Praca oryginalna *Original paper*

Peforelin (GnRH analogue) stimulation of estrus as a tool to improve reproductive performance in gilts and sows

WIESŁAW BIELAS[1], PIOTR KRASOWSKI[2], ANNA RZĄSA[2]

[1]Department of Reproduction and Clinic of Farm Animals,
Wroclaw University of Environmental and Life Sciences, Grunwaldzki Sq. 49, 50-366 Wrocław, Poland
[2]Department of Immunology, Pathophysiology and Veterinary Preventive Medicine,
Wroclaw University of Environmental and Life Sciences, C. K. Norwida 31, Wroclaw 50-375, Poland

Received 30.05.2025 Accepted 01.07.2025

Bielas W., Krasowski P., Rząsa A.

Peforelin (GnRH analogue) stimulation of estrus as a tool to improve reproductive performance in gilts and sows

Summary

This study investigated the effects of peforelin, i.e. synthetic l-GnRH-III, on the reproductive parameters (WEI, FS, PD, TPB, LBP, SBP, WP) and reproduction indicators (ER, RR, FR, LPI) of gilts after altrenogest treatment and of post-weaning sows under commercial farm conditions. The study involved 323 sows divided into Perforelin and Control Groups within which the following subgroups were distinguished: gilts, primiparous and multiparous sows. Gilts were synchronized with altrenogest for 18 days. After 48 hours from the last administration of altrenogest, the gilts, and 24 h post-weaning, the sows, in Experimental groups were treated with peforelin (Maprelin, Veyx-Pharma), based on the manufacturers' instruction. Based on the results presented, the use of peforelin under industrial farm conditions enhances the reproductive performance of production batches in gilts and multiparous sows following synchronization of the estrous cycle. Statistically significant differences were only observed for the estrus rate and pregnancy rate.

Keywords: reproduction performance, peforelin, reproduction management, gilts, sows

Optimal reproductive performance is essential for the economic viability of commercial pig herds (26, 29). To meet the high productivity demands placed on modern sow genetics, various management strategies have been implemented, including optimized nutrition, hyperprolific maternal lines, group housing systems, and extended photoperiods during the post-weaning phase (2, 4, 16, 18, 20, 22, 23). Nevertheless, unavoidable fluctuations in farm conditions, such as seasonal effects (22, 23), pathogen load, and variations in feed composition (5, 16) can negatively influence reproductive outcomes in high-yielding animals.

A key determinant of reproductive success is the weaning-to-estrus interval (WEI) (24). To enhance reproductive efficiency, hormonal interventions are commonly employed, particularly the administration of progesterone analogues and gonadotropins (11). The post-weaning use of gonadotropins in sows or following altrenogest treatment in gilts can promote ovarian follicle development and potentially improve synchronization and reproductive outcomes (3, 19).

In mature swine, gonadotropin secretion is regulated by the hypothalamic peptide gonadotropin-releasing hormone (GnRH), which stimulates the anterior pituitary to release follicle-stimulating hormone (FSH) and luteinizing hormone (LH) (6, 8, 9, 20, 21). While GnRH regulates both FSH and LH, FSH is particularly critical for follicular growth and maturation, whereas LH is primarily responsible for triggering ovulation (3, 20). Sower et al. (27) were the first to identify, in the lamprey Petromyzon marinus, a third form of GnRH: lamprey GnRH-III (l-GnRH-III) which selectively stimulates FSH secretion (10, 27, 33).

Peforelin, a synthetic analogue of l-GnRH-III, has been introduced to stimulate estrus in sows post-weaning and in sexually mature gilts following progestogen treatment. Research has demonstrated that peforelin administration can enhance estrus expression in both gilts and sows (7, 10, 14, 15, 18). Its use has been associated with a shortened interval between the last dose of altrenogest and the onset of estrus (6, 7), and it may mitigate seasonal declines in reproductive performance, particularly during the summer (8). Moreover, studies suggest that peforelin reduces the WEI (1) and may positively influence subsequent litter characteristics (14, 15). Peforelin treatment has also been reported to improve oocyte quality, ovulation rates, and both embryonic and litter survival (16, 18).

The aim of this study was to evaluate the effects of peforelin treatment on reproductive performance in gilts and sows under commercial farm conditions.

