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EFFECT OF BODY WEIGHT CHANGES IN SOWS DURING THE REPRODUCTIVE CYCLE ON REARING OF PIGLETS AND CHEMICAL COMPOSITION OF MILK

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The aim of the study was to analyse reproductive performance of sows depending on body weight changes in the sows during mating, farrowing and weaning. The effect of body weight changes on chemical composition of the colostrum and milk was also analysed. The study was performed with 41 Polish Large White and 52 Polish Landrace sows that farrowed 238 litters. Sows were divided into 3 experimental groups according to differences in body weight between farrowing and mating days, weaning and farrowing days, and weaning and mating days. The study accounted for the number of piglets per litter and their weight at 1, 7 and 21 days of age. The chemical composition of colostrum and of milk at 7 and 21 days of lactation were also evaluated. The results show that sows with the highest weight gain from mating to farrowing, gave birth to and reared the largest number of piglets. No differences were observed in colostrum and milk quality between the groups of sows with different weight gains Only the level of fat in colostrum was highest in fastest growing sows. The analysis of the lactation period demonstrated that sows with the highest body weight loss were mothers which gave birth to and reared the largest number of piglets. No significant differences were found in colostrum and milk quality between the groups of the sows. The sows with intermediate body weight loss showed slightly higher levels of protein and fat in colostrum and of fat on day 21 of lactation. In turn, sows with the smallest difference in body weight between mating and weaning gave birth to and reared the largest number of piglets, and showed the best chemical composition of colostrum and milk.

Key words: body weight change, reproductive performance, chemical composition of colostrum and milk

The condition of gilts and sows as well as its impact on reproductive performance has been analysed in a number of studies. The factors analysed included the age at which gilts are first used for reproductive purposes and their body weight at first mating (Tummaruk et al., 2007). Additionally, the sows' ability to store energy, usually expressed through back fat thickness, was also evaluated. It is commonly believed that in sows that are in a good condition the effects of negative energy balance after lactation can be quickly eliminated. On the other hand, however, higher fertility of sows entails increased production of

high-quality milk and thus causes depletion of the energy stored in their bodies. Consequently, the sows are used for reproduction for shorter periods while the number of weak and stillborn piglets per litter grows (Maes et al., 2004). As suggested by certain hypotheses proposed in selected studies, good reproductive performance of sows may be attributable to their ability to quickly restore health and fitness throughout the reproductive cycle (Rekiel et al., 2007; Bergsma et al., 2009; Patterson et al., 2010). In the available subject literature, there is no data concerning the impact of body weight of sows during subsequent reproductive cycles on their reproductive performance.

The aim of the study was to analyse the reproductive performance of sows during three consecutive lactation periods, depending on body weight changes in the sows at mating, farrowing and weaning. The effect of body weight changes during reproductive cycles on chemical composition of colostrum and milk was also evaluated.

Material and methods

The research was performed at a pig farm of the National Research Institute of Animal Production, on 41 Polish Large White and 52 Polish Landrace sows. All first and second farrows were evaluated, plus third farrows from selected sows. During the research, all sows were fed with the same standard compound feedstuffs. In the period between mating and the first week of lactation, they were given standardised doses, followed by *ad libitum* doses in later periods. Pregnant sows were fed with forage characterised by EM = 11.41 MJ and total protein of 12.50 %, while farrowing sows were given forage with EM = 12.30 MJ and total protein of 15.00%. From day 7 of life, piglets were fed with complete feed mixture, to teach them to take in dry food. Both the sows and the piglets were kept in buildings with standardised microclimate, according to the specific requirements for each technological group.

Each sow was weighed 2 days prior to mating and farrowing and on the day of weaning (hereinafter: at mating, at farrowing and at weaning). The following parameters were established for each litter:

- number of piglets at day 1, 7 and 21 of life,
- weight of piglets at day 1, 7 and 21 of life.

