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The impact of selected genetic and environmental factors on length of use of pulawska breed sows

Oddziaływanie wybranych czynników genetycznych i środowiskowych na długość użytkowania loch rasy puławskiej

Summary. The aim of this analysis was to determine the influence of selected genetic and environmental factors on length of use of breed pulawska sows. The research included a family group, genotype of ryanodine receptor gene (*RYR1*), meat content, backfat thickness, increases daily and the average number of left and right teats. The study was performed in a multiparous sows, coming from eight farm in the Lublin area, which in 2005–2011 were included in the maintenance breeding. Data were collected by analysis of zootechnical documentation and conducting of base measurements and direct observation. The study allowed us to demonstrate the correlation between the length of use of sows pulawska breed, the family and a group from which it came. Genotype ryanodine receptor gene (*RYR1*) proved to be a factor significantly influencing the longevity of sows. The results also confirm the influence of conformation, fat thickness and the rate of accumulation of the parameters analyzed. It also showed that the length of use the sows was determined by using the average number of left and right nipple.

Key words: sows, reproductive performance, genetic factors, environmental factors

INTRODUCTION

In recent years, many studies analyzed the factors affecting the length of use of sows (Yazdi *et al.* 2000a, 2000b, Serenius and Stadler 2004, Tarrés *et al.* 2005, Hoge 2011]. As demonstrated in numerous studies the length of use of sows in the herd is determined by a number of genetic and environmental factors.

One of the most important factors determining the length of breeding performance of sows is the number of litters obtained from sows during the life productivity. It is worth emphasizing that this feature may be a breed-controlled. Some breeds can have a longer time of reproduction performance than others. An example is the population of breed Pulawy sows. Animals of this breed reach reproductive maturity early, are adapted to the difficult conditions, have a greater resistance to disease and have low requirements concerning the quality of feed. Sows are characterized by good fertility, prolificacy and maternal care [Babicz *et al*. 2003, 2007, Walkiewicz *et al*. 2005].

Besides the genetic determinants of significant impact on length of use of breeding sows are related to environmental factors. The most important parameters characterizing reproductive performance include: the age, weight, season of birth and farrowing, stress resistance, % content of meat in the carcass, backfat thickness in the mother's carcass, number of teats, fertility, prolificacy, frequency of farrowing [Stasiak *et al*. 2004]

However, there are some discrepancies between the effect of the impact of some of the above-mentioned factors, hence it is appropriate to incorporate as many elements which potential determine the breeding performance of sows in life.

The aim of this analysis was to determine the influence of selected genetic and environmental factors on length of use of pulawska breed sows in maintenance breeding.

MATERIAL AND METHODS

The study included 1200 litters from sows of pulawska breed. Material for the study came from eight farms in the Province of Lublin, included in maintenance breeding in the years 2005–2011.

The analysis based on zootechnical documentation, and conducted directly zootechnical observations and measurements. The minimum length of use based on four consecutive reproductive cycles.

Among the genetic and environmental factors were analyzed:

1. the family group of which came sows: Akra, Dazerka, Fajka, Fuka, Fura, Multa, Salwa, Sama and Waria;
2. genotype in ryanodine receptor gene: group I – (*RYR*1 C/C), group II – (*RYR*1C/T);
3. meat content noted during the judging of live animals: group I: below 50%, group II: 50.1–52.0%, group III: 52.1–54.0%, group IV: 54.1–56%, group V: 56.1–58.0%;
4. backfat thickness measured at a distance of 3 (P2) and 8 (P4) cm of the back line on the border of the thoracic and lumbar vertebrae: group I: 10–12 mm, group II: 12.5–14.5 mm, group III: 15–17 mm, group IV: 17.5–19.5 mm, group V: ≥ 20 mm;
5. daily gain recorded in the period from birth until the time of judging of live animals: group I: 400–500 g, group II: 501–600 g, group III: 601–700 g, group IV: 701–800 g;
6. average number of teats per one strip: group I: 7.0–7.9, group II: 8.0–8.9, group III: 9.0 and more.