Material and methods

The study was carried out on a Polish commercial farm with 1,800 PLW × PL (Polish Large White × Polish Landrace) sows, kept in a weekly production rhythm with a 28-day lactation period. There was no additional treatment of animals which were subject to routine care and veterinary supervision provided by farm personnel. The Animal Welfare Advisory Team at Wrocław University of Environmental and Life Sciences approved the study design in compliance with Polish and European Union legislation on animal experimentation (no. 12/2025). Sows were vaccinated against *Atrophic Rhinitis*, *Enzootic Pneumonia* and *Clostridium perfringens.* The animals (gilts and sows) were divided into six groups, according to parity and treatment: 82 gilts (approximately 240 days old, body weight 130-140 kg), 120 primiparous sows and 121 multiparous sows from 4 successive technological groups. The scheme of experiment is in Table 1.

Animals with clinical signs and/or reproductive disorders, such as vaginal discharge or abortions, were excluded from the study. Gilts were synchronized with altrenogest (Regumate®; MSD Animal Health, Brussels, Belgium) for 18 days (20 mg per gilt/day) after at least one estrus. They were kept in group pens 30 h/pen, while multiparous sows after weaning were introduced to individual cages. After 48 hours from the last administration of altrenogest, the gilts, and 24 h post-weaning, the sows, in Experimental groups were treated with peforelin (Maprelin, Veyx-Pharma), based on the manufacturers' instruction. Gilts (PG, n = 40) and multiparous (MP, n = 61) sows received 150 µg peforelin (2 ml Maprelin), and primiparous sows (PP, n = 60) 37.5 µg (0.5 ml Maprelin) (20). Animals in Control groups, gilts (CG, n = 42), primiparous (CP, n = 60) and multiparous (CM, n = 60) did not receive peforelin. All treatments were applied via intramuscular injection into the neck. Estrus stimulation began on the first day post-weaning (pw) in sows or 72 h after the last altrenogest treatment in gilts using at least two teaser boars. Gilts were tested for heat and standing response from the second day after the administration of peforelin, gilts from the Control groups were at the same age what experimental ones so the observations were made at the same time. Primiparous and multiparous sows were observed from the second day after weaning. Estrus detection was performed three times a day (around 6 and 12 a.m. and 18 p.m). The same schedule for artificial insemination (AI) was used for all of the animals. In short, sows that were in estrus in the morning on day 4 were bred 24 hours later, and sows that were in estrus in the evening were bred 12 hours later. Sows in estrus on day 5 pw were inseminated 8 h later, while those in estrus on day 6 pw were inseminated immediately. Sows still in estrus 12 h after the first AI were inseminated a second time.

Single boar semen of proven fertility was purchased from commercial AI center. Pregnancy testing was performed by the herd veterinarian. Trans-abdominal ultrasound scans were performed with a sectorial probe at 23 to 28 days after insemination and again two weeks later. Pregnant gilts stayed in their group pens, while pregnant sows were moved to group pens and all of them were fed with gestation feed. Approximately one week before the expected delivery, the sows were moved to the farrowing unit.

Sows' reproductive performance was assessed base on: weaning to estrus interval (WEI, the interval between the day of the last altrenogest treatment for gilts or the day of weaning for sows and the onset of estrus), estrus rate (ER, the proportion of gilts and sows in estrus), first service time (FS), retain rate (RR, the proportion of sows which repeat estrus), pregnancy duration (PD, gestation lengh), pregnancy rate (PR, the proportion of pregnant animals among those inseminated), the farrowing rate (FR, the proportion of animals that farrowed per 100 inseminations), number of born piglets: TPB, total born piglets; LBP, live born piglets; SBP, stillborn piglets; WP, weaned piglets and Piglet index was calculated (PI, PI = LPB × 100 / number of inseminated sows).

Statistical analysis. Dates were recorded according to the GCP guidelines. Treatment comparisons were made by ANOVA for a completely randomised design using the Statistica 10.0 statistical package. Differences between means were determined by the Duncan test when 6 subgroups were analysed and by Tukey test when 2 groups were analysed at $p \leq 0.05$. The results are shown as mean ($\bar{x}$) and standard deviation (±).