Additionally, the chemical composition of colostrum and milk collected from sows after placenta delivery was analysed and milk was evaluated on days 7 and 21 of lactation. The colostrum and milk samples collected from the 1^{st}, 3^{rd} and 6^{th} mammary glands of the left mammary ridge were analysed with Milko-Scan 133B at the Milk Evaluation and Analysis Laboratory of the Wrocław University of Environmental and Life Sciences. The percentage content of protein, fat and lactose in colostrum and milk samples was determined.

In order to analyse the impact of changes in the sows' body weight in the period from mating to farrowing, from farrowing to weaning and from mating to

weaning, on the number and weight of piglets and chemical composition of colostrum and milk, they were divided into 3 experimental groups (Tab. 1). The division did not differentiate between sow races, with each farrow being considered a separate source of data for the analysis, but was based on differences in body weight (bw) of the sows (groups A, B and C), evaluated in the following periods:

- from mating till farrowing (bw at farrowing minus bw at mating),
- from farrowing till weaning (bw at weaning minus bw at farrowing),
- from mating till weaning (bw at weaning minus bw at mating). Table 1 shows the range of sows' body weight values in individual groups and the number of sows in each group.

Table 1. Number of sows in the groups divided based on differences in body weight at mating, farrowing and weaning

Period	A	B	C
	Differences in body weight		
From mating to farrowing	25,9 kg and less 79 head	26 kg to 45,9 kg 86 head	46 kg and over 73 head
From farrowing to weaning	-18 kg and over 71 head	-17.9 kg to -3 kg 83 head	-2,9 kg and less 84 head
From mating to weaning	12,9 kg and less 78 head	13 kg to 35,9 kg 87 head	36 kg and over 73 head

All statistical analyses were performed with the SAS statistical package. The study was based on a multi-factor variance analysis according to the model below:

$$Y_{ijkl} = \mu + a_i + b_j + c_k + e_{ijkl}$$

where:
μ – grand mean
a_i – effect of race i (i = 1.2)
b_j – effect of lactation j (j = 1 – 3)
c_k – effect of group k (k = A-C)
e_{ijkl} – error

The materiality of differences between the mean values were determined based on the LSM MEANS procedure, with significance levels of $P<0.05$ and $P<0.01$.

Results

The study was performed on 93 sows that produced 238 litters. For each sow, changes in body weight at mating, farrowing and weaning in subsequent reproductive cycles were established. The impact of the said changes on the reproductive performance and quality of colostrum and milk were also analysed. The first grouping criterion was the difference between body weight at farrowing and at mating. Depending on this value, each sow was assigned to one of the three groups. In group A, there were sows with the smallest body weight gain between mating and farrowing, while group C gathered sows with the most prominent live weight gain in the same period. In group B, there were sows with in-between values. The analysis of data presented in Table 2 leads to the conclusion that sows from group A farrowed and reared fewer piglets in a litter, with inconsiderably higher body weight at days 7 and 21, than sows from groups B and C. The differences observed between the experimental groups were not confirmed statistically.

Table 2. Number and weight of piglets per litter in different sow groups divided based on the difference in body weight of the sows between mating and farrowing

Item	Group		
	A	B	C
	Difference in body weight		
	25 kg and less	26 kg to 45 kg	46 kg and over
No. of piglets born (head)	11.47	11.49	11.77
No. of piglets on day 7 (head)	10.81	11.05	11.16
No. of piglets on day 21 (head)	10.13	10.32	10.29
Body weight of piglet at birth (kg)	1.44	1.45	1.45
Body weight of piglet on day 7 (kg)	2.69	2.63	2.60
Body weight of piglet on day 21 (kg)	5.55	5.52	5.43

One factor that might have contributed to the absence of differences in piglet rearing was the quality of colostrum and milk of the sows examined. The samples of colostrum and milk collected from sows from different experimental groups (Tab. 3) do not show a marked tendency (in any of the groups) to be richer or reduced in protein, fat or lactose. Only colostrum protein content and milk fat content on day 7 of lactation showed significant statistical differences between groups A and B, as sows from group B had lower content of these.