Calculations were performed by STATISTICA vrs. 5.0. using analysis of variance (ANOVA). For the numerical data obtained was calculated arithmetic means, standard deviations, and found significant differences in the intervals: $P \leq 0.05$ and $P \leq 0.01$.

RESULTS

As demonstrated in the studies, there are many factors that have a significant impact on length of use of sows. One of them was a family group of which came sows (Table 1). The highest lifetime production had by the females of the family Multa, ie 7.71 litters, while sows with Salwa family housed average only by the 4.99 of the reproductive cycle. The recorded values were statistically significant ($P \leq 0.01$).

The results of the analyzes included in Table 2 show that sows of pulawska breed from group resistance to stress having *RYR*1 C/C housed significantly longer ($P \leq 0.01$) compared to the sows with the alleles *RYR*1 C/T. The difference was 1.63 in favor of the litter from sows homozygous in the *RYR*1 genotype.

Table 1. Average number of litters obtained during the use of certain families of sows
Tabela 1. Średnia liczba miotów uzyskanych w okresie użytkowania loch z określonych rodzin

Wyszczególnienie Specification	n	x	SD	Max.
Akra	124	5.76^{Ab}	0.16	11.00
Dazerka	299	5.77^{Ab}	0.10	10.00
Fajka	119	6.18^{A}	0.21	13.00
Fuka	74	7.50^{A}	0.86	8.00
Fura	111	6.19^{A}	0.20	12.00
Multa	97	7.71^{Aa}	0.96	11.00
Salwa	120	4.99^{B}	0.23	6.00
Sama	410	5.07^{A}	0.11	13.00
Waria	49	5.00^{Ab}	0.91	7.00

$P \leq 0.05$ (a, b); $P \leq 0.01$ (A, B) – different letters

Table 2. Distribution of the number of litters, depending on the susceptibility to stress of sows
Tabela 2. Rozkład liczby miotów w zależności od podatności loch na stres

Specification Wyszczególnienie	n	x	SD	Max.
*RYR*1 C/C	81	6.76^{A}	0.31	13.00
*RYR*1 C/T	59	5.13^{B}	0.26	11.00

$P \leq 0.05$ (a, b). $P \leq 0{,}01$ (A, B) – different letters

The study also identified the impact of fleshiness of gilts on the length of their use. The study (Table 3) showed that for the lowest (< 50%) and high (> 58%) meat content the average number of obtained litters from sows remained at a similar level and amounted to respectively 5.68 and 5.88. Sows, which meat content noted during the judging of live animals was 50.1–52 and 56.1–58%, had by a relatively long lifetime, more than six consecutive reproductive cycles.

Table 3. Distribution of the number of litters, depending on the percentage of meat in the sows carcass
Tabela 3. Rozkład liczby miotów w zależności od procentowej zawartości mięsa w tuszy lochy

Specification Wyszczególnienie	n	x	SD	Max.
< 50,0%	54	5.68^{A}	0.27	11.00
50,1–52,0%	99	6.31^{B}	0.21	11.00
52,1–54,0%	247	5.55^{A}	0.10	12.00
54,1–56,0%	360	5.94^{AB}	0.11	13.00
56,1–58,0%	258	6.18^{AB}	0.13	13.00
> 58,0%	79	5.88^{AB}	0.21	9.00

$P \leq 0.05$ (a, b); $P \leq 0.01$ (A, B) – different letters

Analyses show that gilts with backfat thickness (< 12 mm) and (> 20 mm) achieved worse results in comparison with the results of productivity of gilts which backfat thickness were within the 12.5–20.0 mm. But it should be noted that sows with the lowest value of the features 10.0–12.0 mm (at the point P2) reached the highest litter size (13 units), while in gilts with the highest backfat thickness > 20 mm ratio of the maximum number of litters was 9 units (Table 4).

