Comparison of changes in fatness of sows in high pregnancy and at weaning and determination of their association with reproduction results and rearing of piglets

Porównanie zmian otłuszczenia loch w ciąży wysokiej i przy odsadzeniu miotu oraz określenie ich związku z wynikami rozrodu i odchowu prosiąt

Anna REKIEL*, Justyna WIĘCEK, Martyna BATORSKA, Józef KULISIEWICZ and Grażyna TOKARSKA

University of Life Sciences, Faculty of Animal Science, Animal Breeding and Production Department, Swine Breeding Division, Ciszewskiego 8, 02-786 Warsaw, Poland
*correspondence: anna_rekiel@sggw.pl

Abstract

Sixty crossbred sows were investigated for the effect of the level of fat reserves in high pregnancy and pre-weaning changes in lipid reserves on reproductive performance of sows and rearing of piglets. At 104 days of pregnancy and at weaning, sows were analysed for body weight, P_2 and P_4 backfat thickness and *M. Longissimus dorsi* (MLD) thickness at P_4M (Piglog 105). Sows were grouped according to mean backfat thickness $(P_2 + P_4)/2$ at 104 days of pregnancy into primiparous $(P_2 + P_4)/2>18$ mm (group I), primiparous $(P_2 + P_4)/2\leq18$ mm (group II), multiparous $(P_2 + P_4)/2>20$ mm (group I) and multiparous $(P_2 + P_4)/2\leq20$ mm (group II). The body weight of sows from group I was higher than sows from group II at 104 days of pregnancy ($P\leq0.05$) and at weaning ($P\leq0.01$). As assumed in the experiment, fatness in high pregnant sows (points P_2 and P_4) was significantly higher in group I than in group II ($P\leq0.01$), and the differences between the groups persisted when piglets were weaned ($P\leq0.01$). At weaning, sows from group II had a significantly greater P_4M thickness compared to sows from group I. The differences in backfat thickness in late-pregnant sows in groups I and II and in the loss of fat reserves during a 21-day lactation had no effect on reproduction results and rearing of piglets. Sows lost body weight to a small extent and fat reserves to a moderate degree; the changes were greater in primiparous than multiparous sows, regardless of the group (I or II).

Keywords: backfat, body weight, litter size, sows

Streszczenie

U 60 loch mieszańców określono wpływ poziomu rezerw tłuszczu w ciąży wysokiej i zmian zasobów lipidów do odsadzenia miotu, na wyniki rozrodu i odchowu prosiąt. W 104. dniu ciąży i przy odsadzeniu określono u loch masę ciała, grubość słoniny w punktach P_2 i P_4 oraz grubość *M. longissimus dorsi* (MLD) (pkt. P_4M) (Piglog 105). Lochy podzielono na grupy w zależności od średniej grubości słoniny $(P_2 + P_4)/2$ w 104. dniu ciąży; pierwiastki $(P_2 + P_4)/2>18$ mm (grupa I), pierwiastki $(P_2 + P_4)/2≤18$ mm (grupa II), wieloródki $(P_2 + P_4)/2>20$ mm (grupa I) oraz wieloródki $(P_2 + P_4)/2≤20$ mm (grupa II). Masa ciała loch z grupy I vs. II była większa w 104. dniu ciąży (P≤0,05) i przy odsadzeniu (P≤0,01). Otłuszczenie wysoko prośnych loch (pkt. P_2 i P_4) było zgodnie z założeniami eksperymentu istotnie większe w grupie I vs. II (P≤0,01); zróżnicowanie otłuszczenia między grupami utrzymało się przy odsadzeniu prosiąt (P≤0,01). Przy odsadzeniu stwierdzono u loch z grupy II vs. I istotnie większy wskaźnik P_4M. Zróżnicowanie grubości słoniny u wysoko prośnych loch w grupach I i II i strat rezerw tłuszczu w 21. dniowej laktacji, nie miało wpływu na wyniki rozrodu i odchowu prosiąt. Lochy traciły w niewielkim zakresie masę ciała i na umiarkowanym poziomie zasoby tłuszczu; zmiany były większe u pierwiastek vs. wieloródek, niezależnie od przynależności do grup eksperymentalnych (I lub II).

