSD) for multiple comparisons. The student's T-test was used to compare the average weight of the right and left ovaries. Correlation between dependant variables and the strength of direct relationship were measured by the Pearson correlation matrix. The data were considered statistically reliable if the P value was < 0.05.

Results

The genital organs of sixty 3rd or 4th farrowing sows culled due to reproductive disturbances were studied. It was defined during the study that in 80% of the sows culled due to reproductive disturbances, the ovaries remained active and anoestrus was found only in 12 sows, i.e. 20% (Fig. 1). As became evident after post-mortem examination 5% of the sows were in the oestrus stage, in spite of the fact that no signs of oestrus were observed before slaughtering.

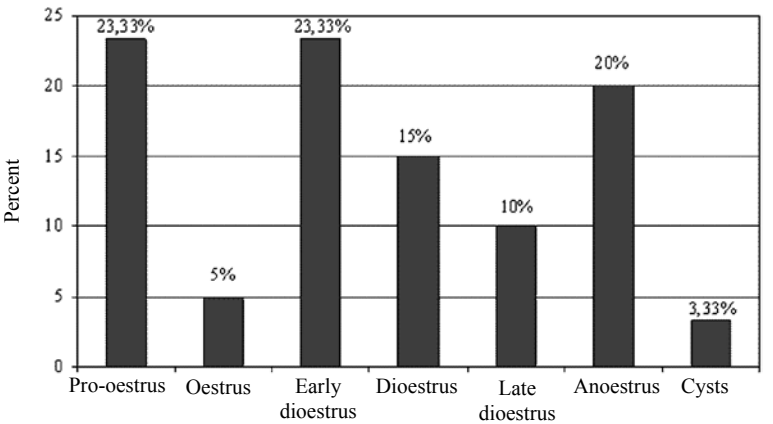

Fig. 1. Stages of oestrus cycle in sows slaughtered due to the reproductive disturbances

The average count of follicles and CL are presented in Table 2. The highest diameter of follicles (9-10 mm) was defined in the stage of oestrus, while it tended to be lowest (1-4 mm or none at all) in the anoestrus sows. It was also defined that the total count of follicles in both ovaries had no statistically reliable effect on the weight of the genital organs, while the CL count was positively correlated with the weight of the genital organs, the stage of the sexual cycle ($P \leq 0.001$) and the consistency of the cervix ($P \leq 0.01$) and vice versa. The size of CL and their colour varied, depending on the stage of sexual cycle. During the period of dioestrus (8-12 days), CL were pink and their diameter reached 9-10 mm. During period of regression in late dioestrus they tended to be smaller (8-5 mm) and lighter (yellowish white). CL were not found in the ovaries of anoestrus sows (Table 2). The average weight of the genital organs (Table 1) varied, depending on the oestrus stage ($P \leq 0.05$). The most significant difference (1.1 g) between the weight of the right and left ovaries was established in anoestrus sows, and the lowest (0.05 g), during the period before oestrus.

Table 1. The effect of oestrus stage on the average weight of genital organs (mean ± SD)

Oestrus cycle stage	Right ovary, g	Left ovary, g	Uterus, g
Anoestrus[a]	4.77 ± 2.82	4.66 ± 2.79[de]	609.27 ± 590.19[e]
Pro-oestrus[b]	4.72 ± 1.06	4.67 ± 1.21[de]	1040.64 ± 271.79
Oestrus[c]	9.05 ± 1.62	8.6 ± 0.56	1060.15 ± 137.39
Early dioestrus[d]	6.70 ± 1.79	6.95 ± 2.61[e]	1094.30 ± 241.74[a]
Dioestrus[e]	10.40 ± 2.70	11.40 ± 2.35[abd]	1209.75 ± 323.65
Late dioestrus[f]	11.22 ± 4.71	10.36 ± 3.99[ab]	1457.48 ± 486.58

Within a column (a, b, c, d and e, f) indicate significant difference ($P<0.05$)

Table 2. The effect of the different stages of sexual cycle on the count of follicles, corpora lutea and cervix consistence (mean ± SD)

Oestrus cycle stage	Count of follicles	Count of corpora lutea	Cervix consistence (G)
Anoestrus[a]	-	0	2.16 ± 1.52[bc]
Pro-oestrus[b]	25.21 ± 13.02	0	3.78 ± 0.69[adef]
Oestrus[c]	22.00 ± 2.83	0	5.00 ± 0[aef]
Early dioestrus[d]	14.86 ± 5.17	16.86 ± 2.77[ab]	2.13 ± 1.12[b]
Dioestrus[e]	31.22 ± 14.03	21.00 ± 3.60[ab]	0.77 ± 0.97[bc]
Late dioestrus[f]	29.83 ± 10.44	22.00 ± 8.39[ab]	0.83 ± 0.41[bc]