Results and discussion

Among a total of 323 females, estrus symptoms were observed in 285 sows. Of these, 143 sows (88.8%) in the Peforelin group and 142 sows (87.6%) in the Control group were inseminated. The results of estrus stimulation are presented in Figure 1.

When comparing the estrus rate (ER) in the experimental and control gilt groups, a significantly higher

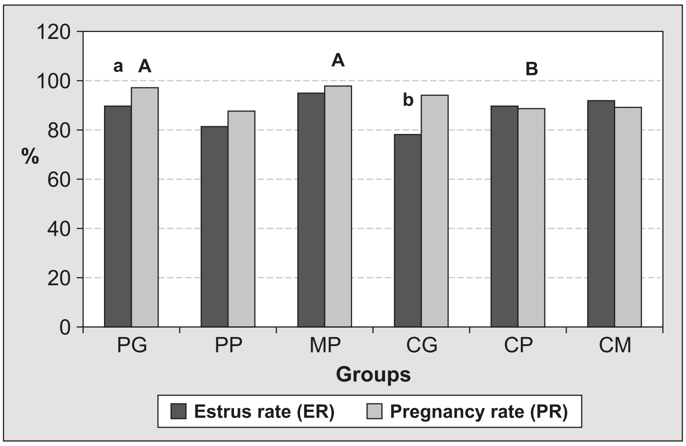

Fig. 1. Effects of estrus stimulation
Explanation: Significant differences marked in small letters indicate $p \leq 0.05$, in capital letters $p \leq 0.01$

Tab. 1. Experiment scheme

Group	Peforelin			Control		
Subgroup	Gilts (PG)	Primiparous (PP)	Multiparous (MP)	Gilts (CG)	Primiparous (CP)	Multiparous (CM)

Tab. 2. Reproduction performance of sows

Parameter		Experimental Group					
		PG (n = 40)	PP (n = 60)	PM (n = 61)	CG (n = 42)	CC (n = 60)	CM (n = 60)
Weaning to oestrus interval (WEI) [days]	x̄ ±	4.73 1.10	4.44 0.75	4.24 0.66	4.91 0.67	4.72 0.60	4.49 0.59
First service time (FS) [days]	x̄ ±	4.94 1.12	4.82 0.56	4.43 0.54	4.97 1.20	4.72 0.60	4.49 0.59
Return rate (RR) [%]		5.71	9.30	5.26	6.45	10.41	10.20
Pregnancy duration (PD) [days]	x̄ ±	115.88 1.32	115.49 1.19	112.92 14.94	115.64 1.25	114.68 1.19	115.07 1.18
Farrow rate (FR)	%	94.28	90.69	94.73	87.87	89.58	89.79

Tab. 3. Farrowing results

Parameter		Experimental Group					
		PG (n = 35)	PP (n = 43)	PM (n = 57)	CG (n = 31)	CC (n = 48)	CM (n = 49)
Total number of piglets born (TPB)/litter	x̄ ±	11.09 1.68	11.28 2.58	11.87 1.94	11.07 2.05	11.74 1.97	11.89 1.87
Life born piglets (LBP)	x̄ ±	10.45 1.94	10.97 2.93	11.30 1.94	10.48 1.88	11.49 2.27	11.07 1.86
Stillborn piglets (SBP)	x̄ ±	0.64 1.34	0.31 0.77	0.54 1.11	0.59 1.18	0.26 0.66	0.82 1.56
Weaned piglets (WP)	x̄ ±	9.96 1.19	10.11 0.89	10.44a 0.78	9.79b 1.02	10.38a 1.04	10.32 1.07

Explanation: Significant differences marked within a row in small letters indicate $p \leq 0.05$

proportion of peforelin-treated gilts exhibited estrus and were inseminated (90.0%) compared to control ones (90.0% vs.78.5%) ($p \leq 0.05$), representing an increase of 11.5%. Conversely, an opposite trend was observed in primiparous sows: 8.3% fewer sows in the peforelin-treated group showed estrus and were inseminated compared to the corresponding control group (ER: 81.66% vs. 90.0%). The highest pregnancy rates (PR) were observed in the PG and PM groups and were significantly higher ($p \leq 0.05$) than those recorded in the PP and CP groups.