Słowa kluczowe: grubość słoniny, liczebność miotu, lochy, masa ciała

Streszczenie szczegółoweg

Celem badań było określenie zależności między kondycją wyrażoną grubością słoniny, rezerwą białka i masą ciała u loch pierwiastek i wieloródek a wybranymi wskaźnikami ich użytkowości rozpłodowej. Eksperymentem objęto 60 loch mieszańców F1 rasy wielka biała polska x polska biała zwisłoucha (wbp x pbz) u których określono wpływ poziomu rezerw tłuszczu w ciąży wysokiej (104. dzień jej trwania) i zmian zasobów lipidów do odsadzenia miotu (21. dzień laktacji), na wyniki rozrodu i odchowu prosiąt. W podanych terminach lochy ważono i określano masę ciała. Grubość słoniny w punktach P_2 i P_4 oraz grubość *M. longissimus dorsi* (MLD) (pkt. P_4M) określono przyżyciowo, wykorzystując do pomiarów aparat ultradźwiękowy Piglog 105. W zależności od średniej grubości słoniny $(P_2 + P_4)/2$ mierzonej w 104. dniu ciąży lochy podzielono na grupy: pierwiastki $(P_2 + P_4)/2>18$ mm (grupa I), pierwiastki $(P_2 + P_4)/2≤18$ mm (grupa II), wieloródki $(P_2 + P4)/2>20$ mm (grupa I) oraz wieloródki $(P_2 + P_4)/2≤20$ mm (grupa II). Stwierdzono, ze masa ciała loch z grupy I w porównaniu z lochami z grupy II była większa w 104. dniu ciąży (P≤0,05) i przy odsadzeniu (P≤0,01). Otłuszczenie wysoko prośnych loch (pkt. P_2 i P_4) było zgodnie z założeniami eksperymentu istotnie większe w grupie I w porównaniu z II (P≤0,01); zróżnicowanie otłuszczenia między grupami utrzymało się przy odsadzeniu prosiąt (P≤0,01). Przy odsadzeniu stwierdzono u loch z grupy II vs. I istotnie większy wskaźnik P_4M. Zróżnicowanie grubości słoniny u wysoko prośnych loch w grupach I i II oraz strat rezerw tłuszczu w 21. dniowej laktacji, nie miało wpływu na wyniki rozrodu i odchowu prosiąt. Lochy traciły w niewielkim zakresie masę ciała i na umiarkowanym poziomie zasoby tłuszczu co wynikało zapewne z krótkiej, 3. tygodniowej laktacji. Zmiany były większe u pierwiastek w porównaniu do grupy wieloródek, niezależnie od przynależności do grup eksperymentalnych - I lub II, co mogło mieć związek z trwającym u młodych samic rozwojem somatycznym. Dobre wyniki w rozrodzie i odchowie były też prawdopodobnie efektem dobrych warunków środowiskowych, przede wszystkim żywienia.

Introduction

Intensive breeding work has led to considerable progress in meat content in pigs. During the 1997-2006 decade alone, the annual progress in carcass meat percentage in Polish Large White and Polish Landrace gilts was 0.31% (Szyndler-Nędza et al., 2008). As a result, backfat thickness decreased in growing animals and in lipid reserves in reproductive females (Rekiel, 2002). This is one of the factors adversely affecting reproductive performance of sows and rearing of piglets. Knowledge about body composition allows understanding issues concerning growth, nutrition and reproduction and the interrelationships between them. The relationships between reproductive function and body composition have been established in humans and in animals, including sheep, cattle and pigs (Charette et al., 1996).

The mammalian organism can deposit fat in the form of subcutaneous, organ, intermuscular and intramuscular fat. Around 70% of fat in the pig's body is stored in subcutaneous adipose tissue. This facilitates determining body condition by ultrasound, which is more accurate than the visual method, for which the correlation estimated by Young et al. (2001) is only 0.19. The condition of females is reflected in body weight and fat reserves, which are determined ultrasonically on live animals in successive stages of the reproductive cycle (mating, pregnancy, parturition, lactation, drying off) (Rekiel and Beyga, 2008). It is also reflected in changes in the body's protein and lipid reserves during the reproductive cycle. Body condition depends on nutrition and shows an association with reproductive traits (Beyga and Rekiel, 2010; Čechová and Tvrdoň, 2006; Maes et al., 2004; Young et al., 2004; Wähner et al., 2001). The correlations between growth rate, fat reserves and meat content at mating and reproductive results of gilts are known quite well (Amaral Filha et al., 2010; Bečková et al., 2005; Kawęcka et al., 2009; Roongsitthichai et al., 2011). Less study has been given to the issues concerning changes in fat reserves from high pregnancy to weaning, and their relationship with reproductive performance and rearing of piglets from primiparous and multiparous sows. Fat reserves accumulated during the gestation period reach a certain level during high pregnancy and parturition. They are subject to change in this short time period, which is important in terms of intrapartum and perinatal deaths in the litter, quality of colostrum and milk produced by the sow, body weight gains, rearing performance of piglets, and body condition of females (Rekiel et al., 2007, 2011). Therefore, prevention of fat body condition is an important element of preparing the sows for farrowing. It facilitates farrowing and helps to improve reproductive performance of sows and rearing of piglets (Lawlor and Lynch, 2007).