Within a column (a, b, c, d and e, f) indicate significant difference ($P<0.05$)

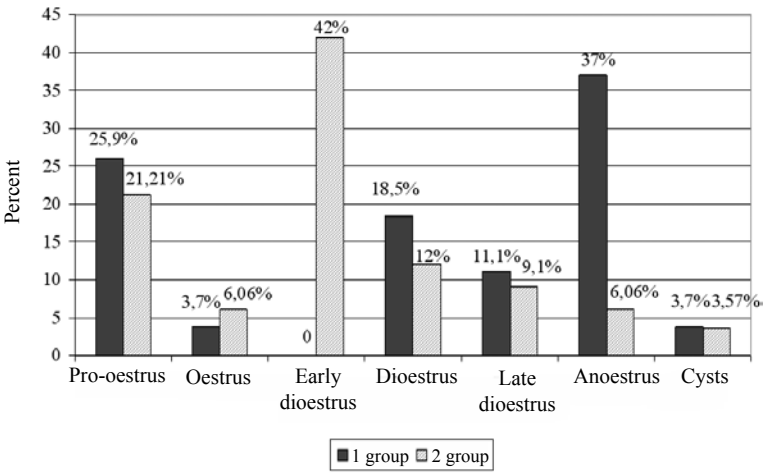

Fig. 2. Percentage distribution of the stages of oestrus cycle in the 1st and 2nd groups of sows depending of culling reasons

The lowest uterine weight was in anoestrus sows and the highest during the late dioestrus - 609.27 ± 590.19 g and 1457.48 ± 486.58 g respectively. For each stage of the sexual cycle, the weights of the right and left ovaries correlated ($P \leq 0.01$), and the average weight of the ovaries correlated with the average weight of the uterus ($P \leq 0.05$). We also defined that between both sides of the ovaries and uterus there is a fairly strong correlation, which changes, depending on changes in ovarian weight and v.v. ($P \leq 0.05$). A strong, significant direct relationship in all stages of the sexual cycle was confirmed between the weight of the right and left ovaries ($P \leq 0.01$). Edema of the uterus endometrium manifested most significantly in the stage of late oestrus; this manifestation was less significant before oestrus and during oestrus. The epithelium of the uterus in the anoestrus sows was dry and rough.

Investigation of the consistency of the cervix in anoestrus sows led to the conclusion that it was rather soft (0-2 grades). The consistency of the cervix among cyclic sows depended significantly on the stage of the sexual cycle, ovarian weight and the CL count ($P \leq 0.001$). The hardest consistency of the cervix was observed in the stage of oestrus (5 grades), and the softest after oestrus in farrowing sows (Table 2).

Post-mortem examination of the culled sows due to the failure of oestrus (1st group) revealed that 63% of the sows' ovaries were cyclically active and, among those with oestrus which had been inseminated several times but experienced failure (2nd group), remained active in as many as 93.94%. Anoestrus ovaries were found only in 37% of the sows in the 1st group and in 6.06% of the sows in the 2nd group. (Fig. 2).

Discussion

Sows are usually culled due to disturbances of the reproductive cycle (anoestrus) or due to failure of oestrus, repeated oestrus, external, mechanical traumas, low numbers of piglets, small, weak piglets, metabolic disturbances and gynaecological diseases (DALIN et al., 1997; KOKETSU et al., 1999). D'ALLAIRE et al. (1992) analysed the reasons for culling a fairly large number of sows and stated that, on average, about 12.9% - 41.4% of sows are culled due to reproductive disturbances. Pig farms in Lithuania experience quite severe economic loss due to this culling. That is why post-mortem examinations of the genital organs of culled sows were carried out, in order to define changes to their genital organs, evaluate the functional state of the ovaries and the stage of the sexual cycle and review the possible reasons for culling.

Post-mortem examination of the genital organs of sows culled due to the anoestrus carried out by BISHOP (2003) demonstrated that only in 10% of sows were ovaries anoestrus. Investigations during our research demonstrated that, of 60 sows culled due to reproductive disturbances, only 20% were in the anoestrus stage, while the ovaries of other sows were cyclically active. External signs of oestrus manifestation may not have been observed due to "silent oestrus" or failure in choosing the method to define oestrus, so quite a considerable number of sows were culled due to mistakes in evaluating their reproductive stage.