Table 2 presents selected results of sows' reproductive performance. The weaning-to-estrus interval (WEI) and first service (FS) were similar across all groups. The calculated return rate (RR) was lower in the peforelin-treated groups, and notably, it was twice as low in multiparous sows. The average pregnancy duration (PD) was 114.94 days. The shortest PD was observed in multiparous sows treated with peforelin (PM); however, due to high variability within this subgroup, no statistically significant differences in PD were found between the groups. A marked effect of peforelin on farrowing rate (FR) was observed. In the Peforelin groups, the average FR was 93.33%, compared to 89.23% in the Control groups. The largest differences were found in gilts and multiparous sows, showing increases of 6.4% and 4.9%, respectively, in favor of the peforelin-treated animals. These differences were not statistically significant when all groups were analyzed together, but when analyzed by parity group, the differences in gilts were statistically significant ($p \leq 0.05$).

No statistically significant differences were found between the Peforelin and Control groups in any parameters related to the number of piglets born (Tab. 3). The total number of piglets born per litter was similar between groups: 11.48 in the Peforelin group and 11.63 in the Control group. The number of stillborn piglets (SBP) averaged 0.49 in the Peforelin group and 0.55 in the Control group. The number of weaned piglets per litter (WPL) was nearly identical: 10.22 and 10.20, respectively.

The calculated Piglets index (PI, Fig. 2) was slightly higher in the control group (24.38) compared to the Peforelin group (23.62), except among primiparous sows, where the opposite trend was observed.

Peforelin, a gonadotropin-releasing hormone (GnRH) analogue, is widely used in swine production to enhance reproductive performance. It stimulates the release of gonadotropins, which in turn promote follicular development and ovulation. This hormone is particularly effective in synchronizing estrus and improving fertility in

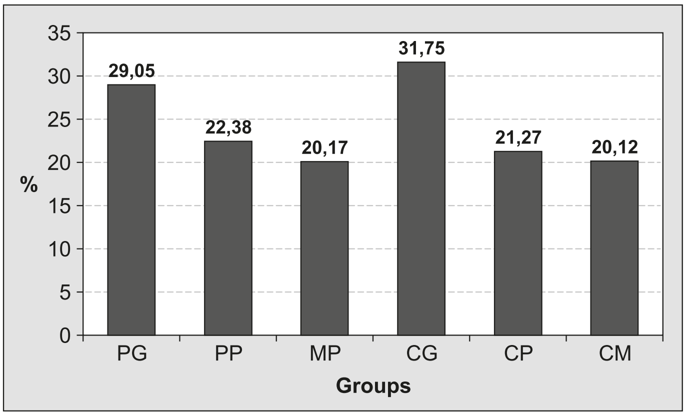

Fig. 2. Piglet index

gilts and sows, both of which are critical for maintaining high productivity in pig farming (25, 31).

ER is one of the most important parameters influencing the reproductive performance of sows. In the present study, the average ER was 87.8%, with the Control group showing an ER 1.2% lower than that of the Peforelin group. In a previous study involving 400 sows, the ER in the peforelin-treated group was higher than in our findings, reaching 93.2% compared to 87.2% in the control group (31). Nonetheless, our results confirmed the same trend: ER in peforelin-treated gilts (PG) was significantly higher than in control gilts (CG). This observation is especially relevant from both economic and practical perspectives, as it facilitates the formation of technological groups (batches) and reduces the number of non-productive days.

In another study by Segura-Correa et al. (25), conducted solely on primiparous sows, peforelin treatment increased the ER by 11.4% (24). In contrast, our results showed that the Control group of primiparous sows (CP) had a higher ER than the peforelin-treated group (PP). The reason for this unexpected outcome remains unclear. It is possible that the timing of insemination in the PP group was suboptimal, as previously suggested (1, 28). Alternatively, the administered dose of peforelin may not have been adequate.

It is also worth noting that the slightly lower ER observed in the Control group of multiparous sows compared to the peforelin-treated group suggests a generally high level of reproductive performance on the farm where our study was conducted. Under such conditions, additional hormonal stimulation may not be necessary (13, 31).

Peforelin treatment can be easily integrated into sow batch management systems, particularly for primiparous sows. Those that fail to enter estrus within a predefined time frame are often candidates for culling; however, peforelin administration may offer a second opportunity, potentially reducing the replacement rate (13). The primary value of this treatment lies in improving estrus synchronization and follicular readiness, which must be paired with precise breeding management to achieve optimal results.