The aim of the study was to determine the level of fat reserves in high pregnant sows, pre-weaning changes in lipid reserves and their impact on reproductive performance of sows and rearing of piglets.

Materials and Methods

The study included two groups of sows - crossbreds of Polish Large White × Polish Landrace and their progeny, with multiparous and primiparous sows accounting for 2/3 and 1/3, respectively. Backfat thickness was measured during late pregnancy (day 104 of pregnancy) and weaning (day 21) at points P_2 (over the last rib, 3 cm from the dorsal midline, on the right side) and P_4 (over the last rib, 8 cm from the dorsal midline, on the right side) using a Piglog 105 ultrasound device (Eckert and Szyndler-Nędza, 2004). The animals were divided into groups based on the arithmetic mean of $(P_2 + P_4)/2$, calculated using P_2 and P_4 backfat thickness. Measurements were performed on day 104 of pregnancy when the sows were transferred to the farrowing section. Primiparous sows with average $(P_2 + P_4)/2$ backfat thickness of >18 mm were assigned to group I, and primiparous sows with average $(P_2 + P_4)/2$ backfat thickness of ≤18 mm were assigned to group II; multiparous sows with average $(P_2 + P_4)/2$ backfat thickness of >20 mm were allotted to group I, and multiparous sows with average $(P_2 + P_4)/2$ backfat thickness of ≤20 mm were allotted to group II (Table 1.). On day 104 of pregnancy and at weaning, the sows were weighed and Musculus longissimus dorsi (MLD) thickness was measured at P_4 (P_4M) on live animals. Total litter size at birth, number of live-born and stillborn piglets, number of weaned piglets, and litter size and average body weight of a piglet at birth and at weaning were also determined.

Table 1. Experimental scheme

Tabela 1. Układ doświadczenia

Sows:	Primiparous group I > 18 mm	Primiparous group II ≤ 18 mm	Multiparous group I > 20 mm	Multiparous group II ≤ 20 mm	Total
Primiparous, no.	10	10	-	-	20
Multiparous, no.	-	-	20	20	40
Total, no.	10	10	20	20	60

Note: Group I: primiparous $(P_2 + P_4)/2>18$ mm, multiparous $(P_2 + P_4)/2>20$ mm;
Group II: primiparous $(P_2 + P_4)/2\leq18$ mm, multiparous $(P_2 + P_4)/2\leq20$ mm.

Objaśnienia: Grupa I: pierwiastki $(P_2 + P_4)/2>18$ mm, wieloródki $(P2 + P_4)/2>20$ mm;
Grupa II: pierwiastki $(P_2 + P_4)/2\leq18$ mm, wieloródki $(P_2 + P_4)/2\leq20$ mm.

The experimental sows were housed in controlled climatic conditions. They were kept individually in farrowing pens with standard welfare requirements in place (Rozporządzenie MRiRW, 2010).

Sows and piglets had free access to water (nipple drinkers). Sows were fed a complete diet (12.7 MJ ME*kg^{-1}, 17% protein, 1% lysine) in accordance with Polish Swine Nutrient Requirements (1993). Feed was offered twice a day during pregnancy and three times a day during lactation. Piglets were additionally fed a prestarter diet, beginning on day 5 of life until weaning on day 21 (13.5 MJ ME*kg^{-1}, 19.9% protein, 1.53% lysine) (AOAC, 1990). Both sows and piglets were included in a prevention programme, and all farrowings were supervised. The reproduction and piglet rearing parameters were monitored.

The results were analyzed statistically. Tables present the means with standard error. In our experiment we have been testing the influence of two factors – sows and group - on reproductive performance and rearing of piglets. We assume a statistical model:

$Y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_{ij} + \varepsilon_{ijk}$,

where $k = 1,\dots,n_{jk}$; $i = 1, 2$; $j = 1, 2$ and

- Y_{ijk} the observation for subject k assigned to level i of variable sows and level j of variable group,
- μ the grand mean,
- α_i the level associated with level i of variable sows,
- β_j the level associated with level j of variable group,
- γ_{ij} the interaction effect associated with level i of variable sows and level j of variable group,
- ε_{ijk} the within cell error.