The manifestation of oestrus after weaning greatly depends on functional homeostasis of the organism and neuroendocrine balance. In 95% of sows, the first signs of oestrus can be observed 3-8 days after weaning piglets (KNOX and RODRIGUEZ, 2001). However, after this period, oestrus is observed not in all sows. If the manifestation of oestrus is not observed during the two weeks after weaning, the sow is considered to be anoestrus, and usually culled (BISHOP, 2003). During our experiments, 27 sows had no visible signs of oestrus, on average, 45 days after weaning. For the diagnosis of anoestrus in sows instantaneous investigation of the hormone concentration alone is insufficient (BISHOP, 2003), so such investigations should be carried out repeatedly and more variable measures and methods are required for diagnosing anoestrus (CHUNG et al., 2002).

The weight of the genital organs in sows changes from birth to maturity, when a considerable increase oin weight is observed (HEINOEN et al., 1998). The weight of the genital organs in culled sows, in our experiment, was caused by different stages of the sexual cycle. The average weight of the uterus in anoestrus sows was defined by DALIN et al. (1997) and HEINOEN et al. (1998) as 728 g. We defined that the weight of the uterus in such sows was 609.27 g, i.e. 119 g lower than in previous experiments, which may be due to differences in breeds, age and feeding technology. Mutual positive correlation of the uterine weight with the right and left ovaries was also confirmed during our experiments

at different stages of the sexual cycle ($P \leq 0.05$). This fact confirms that hormonal changes are observed in the uterus and ovaries at the same time and they are closely related.

The manifestation of oestrus and growth of follicles is considered to be a complex model, which involves the endocrine system of the organism itself (individual differences in the amount of insulin, insulin-growth factors (IGF-I), luteinizing hormone (LH) and follicle stimulating hormone (FSH)), the common functional system (mutual relationship between growth of follicles and manifestation of oestrus) and the morphological mechanism (weaning time depends on the development of follicles in the ovaries) (GUTHRIE, 2005; LUCY, 2001). In the organism of sows, a system of self-regulation is observed between the hypothalamus, hypophysis and genital organs, which ensures sexual development, maturation, cycle, fertility, lactation and other phenomena (DALIN et al., 1997; HEINOEN et al., 1998). However, there are other factors, apart from hormones, which control reproduction in sows, secretion and excretion. Such factors include the age of the animal, disease, exposure to light, boars, heat, feed rations, fattening, stress, and environment. Under the effect of these factors, hormone imbalance can occur in the organism (BISHOP, 2003). When propagation of ovarian cells weakens, hormonal hypofunction occurs. Due to the disturbed excretion of gonadotropic, steroid hormones and local factors such as inhibitors, mitotic follicle processes are disturbed as well (GUTHRIE et al., 1995; LUCY et al., 2001). A fairly common reason for ovarian hypofunction is imbalanced feed ration (lack of amino acids), a lack of constituents, or diseases (YANG et al., 2000). These negative factors cause limited growth and maturation of the follicles in the ovaries and failure to ovulate. In our experiments, post-mortem investigation of the genital organs of anoestrus sows revealed that the ovaries in such sows tended to be small and hard, CL was not found, and the follicles were inseparable from connective tissue growing over the ovaries. The low weight of ovaries in anoestrus sows (Table 1) and their appearance (no follicles or CL) led to the conclusion that cyclical processes in such ovaries are not observed. Our investigation was carried out in the autumn. During the summer, sows suffer from temperature stress, the consequences of which are observed in the autumn. The functions of genital organs weakened during the summer period do not regain the required level in the autumn, which leads to disturbances of the sexual cycle, a small uterus and seasonal infertility, which is rather common in sows. Other authors have successfully proved that this period is marked by instability in the sow's reproductive functions (KAEOKET et al., 2002; PELTONIEMI et al., 1999; XUE et al., 1994).

The different histological and functional peculiarities of the cervix are well known. The dynamic structures of the cervix ensure its adaptability to various physiological conditions, and it changes with changes of the oestrus cycle. The cells of the cervix can react differently and respond to altered hormonal regulation. These different responses are generated by such factors as oestradiol-17β (E_2), which stimulates infiltration of

eosynophyles, degranulation of mastocytes, histamine release, and other mediators which stimulate the contractability of the cervix, the expression of steroidic hormonal receptors, the metabolism of collagene and the plasticity of fibroblasts (RAMOS et al., 2000). During the sexual cycle the consistency of cervix changes depends on the stage of the sexual cycle and prevailing hormones. In our experiment, the hardest cervix was observed during oestrus, the softest after it (Table 2). These results are in close correlation with the data of RIŠKEVIČIENĖ and ŽILINSKAS (2001) who defined that increased concentration of oestradiol -17β and decreased concentration of progesterone caused changes in the consistency of the cervix, the hardest consistency of which was observed during oestrus, when the concentration of oestrogens was at its peak.