Pregnancy rate (PR) in swine – both sows and gilts – is a key metric in pig production, reflecting the proportion of animals confirmed pregnant after insemination. It serves as a direct measure of reproductive efficiency and economic viability. Peforelin helps synchronize estrus and promote follicular development, but while its benefits for ER and follicular growth are well-documented, evidence for its effect on PR is more variable, depending on parity and farm conditions.

Nevertheless, our study clearly demonstrated a significantly higher PR in the Peforelin group, in contrast to previous research in which PR did not differ significantly between peforelin, eCG, and control groups (13). Similarly, other studies reported improvements in farrowing efficiency index (FEI) with peforelin, but no significant differences in PR for either gilts or sows (31).

Although numerical differences were observed in litter performance indicators, such as weaning-to-estrus interval (WEI), total born piglets (TBP), live-born piglets (LBP), weaned piglets (WP), stillborn piglets (SBP), and Piglets index (PI), treatment with peforelin did not result in statistically significant changes in any of these parameters in our study. These findings are in line with those of Vangroenweghe et al. (31) and Poleze et al. (24). In their studies, no significant differences in WEI were found between treatment groups, with the exception of primiparous sows treated with PMSG, a product not included in our study.

The lack of significant differences in litter size between the control and treatment groups is consistent with results from other studies (12, 13, 17). In our trial, the return rate (RR) was lower in the peforelin-treated group, particularly in multiparous sows, where RR was 4.94% lower compared to the control multiparous sows. However, in previous research, this difference was more pronounced, with a 14.2% reduction in RR reported in favor of peforelin-treated sows (25).

These observations suggest that peforelin may improve estrus synchronization in sows, thereby indirectly contributing to a reduced RR. This can enhance reproductive predictability, support more efficient breeding schedules, and reduce the number of non-productive days (13). Farrowing rate (FR) is another crucial parameter in evaluating reproductive efficiency. Several studies have examined the effects of peforelin on FR across different parity groups (12, 13, 31). While findings have been inconsistent, peforelin has been shown to perform comparably to or slightly better than other hormonal treatments under specific conditions, particularly in mitigating the effects of seasonal infertility during summer months (8, 31).

In contrast to these mixed findings, our study demonstrated higher FR in the peforelin-treated groups, especially among gilts and multiparous sows, although these differences were not statistically significant. Nevertheless, such an increase may still have meaningful biological and practical implications in commercial pig farming. In batch management systems, improved FR can enhance batch uniformity and reduce disruptions caused by returns to estrus or non-pregnancies (32, 33). Similar results were reported by Untaru et al. (30), who found that peforelin-treated sows achieved higher FR compared to those treated with PG600 or left untreated during the summer period. This suggests that peforelin may offer a valuable advantage in improving reproductive outcomes under conditions of heat stress or seasonal infertility.

While the hormone's primary role is reproductive synchronization, peforelin may also indirectly influence piglet outcomes through improved ovarian function and more precise ovulation timing. In the present study, no consistent improvement was observed in the total number of piglets born or the number of liveborn piglets, which aligns with findings from other studies (12). Research across various parity groups has similarly shown no significant differences in litter size between peforelin, eCG, or control groups. Stillbirth numbers were slightly higher in multiparous sows treated with peforelin, averaging 2.2 piglets per litter, compared to 0.9 in the eCG group and 1.4 in the control group (12). However, mortality during lactation did not differ significantly between treatment groups, indicating that peforelin does not negatively impact postnatal piglet survival.

The effects of peforelin on piglet performance appear to be context-dependent, with more pronounced benefits observed under specific conditions such as heat stress or in parity extremes (gilts or older sows). These advantages are likely due to better follicular synchronization and optimized ovulation timing, which together contribute to improved intrauterine conditions and early embryonic development.

Although peforelin does not consistently increase litter size or reduce piglet mortality, it may enhance early piglet viability metrics, such as uniform birth weights and vitality when implemented as part of a strategically timed and parity-specific reproductive protocol (12). This is supported by the findings of the current study, which, although not statistically significant in litter size or survival outcomes, reinforce the role of peforelin in improving overall reproductive management and predictability in swine production.