Table 4. Distribution of the number of litters based on carcass fat thickness in sows
Tabela 4. Rozkład liczby miotów w zależności od grubości słoniny w tuszy lochy

Specification Wyszczególnienie	n	x	SD	Max.
10.0–12.0 mm	364	5.82^{A}	0.10	13.00
12.5–14.5 mm	443	6.05^{B}	0.10	12.00
15.0–17.0 mm	194	6.04^{B}	0.13	12.00
17.5–19.5 mm	62	6.20^{B}	0.30	12.00
≥ 20.0 mm	34	5.82^{A}	0.30	9.00

$P \leq 0.05$ (a, b); $P \leq 0.01$ (A, B) – different letters

Table 5. Distribution of the number of litters based on daily gains of sows
Tabela 5. Rozkład liczby miotów w zależności od przyrostów dobowych lochy

Specification Wyszczególnienie	n	x	SD	Max.
400–500 g	72	6.02^{AB}	0.31	12.00
501–600 g	450	6.11^{A}	0.10	13.00
601–700 g	453	5.93^{AB}	0.09	13.00
701–800 g	122	5.58^{B}	0.16	11.00

$P \leq 0.05$ (a, b); $P \leq 0.01$ (A, B) – different letters

Table 6. Distribution of the number of litters based on the number of sows left nipple
Tabela 6. Rozkład liczby miotów w zależności od ilości sutek lewych loch

Specification Wyszczególnienie	n	x	SD	Max.
7 pcs.	65	5.80^{a}	0.24	10.00
8 pcs.	820	6.94^{a}	0.07	13.00
9 pcs.	212	6.13^{b}	0.15	12.00

$P \leq 0.05$ (a, b); $P \leq 0.01$ (A, B) – different letters

Table 7. Distribution of the number of litters based on the number of sows right nipple
Tabela 7. Rozkład liczby miotów w zależności od ilości sutek prawych loch

Specification Wyszczególnienie	n	x	SD	Max.
7 pcs.	53	5.66^{A}	0.27	9.00
8 pcs.	761	5.98^{AB}	0.07	13.00
9 pcs.	279	6.00^{B}	0.12	12.00

$P \leq 0.05$ (a, b); $P \leq 0.01$ (A, B) – different letters

A factor significantly modifying the parameter length of use of sows was also the growth rate of sows (Table 5). It was shown that daily gains are within the 400–700 g contributes to longer period of housing sows. When daily gains of animals were greater than 700 g, sows had the lowest maximum number of litters and also reached the minimum number of reproductive cycles of at 5.58.

Data presented in Tables 6 and 7 also shows that the average number of litters obtained from the sows was also associated with the number of left and right teats. This parameter significantly differentiated the length of use of sows. With regard to the teats of both left and right, the biggest indicator of the maximum number of litters (13 pcs.) reached sows an average number of teat per one strip in the amount of 8 pieces. At this value of left and right teats average number of litters obtained from sows was at a high level and amounted respectively to 6.94 and 5.98.

DISCUSSION

As follows from observations carried out in groups of sows from the family Fajka and Sama were individuals that housed by 13 consecutive reproductive cycles. This may be associated with the hyperfertility phenomenon of some sows of pulawska breed, which can increase the birth rate in the herd and also improve the lifetime productivity of sows.

The results of molecular analyzes show that the genotype of the *RYR*1 gene is significantly associated with the level of sows reproductive performance parameters such as number of piglets born and raised. Reduction of the value of these parameters is associated with a mutation in the *RYR*1 locus and the allele *RYR*1 T appearance. The results

obtained are consistent with studies presented by the Kurył and Wróblewski [1992] and Omelka *et al.* [2006]. Also, the study Mucha *et al*. [2007] and Klocek [2006] show that sows homozygous at *RYR*1 locus have a higher reproductive performance parameters.

Data from Table 3, do not confirm the misconceived notion that a higher percentage of muscle tissue in the carcass has a negative impact on female reproductive performance.