Significance differences between groups were tested using Kruskal-Wallis test.

Results

Results for the sows' body weight, P_2 and P_4 backfat thickness and MLD thickness at P_4M are presented in Table 2.

As assumed in the experiment, fatness was significantly higher ($P \le 0.01$) in group I than in group II. The body weight of sows at 104 days of pregnancy was also higher ($P \le 0.05$) in group I compared to group II. The body weight of multiparous sows (M) was higher than in primiparous sows (P) by 65.1 kg ($P \le 0.01$). Compared to P sows, experimental sows from group M had thicker backfat at 104 days of pregnancy, but the difference of 4.2 mm was statistically significant only at P_2 ($p \le 0.05$) (Table 2.).

The body weight of sows at weaning differed significantly between groups I and II ($P \le 0.05$). Fat reserve reflected in P_2 and P_4 backfat thickness was significantly ($P \le 0.01$) greater in group I than in group II ($P \le 0.01$). At weaning, there was a significant ($P \le 0.01$) difference in P_4M value in favour of group II compared to group I (3.6 mm, 8.8%). The evaluation of sows at weaning demonstrated considerable differences in body weight and in P_2, P_4 and P_4M values between P and M. Compared to primiparous sows, multiparous sows had 58.1 kg (37.9%) greater body weight ($P \le 0.01$), 5.4 mm (40.0%) greater P_2 backfat thickness ($P \le 0.01$), and 4.4 mm (29.5%) greater P_4 thickness ($P \le 0.05$), as well as 2.9 mm (6.6%) smaller MLD thickness at P_4M ($P \le 0.01$).

A sow × group interaction was found for the body weight of sows at 104 days of pregnancy and at weaning (P≤0.05), and for P_2 and P_4 backfat thickness (P≤0.01). There was also a sow × group interaction for P_4M at weaning.

It was shown that compared to P sows, M sows gave birth to litters that were larger by 1.06 piglets (P≤0.05) and heavier by 2.66 kg (P≤0.01) (Table 3.). Statistically significant differences between sows from groups P and M were also found for the number of piglets born alive (P≤0.01) and the number of stillborn piglets (P≤0.05). At weaning, the number of piglets per litter and litter weight were significantly greater (P≤0.05) in group M compared to group P. No significant differences were found between the experimental groups (I, II) in basic reproductive parameters of the sows and rearing of their offspring. A sow × group interaction did not occur for reproductive and rearing traits.

During the period from 104 days of pregnancy to weaning, sows lost body weight and fat reserves (P_2, P_4) (Table 2.). Body weight loss was similar but slightly lower in group I than in group II (approx. 10-12%). Compared to sows from group II, those from group I were characterized by a slightly lower loss of P_2 backfat thickness from 104 days of pregnancy until weaning and the end of lactation. The loss of fat reserves (P_2, P_4) was greater in P than M sows. MLD thickness increased in multiparous sows. Differences in P_4M value between P and M sows and between groups I and II were significant (P≤0.05).

Table 2. Body weight, P_2 and P_4 backfat thickness and Longissimus dorsi muscle thickness at point P_4M in sows (mean and standard error)

Tabela 2. Masa ciała, grubość słoniny w punkcie P_2 i P_4 i grubość mięśnia Longissimus dorsi w punkcie P_4M u loch (średnia i błąd standardowy)