Peforelin consistently increases estrus and pregnancy rates in both sows and gilts. These benefits make it a valuable tool for managing herd fertility, particularly under challenging conditions such as seasonal infertility, or when applied in parity-specific reproductive strategies.

These findings suggests that overstimulation or hormonal stress of young sows can be avoided with this protocol. However, the reproductive performance of individual primiparous sows was not significantly affected by peforelin treatment. Thus, further research is warranted to evaluate the potential benefits and refine the application of peforelin specifically in primiparous sows.

References

1. *Arnauts J., Jourquin J., Goossens L.*: Improving oestrus behaviour with peforelin, a specific FSH releasing GnRH. Proc. 21st IPVS Congress; Vancouver, Canada, 2010, p. 1093.
2. *Beaulieu A. D., Aalhus J. L., Williams N. H., Patience J. F.*: Impact of piglet birth weight, birth order, and litter size on subsequent growth performance, carcass quality, muscle composition, and eating quality of pork. J. Anim. Sci. 2010, 88, 2767-2778.
3. *Brüssow K. P., Schneider F., Tuchscherer A., Kanitz W.*: Influence of synthetic lamprey GnRH-III on gonadotropin release and steroid hormone levels in gilts. Theriogenology 2010, 74, 1570-1578.
4. *Claus R., Weiler U.*: Influence of light and photoperiodicity on pig prolificacy. J. Reprod. Fertil. Suppl. 1985, 33, 185-197.
5. *Einarsson S., Rojkittikhun T.*: Effects of nutrition on pregnant and lactating sows. J. Reprod. Fertil. Suppl. 1993, 48, 229-239.
6. *Engl S.*: Untersuchungen zur Eignung einer neuen GnRH-Variante zur Brunstinduktion bei pluriparen Sauen [doctoral thesis]. Universität Leipzig, Leipzig, Germany, 2006.
7. *Engl S., Bischoff R., Zaremba W.*: Use of a new GnRH to control reproduction in gilts. Proc. 21st IPVS Congress; Vancouver, Canada, 2010, p. 1084.
8. *Engl S., Zepperitz H., Rath R., Zaremba W.*: Practical experience with Peforelin in a large sow herd: data from primiparous sows. Proc. 21st IPVS Congress; Vancouver, Canada, 2010, p. 1085.
9. *Falceto M. V., Suárez-Usbeck A., Tejedor M. T., Ausejo R., Garrido A. M., Mitjana O.*: GnRH agonists: Updating fixed-time artificial insemination protocols in sows. Reprod. Domest. Anim. 2023, 58, 571-582.
10. *Guthrie H. D., Garrett W. M.*: Apoptosis during folliculogenesis in pigs. Reprod. Suppl. 2001, 58, 17-29.
11. *Jong E. de*: Weaning practices and culling policy: critical steps for optimal reproductive performance of female breeding pigs [PhD thesis]. Ghent University; Ghent, Belgium, 2014.
12. *Jong E. de, Jourquin J., Kauffold J., Sarrazin S., Dewulf J., Maes D.*: Effect of a GnRH analogue (peforelin) on the litter performance of gilts and sows. Porcine Health Manag. 2017, 3, 6.
13. *Jong E. de, Kauffold J., Engl S., Jourquin J., Maes D.*: Effect of a GnRH analogue (Maprelin®) on the reproductive performance of gilts and sows. Theriogenology 2013, 80, 870-877.
14. *Jourquin J., Goossens L.*: Impact of oestrus induction with Peforelin on subsequent litter performance. Proc. 15th ESDAR Conference; Belek, Turkey 2011, p. 129.
15. *Jourquin J., Goossens L.*: Oestrus induction with Peforelin, new insights from the field. Proc. 15th ESDAR Conference; Belek, Turkey 2011, p. 128.
16. *Kim S. W., Weaver A. C., Shen Y. B., Zhao Y.*: Improving efficiency of sow productivity: nutrition and health. J. Anim. Sci. Biotechnol. 2013, 4, 26.
17. *Leeuwen J. J. J. van, Williams S. I., Martens M. R. T. M., Jourquin J., Driancourt M. A., Kemp B., Soede N. M.*: The effect of different postweaning altrenogest treatments of primiparous sows on follicular development, pregnancy rates, and litter sizes. J. Anim. Sci. 2011, 89, 397-403.