One of the important indicators of the reproductive value of sows is the size of energy reserve in organism, expressed in backfat thickness. Koczanowski [2000] considers that the backfat thickness has no significant effect on the number and weight of piglets born. A study by Hughes and Smits [2002], Young *et al*. [2001, 2004] show, that the backfat thickness is an important parameter affecting fertility. The effect of fatness condition of pregnant females may be abnormalities in the parturition process and inferior results of reproduction and rearing of piglets [Lawlor and Lynch 2007]. The self-assessment shows that both too thick and too thin fat negatively affects reproductive performance.

Obtained results confirm the importance size analysis of daily increments in utility breeder sows. According to Lindermayer and Probstmayer [2007] raport it is know, that depending on the amount of food taken sows show differences in the number of litters delivered. As shown by studies published by Tarrés *et al*. [2006] a common cause of culling of sows were problems with the limbs.

Research carried out by Buczyński *et al.* [2000] and Tarrés *et al*. [2006] showed that the number of the teats was an important characteristic which determined the length of use of sows. Moreover, it has a significant impact on the number of piglets born, proves the potential of feeding at the numerous litter, which directly affects the number of piglets reared to 21 days of age.

CONCLUSIONS

1. Comparative analysis of genetic and environmental factors affecting the length of use of breeding sows of pulawska breed allowed to formulate the following conclusions.

2. The genotype of sows in *RYR*1 gene significantly determined the value of reproductive sows. Females of the genotype *RYR*1 C/C were longer used (6.76 reproductive cycles) and had significantly higher reproductive cycles values than the sows of the genotype *RYR1* C/T (5.13 cycles).

3. The highest productivity had sows, which meatiness content ranged from 50.1 to 52.0% and 56.1–58.0% the backfat thickness from 12.5 mm to 19.5 mm.

4. Daily growths in excess of 700 g proved to be a factor significantly shorten life of sows.

5. Depending on the number of their teats, long used were those sows that held after 8 left and right breast.

REFERENCES

Babicz M., Kasprzyk A., Stasiak A., 2007. Analiza efektywności rozrodu loszek i loch rasy puławskiej o zróżnicowanych parametrach tucznych i rzeźnych krytych knurami rasy wbp i pbz. Rocz. Nauk. Zoot., 34, 179–188.

Babicz M., Kurył J., Walkiewicz A., 2003. Evaluation of the genetic profile of the Pulawska breed. J. Appl. Genet., 44 (4), 497–508.

Buczyński J., Panek A., Fajfer E., Lesiuk S., Luciński P., 2000. Wpływ liczby sutków u loch i knurów na wyniki użytkowości rozpłodowej. Rocz. Nauk. Zoot., 10, 65–72.

Hoge M.D., Bates R.O., 2011. Developmental factors that influence sow longevity. J. Anim. Sci., 89, 1238–1245.

Hughes P. E., Smits R., 2002. Breeding herd feeding strategies to optimize productive efficiency and reduce culling rates. Pig Research Report. Australian Pork Limited, Canberra, Australia, 1–31.

Klocek C., Kalinowska B., Koczanowski J., 2006. Zachowanie loch prośnych o zróżnicowanym genotypie *RYR1*. LXXI Zjazd Polskiego Towarzystwa Zootechnicznego w Bydgoszczy, 18–20 września 2006, 8.

Kurył J., Wróblewski P., 1992. The effect of halothane-sensitivity gene (HALn) in pigs on litter size, piglets live and rate of piglets survival to the age of 9–11 weeks. Anim. Sci. Pap. Rep., 9, 47–52.

Koczanowski J., Migdał W., Klocek Cz., Stawarz M., 2000. Wpływ otłuszczenia loszek przed pokryciem na ich użytkowość rozpłodową. Biul. Nauk. ART Olsztyn, 7, 109–113.

Lawlor P.G., Lynch P.B., 2007. A review of factors influencing litter size in Irish sows. Irish Veter. J., 60, 359–366.

Lindermayer H., Probstmayer G,. 2007. Więcej energii dla loch prośnych? Top Agrar, 5, 30–32.