Trait	Sows		Group		P		
	Primiparous	Multiparous	I	II	Sows	Group	Sows x Group
104 days of pregnancy							
Body weight, kg	171.9 ±4.07	237.0 ±5.16	219.5 ±8.19	194.4 ±6.16	0.01	0.05	0.05
Backfat thickness over the last rib, 3 cm from the dorsal midline, at point P_2, mm	17.2 ±0.79	21.4 ±1.27	23.7 ±0.99	14.7 ±0.48	0.05	0.01	0.01
Backfat thickness over the last rib, 8 cm from the dorsal midline, at point P_4, mm	19.5 ±1.14	22.8 ±1.38	26.5 ±0.95	15.3 ±0.59	ns	0.01	0.01
Longissimus dorsi muscle thickness at point P_4M, mm	41.9 ±1.06	44.5 ±1.11	43.7 ±1.26	42.8 ±0.89	ns	ns	ns
Weaning day							
Body weight, kg	153.2 ±2.97	211.3 ±5.23	197.1 ±7.45	171.7 ±5.37	0.01	0.05	0.05
Backfat thickness over the last rib, 3 cm from the dorsal midline, at point P_2, mm	13.5 ±0.73	18.9 ±1.23	20.4 ±1.10	12.0 ±0.45	0.01	0.01	0.01
Backfat thickness over the last rib, 8 cm from the dorsal midline, at point P_4, mm	14.9 ±0.94	19.3 ±1.43	21.7 ±1.19	12.3 ±0.63	0.05	0.01	0.01
Longissimus dorsi muscle thickness at point P_4M, mm	44.0 ±0.60	41.1 ±0.85	40.7 ±0.85	44.3 ±0.56	0.01	0.01	0.01
Changes of parameters between 104 days of pregnancy and weaning day							
Body weight, kg	-10.3 ±1.63	-10.9 ±0.88	-9.9 ±1.03	-11.4 ±1.45	ns	ns	ns
Backfat thickness over the last rib, 3 cm from the dorsal midline, at point P_2, mm	-21.1 ±2.82	-10.6 ±3.30	-13.7 ±3.45	-17.1 ±3.00	ns	ns	ns
Backfat thickness over the last rib, 8 cm from the dorsal midline, at point P_4, mm	-21.7 ±4.56	-14.4 ±3.80	-17.7 ±3.89	-17.6 ±4.54	ns	ns	ns
Longissimus dorsi muscle thickness at point P_4M, mm	6.4 ±2.21	-6.1 ±2.75	-4.8 ±3.12	4.5 ±1.94	0.05	0.05	0.05

Explanations: Group I: primiparous $(P_2 + P_4)/2>18$ mm, multiparous $(P_2 + P_4)/2>20$ mm;
Group II: primiparous $(P_2 + P_4)/2\leq18$ mm, multiparous $(P_2 + P_4)/2\leq20$ mm; ns not significant P>0.05

Objaśnienia: Grupa I: pierwiastki $(P_2 + P_4)/2>18$ mm, wieloródki $(P_2 + P_4)/2>20$ mm;
Group II: pierwiastki $(P_2 + P_4)/2\leq18$ mm, wieloródki $(P_2 + P_4)/2\leq20$ mm; ns nieistotne P>0.05

Table 3. Results of reproductive performance and rearing of piglets (mean and standard error)

Tabela 3. Wyniki rozrodu i odchowu prosiąt (średnia i błąd standardowy)

Trait	Sows		Group		P		
	Primiparous	Multiparous	I	II	Sows	Group	Sows x Group
Farrowing day							
Piglets born in total, no.	10.10 ±0.24	11.16 ±0.36	11.11 ±0.45	10.35 ±0.17	0.05	ns	ns
Piglets born alive, no.	9.95 ±0.25	11.16 ±0.36	11.11 ±0.45	10.23 ±0.19	0.01	ns	ns
Stillborn piglets, no.	0.14 ±0.08	0.00 ±0.00	0.00 ±0.00	0.12 ±0.06	0.05	ns	ns
Litter weight at birth, kg	15.25 ±0.68	17.91 ±0.70	17.31 ±0.79	16.37 ±0.69	0.01	ns	ns
Average piglet's weight at birth, kg	1.53 ±0.05	1.61 ±0.04	1.56 ±0.04	1.59 ±0.05	ns	ns	ns
Weaning day							
Weaned piglets, no.	9.33 ±0.25	9.91 ±0.19	9.74 ±0.22	9.62 ±0.22	0.05	ns	ns
Litter weight at weaning, kg	49.64 ±6.75	54.57 ±3.93	52.75 ±4.15	51.61 ±3.25	0.05	ns	ns
Average piglet's weight at weaning, kg	5.32 ±0.58	5.50 ±0.42	5.42 ±0.24	5.36 ±0.34	ns	ns	ns

Explanations: as in Table 2.

Objaśnienia: jak w Tabeli 2.