18. *Manjarin R., Garcia J. C., Dominguez J. C., Castro M. J., Alegre B., Munoz J. D., Kirkwood R. N.*: Effect of gonadotropin treatment on oestrus, ovulation and litter size in weaned and anestrus sows. J. Anim. Sci. 2010, 88, 2356-2360.
19. *Martinat-Botté F., Venturi E., Guillouet P., Driancourt M. A., Terqui M.*: Induction and synchronization of ovulations of nulliparous and multiparous sows with an injection of gonadotropin-releasing hormone agonist (Receptal). Theriogenology 2010, 73, 332-342.
20. *McCann S. M., Karanth S., Mastronardi C. A., Dees W. L., Childs G., Miller B., et al.*: Control of gonadotropin secretion by follicle-stimulating hormone-releasing factor, luteinizing hormone-releasing hormone and leptin. Arch. Med. Res. 2001, 32, 476-485.
21. *McCann S. M., Marubayashi U., Sun H. Q., Yu W. H.*: Control of follicle-stimulating hormone and luteinizing hormone release by hypothalamic peptides. Ann. NY Acad. Sci. 1993, 687, 55-59.
22. *Peltoniemi O. A., Love R. J., Heinonen M., Tuovinen V., Saloniemi H.*: Seasonal and management effects on fertility of the sow: a descriptive study. Anim. Reprod. Sci. 1999, 55, 47-61.
23. *Peltoniemi O. A. T., Virolainen J. V.*: Seasonality of reproduction in gilts and sows. Soc. Reprod. Fertil. Suppl. 2006, 62, 205-218.
24. *Poleze E., Bernardi M. L., Amaral Filha W. S., Wentz I., Bortolozzo F. P.*: Consequences of variation in weaning-to-estrus interval on reproductive performance of swine females. Livest. Sci. 2006, 103, 124-130.
25. *Segura-Correa J. C., Vera J. F., López A. A.*: Effect of the Peforelin on oestrous, fertility and litter size of primiparous sows. Rev. Cient. FCV-LUZ. 2013, 23 (3), 232-237.
26. *Smith C., Dickerson G. E., Tess M. W., Bennett G. L.*: Expected relative responses to selection for alternative measures of life cycle economic efficiency of pork production. J. Anim. Sci. 1983, 56, 1306-1314.
27. *Sower S. A., Chiang Y., Lovas S., Conlon J. M.*: Primary structure and biological activity of a third gonadotropin-releasing hormone from lamprey brain. Endocrinology 1993, 60, 1125-1131.
28. *Steverink D. W. B., Soede N. M., Groenland G. J. R., van Schie F. W., Noordhuizen J. P. T. M., Kemp B.*: Duration of estrus in relation to reproduction results in pigs on commercial farms. J. Anim. Sci. 1999, 77, 801-809.
29. *Tess M. W., Bennett G. L., Dickerson G. E.*: Simulation of genetic changes in life cycle efficiency of pork production. II. Effects of components on efficiency. J. Anim. Sci. 1983, 56, 354-368.
30. *Untaru R., Matthisl R., Neale N.*: Researches regarding the estrus induction to wean sows, during the summer season, using the hormonal products Maprelin XP10 and P.G. 600. Sci. Pap. Anim. Sci. Biotechnol. 2010, 43 (1), 251-254.
31. *Vangroenweghe F., Goossens L., Jourquin J.*: An evaluation of gonadotropin-releasing hormone analogue administered to gilts and sows on subsequent reproductive performance and piglet birth weight. Porcine Health Manag. 2016, 2, 1.
32. *Vangroenweghe F., Suls L., Van Driessche E., Maes D., De Graef E.*: Health advantages of transition to batch management system in farrow-to-finish pig herds. Vet. Med-Czech. 2012, 57, 83-91.
33. *Yu W. H., Karanth S., Sower S. A., Parlow A. F., McCann S. M.*: The similarity of FSH-releasing factor to lamprey gonadotropin-releasing hormone III (l-GnRH-III). Proc. Soc. Exp. Biol. Med. 2000, 224, 87-92.

Corresponding author: prof. dr hab. Anna Rząsa, Norwida 31, 50-375 Wrocław, Poland; e-mail: anna.rzasa@upwr.edu.pl