Mucha A., Różycki M., Blicharski T., 2007. Użytkowość tuczna, rzeźna i rozpłodowa loch zarodowych rasy pbz w zależności od genotypu RYR1. Rocz. Nauk. Zoot., 34, 151–156.

Omelka R., Peškovičová D., Martiniaková M., Bauer M., Bauerova M., 2006. Effect of the estrogen receptor (*ESR*) and ryanodine receptor (*RYR1*) genes on reproductive traits of Slovak Large White, White Meaty and Landrace pigs. Arch. Tierz., 49 (4), 357–362.

Serenius T., Stalder K.J., 2004. Genetics of length of productive life and lifetime prolificacy in the Finnish Landrace and Large White pig populations. J. Anim. Sci., 82, 3111–3117.

Stasiak A., Mazur A., Babicz M., Kamyk P., 2004. Ocena użytkowości rozpłodowej loch o zróżnicowanej mięsności. Annales UMCS, sec. EE, Zootechnica, 22, 117–121.

Tarrés J., Tibau J., Piedrafita J., Fa`brega E., Reixach J., 2005. Factors affecting longevity in maternal Duroc swine lines. Livest. Prod. Sci., 100, 121–131.

Tarrés J., Bidanel J.P., Hofer A., Ducrocq V., 2006. Analysis of longevity and exterior traits on Large White sows in Switzerland. J. Anim. Sci., 84, 2914–2924.

Walkiewicz A., Kasprzyk A., Babicz M., Kamyk P., 2005. Analysis of family variability for reproductive traits of pulawska sows. Ann. Anim. Sci., Suppl., 1, 75–77.

Yazdi M.H., Rydhmer L., Ringmar-Cederberg E., Lundeheim N., Johansson K., 2000a. Genetic study of longevity in Swedish Landrace sows. Livest. Prod. Sci., 63, 255–264.

Yazdi M.H., Rydhmer L., Ringmar-Cederberg E., Lundeheim N., Johansson K., 2000b. Survival of Landrace and Yorkshire sows in relation to osteochondrosis: A genetic study. Anim. Sci., 71, 1–9.

Young M.G., Tokach M.D., Goodband R.D., Nelssen J.L., Dritz S.S., 2001. The relationship between body condition score and backfat in gestating sows. Kansas State University Swine Day Report of Progress, 5–9.

Young M.G., Tokach M.D., Aherne F.X., Main R.G., Dritz S.S., Goodband R.D., Nelssen J.L., 2004. Comparison of three methods of feeding sows in gestation and the subsequent effects on lactation performance. J. Anim. Sci., 82, 3058–3070.

Streszczenie. Celem badań było określenie wpływu wybranych czynników genetycznych i środowiskowych na długość użytkowania loch rasy puławskiej. W analizie uwzględniono grupę rodzinową, genotyp genu receptora ryanodiny (*RYR1*), wartość rzeźną (mięsność, grubość słoniny), wartość tuczną (przyrosty dobowe) oraz średnią liczbę sutek lewych i prawych. W badaniach uwzględniono lochy wieloródki, pochodzące z 8 gospodarstw, które w latach 2005–2011 objęte były hodowlą zachowawczą na terenie Lubelszczyzny. Dane do analizy zostały zebrane z dokumentacji zootechnicznej oraz z bezpośrednich obserwacji i pomiarów. Przeprowadzone badania pozwoliły na wykazanie zależności pomiędzy długością użytkowania loch rasy puławskiej a grupą rodzinową, z której pochodziły. Genotyp genu receptora ryanodiny (*RYR1*) okazał się czynnikiem istotnie wpływającym na długowieczność loch. Uzyskane wyniki potwierdzają również wpływ mięsności, grubości słoniny, a także szybkości przyrastania na analizowany parametr. Wykazano także, iż długość użytkowania loch rasy puławskiej determinowana była średnią liczbą sutek lewych oraz prawych.

Słowa kluczowe: locha, użytkowość rozpłodowa, czynniki genetyczne, czynniki środowiskowe