Discussion

As reported by Mullan and Williams (1989) the correlation between feed intake by pregnant sows, backfat thickness on farrowing day and the appetite of lactating females is r = -0.52. This indicates restricted feed intake by the lactating sows that were overfed during pregnancy and are in overfat condition before parturition. Such sows decrease milk production with an increase in catabolic at the expense of anabolic processes. This causes a considerable (>20%) loss of protein and fat from the body, especially in primiparous sows (Thaker and Bilkei, 2005; Young et al., 2004). The body weight loss in the investigated sows was similar in groups and in sows differing in the reproductive period (primiparous and multiparous sows). All females lost fat reserves during lactation. This process increased in primiparous in relation to multiparous sows, which could result from their greater needs determined by incomplete somatic development. The optimization of P_2 backfat thickness should be accounted for by the herd manager. This is additionally confirmed by the changes that we observed in MLD thickness at P_4M on day 104 of pregnancy and at weaning. Greater fat reserves – optimal for reproductive performance and rearing of piglets – are desirable. As a result, multiparous sows showed better productivity. Smaller fat reserves are undesirable, especially for primiparous sows (Amaral Filha et al., 2010; Bečková et al., 2005; Kawęcka et al., 2009; Roongsitthichai et al., 2011). Young females undergo ontogenetic changes and the production process (pregnancy and rearing of the litter) puts an enormous strain on their body; this concerns both multiparous sows and sows in the second reproductive cycle, which still undergo somatic development. In primiparous sows, the protein reserves reflected in MLD thickness (P_4M) increased.

Because the hormone metabolism is determined by the level of fat reserves, different authors believe that lactating and dry sows should be fed *ad libitum* to improve the condition of the females (Rekiel, 2002; Thaker and Bilkei, 2005). A relationship was also noted between oxytocin concentration in the sow's body and the mobilization of body reserves; the greater the concentration, the greater the mobilization, which positively affects milk production and the growth rate of piglets (Valros et al., 2004). In our study, the body weight of piglets was only slightly higher ($P \leq 0.05$) in multiparous sows from group I compared to those from group II. During the perinatal period, mother's colostrum (and later milk) stimulate the development of the digestive tract in neonates and determine their subsequent growth and development. Because the components necessary for their production are synthesized several weeks prepartum (Dodd et al., 1994; Whitley et al., 1990), the level of fat and protein reserves accumulated in the body of high pregnant females is very important. However, some sows lose part of their reserves during the prepartum period. This is associated not exclusively with the synthesis of colostrum and milk components but also with the somatic development of young females and fetal weight gains (Rekiel, 2000). The use varies according to the degree of somatic maturity in the female, its age, body weight, protein and fat reserves, but also to the number of fetuses and piglets born, the meeting of nutritional requirements, and environmental conditions (Wähner et al., 2001). Heyer et al. (2004), Lawlor et al. (2007) and Musser et al. (2006) report that the feeding level of pregnant sows and their condition are correlated to reproduction, while the nutrition of pregnant females is correlated to the birth weight of piglets and their growth rate. According to Heyer et al. (2004), the birth weight of piglets has a positive effect on rate of their growth and carcass traits. Lawlor et al. (2007) observed no effect of the feeding level of pregnant sows on progression of body weight in piglets at birth and at weaning. Cerisuelo et al. (2009) and Dwyer et al. (1994) hold that the feeding level of sows in certain stages of gestation may influence the extent of fat reserves accumulated in females. It may also affect the number and development of muscle fibres in growing fetuses, and consequently neonatal weight and the growth rate of piglets after birth. The low birth weight of piglets is associated with the limited amount of secondary muscle fibres. This trait is determined by the feeding level of mother between 25 and 50 days of pregnancy (Dwyer et al. 1994). In our study, we found no differences in birth weight of piglets from the compared groups (I and II). This result demonstrates that maintaining in prepartum sows a P_2 backfat thickness below 20 mm (primiparous sows) and 25 mm (multiparous sows) (Sinclair et al., 1998; Whittemore, 1996) conditions optimum fetal weight gain and uniform neonatal weight while having no negative effect on the number of stillborn piglets, as confirmed by the results obtained. These results show that the level and quality of feeding met the requirement of the females investigated.

In some countries, such as Denmark and Ireland, the monitoring of sow condition in herds makes it possible to assess whether their nutrition during the reproductive cycle is appropriate. It allows for adjusting feeding level and optimizing fat and protein reserves in the female's body, thus improving reproductive performance of the sows. However, Musser et al. (2006) obtained varying reproductive results when giving, for 20 days, 100% higher feed rations to experimental vs. control sows in the second trimester of gestation. In the first experiment, they found an increase in the number of stillborn piglets, but in another experiment they failed to confirm the results of the first study. Heyer et al. (2004) observed that giving complementary feed to pregnant sows was followed by an increase in the number of piglets weaned, but this only concerned multiparous sows. In our experiment, sow diets did not differ among the groups. Using uniform standard feeding, we only obtained a greater number of piglets born and weaned by multiparous compared to primiparous sows (1.06 piglet and 10.5% vs. 0.58 piglet and 6.2%). This result is correct and beneficial for overall herd performance while showing that farrowing sows had been appropriately prepared for reproduction.