We also confirmed that the functional state of the genital organs differed depending on the reasons for culling (Fig. 2). The evaluation of the first group of sows culled due to the failure of oestrus, showed that the genital organs of 37% were anoestrus, while the remaining sows' ovaries were cyclically active. In the second group, only 6% (Fig. 2) of the animals were anoestrus and 31 sows' ovaries were active, but at different stages of oestrus cycle. It can be concluded from the data from the experiments that the reason for failed insemination in this group of sows was not disturbances of the genital organs. The sows in the 2nd group failed to be inseminated, not only due to disturbances of the genital organs, but also for other reasons, such as the time of insemination. According to ROZEBOOM and ROZEBOOM (2001), the best time for insemination is at the beginning of oestrus, 0-24 hours before ovulation, when the manifestation of uterine contractability is most evident, and the environment for spermatozoid motility most favourable. Stress may have negative effects on infertility (ELBERTS et al., 1996; MADEJ et al., 2005) as may unsuccessful management (PELTONIEMI et al., 1999; TUMMARUK et al., 2001). The quantitative parameters of insemination in sows can also be affected by seasonal changes, the method of insemination, the age of the animal, fattening, and number of inseminations (DRICKAMER et al., 1997; SOEDE et al., 1995).

Follicular cysts and culling can play a rather important role in reproductive disturbances (CASTAGNA et al., 2004; MCENTEE, 1990). The real origin of these cysts is not yet clear. It is stated by some authors to be caused by the disturbance of neurohumoral activity in the organism, and the physiological relationship between the hypophysis, epiphysis and nervous system (LEVIN, 1990). Cysts may form during the inovular cycle and as the result of poor feeding technologies, management, stress and other factors (DALIN et al., 1997). During our experiments, multiple follicular cysts were observed in 3.33% of all culled sows, and this was the main reason for culling, although the actual cause was failed oestrus (1.66%) and failed insemination (1.66%).

It was also proved by our studies that post-mortem investigation of the genital organs of sows with reproductive disturbances and palpation of the cervix are effective

diagnostic tools in defining the stage of the sexual cycle and diagnosing reproductive disturbances. In order to eliminate extreme risk factors and implement effective treatment for reproductive functions of sows, direct monitoring seems to be an unavoidable measure. If feeding is optimal, holding and management are possible reasons for reproductive disturbances. Failed oestrus can be easily predicted and the culling of pigs and failed oestrus after weaning avoided. Furthermore, the most effective measures for regulating the reproductive cycle can be applied. This will ensure the maintenance of pure breeds and healthy generations of piglets.

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SAŽETAK

Svrha ovog istraživanja bila je ustanoviti promjene na spolnim organima krmača izlučenima zbog reprodukcijskih poremećaja, procijeniti funkcionalnu sposobnost jajnika i stupanj spolnoga ciklusa. Ukupno je bilo zaklano 60 krmača s poremećenim spolnim ciklusom pasmine danski landras (DL×DL) i križane litavske bijele svinje s danskim landrasom. Nakon klanja pretraženi su bili spolni organi svih krmača te je zaključeno da je 80% jajnika izlučenih krmača bilo aktivno, dok je anestrus ustanovljen u 20% krmača. Multiple folikulske ciste ustanovljene su u 3,33% izlučenih krmača. Ukupan broj folikula na oba jajnika nije imao statistički značajnog učinka na masu spolnih organa, dok je broj CL imao značajan učinak ne samo na masu spolnih organa nego i na stupanj spolnoga ciklusa ($P \leq 0,001$), konzistenciju materničnoga grljka ($P \leq 0,01$) i obratno. Prosječna masa spolnih organa razlikovala se ovisno o stupnju spolnoga ciklusa ($P \leq 0,05$). Ovim istraživanjem pokazano je da su post mortem pretraga spolnih organa krmača i palpacija materničnoga grljka učinkovite metode za određivanje stupnja spolnoga ciklusa i važna dijagnostička metoda za prosudbu spolnih poremećaja.

Ključne riječi: reprodukcijski poremećaji, maternica, jajnici, estrus, anestrus, krmača