In conclusion, compared to females with a smaller mean backfat thickness, those with more fat had higher body weight in both study periods, i.e. at 104 days of pregnancy and at weaning. The significant differences noted during high pregnancy in fat reserves between groups I and II persisted at weaning ($P \leq 0.01$). Multiparous vs. primiparous sows had significantly thicker backfat at point P2 during pregnancy ($P \leq 0.05$) and at weaning ($P \leq 0.01$), and at point P_4 at weaning ($P \leq 0.05$). The level of changes in body weight and fat reserves was similar in groups I and II. From 104 days of pregnancy to weaning, body weight loss was similar in P and M sows, and fat reserve loss (P_2, P_4) was greater in P than M sows. During the study period, P_4M increased in the group of younger sows (P) with lower fat reserves (group II) and decreased in the group of older sows (M) with higher fat reserves (group I). Litter size and litter weight were significantly greater ($P \leq 0.05$) in multiparous compared to primiparous sows. In experimental sows, however, backfat thickness and changes in fat reserve between 104 days of pregnancy and weaning after 21-day lactation were found to have no effect on reproductive performance of the sows and rearing of their offspring.

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References

Amaral Filha, W.S., Bernardi, M.L., Wentz, I., Bortolozzo, F.P. (2010) Reproductive performance of gilts according to growth rate and backfat thickness at mating. Animal Reproduction Science, 121, 139-144.

Association of Official an Analytical Chemists. Official Methods of Analysis of the Associated Official Analytical Chemists, 15th ed, Chapter 32, Washington DC, USA. 1990.

Bečková, R., Daněk, P., Václavková, E., Rozkot, M. (2005) Influence of growth rate backfat thickness and meatiness on reproduction efficiency in Landrace gilts. Czech Journal of Animal Science, 50, 535-544.

Beyga, K., Rekiel, A.,(2010) The effect of the body condition of late pregnant sows on fat reserves at farrowing and weaning and on litter performance. Archiv Tierzucht, 53, 50-64.

Cerisuelo, A., Baucells, M.D., Gasa, J., Coma, J., Carrión, D., Chapinal, N., Sala, R. (2009) Increased sow nutrition during mid-gestation affects muscle fiber development and meat quality with no consequences on growth performance. Journal of Animal Science, 87, 729-739.

Charette, R., Bigras-Poulin, M., Martineau, G.P. (1996) Body condition evaluation in sows. Livestock Production Science, 46, 107-115.

Čechová, M., Tvrdoň, Z. (2006) Relationships between backfat thickness and parameters of reproduction in the Czech Large White sows. Archiv Tierzucht, 49, 363-369.

Dodd, S.C., Forsyth, I.A., Buttle, H.L., Gurr, M.I., Dils, R.R. (1994) Milk whey proteins in plasma of sows: variation with physiological state. Journal of Dairy Research, 61, 21-34.

Dwyer, C.M., Stickland, N.C., Fletcher, J.M. (1994) The influence of maternal nutrition on muscle fiber number development in the porcine fetus and on subsequent postnatal growth. Journal of Animal Science, 72, 911-917.

Eckert, R., Szyndler-Nędza, M. (2004) Judging of live of young boars. Report on pig breeding in 2003. Instytut Zootechniki, XXIV, Kraków, Poland, 31-46.

Heyer, A., Andersson, H.K., Lindberg, J.E., Lundström, K. (2004) Effect of extra maternal feed supply in early gestation on sow and piglet performance and production and meat quality of growing/finishing pigs. Acta Agriculturae Scandinavica. Section A – Animal Science, 54, 44-55.

Kawęcka, M., Matysiak, B., Kamyczek, M., Delikator, B. (2009) Relationships between growth, fitness and meatiness traits in gilts and their subsequent reproductive performance. Annals of Animal Science, 9, 249-258.

Lawlor, P.G., Lynch, P.B. (2007) A review of factors influencing litter size in Irish sows. Irish Veterinary Journal, 60, 359-366.

Lawlor, P.G., Lynch, P.B., O'Connell, M.K., McNamara, L., Reid, P., Stickland, N.C. (2007) The influence of over feeding sows during gestation on reproductive performance and pig growth to slaughter. Archiv Tierzucht. Dummerstorf, Special Issue 50, 82-91.

Maes, D.G.D., Janssens, G.P.J., Delputte, P., Lammertyn, A., De Kruif, A. (2004) Back fat measurements in sows from three commercial pig herds: relationship with reproductive efficiency and correlation with visual body condition scores. Livestock Production Science, 91, 57-67.

Mullan, B.P., Williams, I.H. (1989) The effect of body reserves at farrowing on the reproductive performance of first-litter sows. Animal Production, 48, 449-457.

Musser, R.E., Davis, D.L., Tokach, M.D., Nelssen, J.L., Dritz, S.S., Goodband, R.D. (2006) Effect of high feed intake during early gestation on sow performance and offspring growth and carcass characteristics. Animal Feed Science and Technology, 127, 187-199.

Polish Swine Nutrition Requirements (1993) The Kielanowski Institute of Animal Physiology and Nutrition. Omnitech-Press, Warszawa.

Rekiel, A. (2000) Lactation cycle in sows. Medycyna Weterynaryjna 56, 163-167

Rekiel, A. (2002) Wpływ odmiennych technik zasuszania na poziom rezerw tłuszczowych i wyniki reprodukcji loch. Praca habilitacyjna 246, Wyd. SGGW, pp. 1-99.

Rekiel, A., Beyga, K. (2008) Body condition scoring in sows. Przegląd Hodowlany, 76 (9), 7-13.

Rekiel, A., Beyga, K., Vasko, V. (2007) Effect of backfat in point P2 and of body weight of primiparous sows in high pregnancy on their condition at weaning. Roczniki Naukowe Polskiego Towarzystwa Zootechnicznego, 3, 89-104.

Rekiel, A., Więcek, J., Beyga, K. (2011) Analysis of the relationship between fatness of late pregnant and lactating sows and selected lipid parameters of blood, colostrum and milk. Annals of Animal Science, 11, 485–493.

Roongsitthichai, A., Koonjaenak, S., Tummaruk, P. (2011) Association between backfat depth and litter size at birth in primiparous sows. Kasetsart Journal. Natural Science, 45, 422-427.

Rozporządzenie Ministra Rolnictwa i Rozwoju Wsi z dnia 15 lutego 2010 r. w sprawie wymagań i sposobu postępowania przy utrzymaniu gatunków zwierząt gospodarskich, dla których normy ochrony zostały określone w przepisach Unii Europejskiej. Dziennik Ustaw Nr 56, poz. 344.

Sinclair, A.G., Cia, M.C., Edwards, S., Hoste, S. (1998) Response to dietary protein during lactation of Meishan synthetic, Large White and Landrace gilts given food to achieve the same target backfat level at farrowing. Animal Science, 67, 349-354.

Szyndler-Nędza, M., Żak, G., Luciński, P., Bajda, Z. (2008) Changes in fattening and slaughter traits of gilts performance tested in 1997–2006. Roczniki Naukowe Zootechniki, 35, 25-35.

Thaker, M.Y.C., Bilkei, G. (2005) Lactation weight loss influences subsequent reproductive performance of sows. Animal Reproduction Science, 88, 309-318.

Valros, A., Rundgren, M., Špinka, M., Salonim, H., Hulten, F., Uvnäs-Moberg, K., Tománek, M., Krejci, P., Algers, B. (2004) Oxytocin, prolactin and somatostatin in lactating sows: associations with mobilisation of body resources and maternal behaviour. Livestock Production Science, 85, 3-13.

Wähner, M., John, A., Hoffmeyer, C. (2001) Influence of growth and side fat thickness on reproduction and rearing performance of gilts. I. Comparison of characteristics growth, side fat thickness and reproduction performances. Archiv Tierzucht, 44, 157-166.

Whitely, J.L., Hartman, P.E., Willcox, D.L., Bryant-Greenwood, G.D., Greenwood, F.C. (1990) Initiation of parturition and lactation in the sow. Journal of Endocrinology, 124, 475-484.

Whittemore, C.T. (1996) Nutrition reproduction interactions in primiparous sows. Livestock Production Science, 46, 65-83.

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. Journal of Animal Science, 82, 3058-3070.

Young, M.G., Tokach, M.D., Goodband, R.D., 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.