Analysis of the reproductive performance of sows divided into experimental groups by body weight difference between farrowing and weaning revealed statistically significant differences for some of the characteristics examined (Tab. 4). The differences between sows from groups A and C, i.e. those with the most and the least pronounced differences, related primarily to the number of piglets born in a litter, while the differences between groups A and B referred to the number of piglets on day 21 of life. When it comes to piglet body weight, significant differences were reported only for day 21 of life and only between groups with the most and the least prominent body weight changes. Sows from group A farrowed and reared the biggest number of piglets with the biggest body weight on day 21 of life.

Table 3. Chemical composition of colostrum and milk in sow groups divided based on the difference in body weight of the sows between mating and farrowing

Item	Group		
	A	B	C
	Difference in body weight		
	25 kg and less	26 kg to 45 kg	46 kg and over
Colostrum:			
protein (%)	15.21 a	14.63 b	14.75
fat (%)	4.61	5.21	5.36
lactose (%)	1.93	2.00	1.88
Milk on day 7 of lactation:			
protein (%)	4.69	4.81	4.89
fat (%)	7.91 a	7.40 b	7.45
lactose (%)	5.70	5.63	5.54
Milk on day 21 of lactation:			
protein (%)	4.76	4.83	5.02
fat (%)	7.19	6.94	6.99
lactose (%)	5.74	5.80	5.88

a, b - means with different small letters differ significantly at $P<0.05$.

As far as the chemical composition of colostrum produced by sows from the above-mentioned groups is concerned, statistically significant differences were reported between colostrum from B-group and C-group sows (Table 5). No major relationships between experimental groups were observed in terms of the content of other ingredients of colostrum and milk in subsequent days of lactation.

Table 4. Number and weight of piglets per litter in different sow groups divided based on the difference in body weight between farrowing and weaning

Item	Group		
	A	B	C
	Difference in body weight		
	-18 kg and over	-17 kg to -3 kg	-2 kg and less
No. of piglets born (head)	11.69 a	11.59	11.44 b
No. of piglets on day 7 (head)	11.14	10.99	10.90
No. of piglets on day 21 (head)	10.49 a	10.04 b	10.25
Body weight of piglet at birth (kg)	1.51	1.45	1.39
Body weight of piglet on day 7 (kg)	2.71	2.64	2.58
Body weight of piglet on day 21 (kg)	5.68 a	5.56	5.3 0 b

a, b - means with different small letters differ significantly at P<0.05.

Table 5. Chemical composition of colostrum and milk in sow groups divided based on the difference in body weight of the sows between farrowing and weaning

Item	Group		
	A	B	C
	Difference in body weight		
	-18 kg and over	-17 kg to -3 kg	-2 kg and less
Colostrum:			
protein (%)	14,90	15,03a	14,65b
fat (%)	5,97	5,12	5,07
lactose (%)	1,95	1,86	2,01
Milk on day 7 of lactation:			
protein (%)	4,74	4,81	4,82
fat (%)	7,67	7,52	7,58
lactose (%)	5,60	5,60	5,67
Milk on day 21 of lactation:			
protein (%)	4,83	4,88	4,87
fat (%)	6,87	7,34	6,89
lactose (%)	5,76	5,84	5,80

a, b - means with different small letters differ significantly at P<0.05.

Table 6. Number and weight of piglets per litter in different sow groups, divided based on the difference in body weight between mating and weaning

Item	Group		
	A	B	C
	Difference in body weight		
	12 kg and less	13 kg to 35 kg	36 kg and over
No. of piglets born (head)	11.60	11.59	11.51
No. of piglets on day 7 (head)	11.01	10.99	11.01
No. of piglets on day 21 (head)	10.33	10.24	10.16
Body weight of piglet at birth (kg)	1.48 a	1.47 a	1.38 b
Body weight of piglet on day 7 (kg)	2.73 a	2.67	2.52 b
Body weight of piglet on day 21 (kg)	5.69	5.53	5.29

a, b - means with different small letters differ significantly at $P<0.05$.

For sows divided by differences in body weight between mating and weaning, there were no statistically significant differences in the number of piglets farrowed and reared in a litter between individual experimental groups (Tab. 6). When it comes to the body weight of piglets at birth, however, it was proved that sows from groups A and B farrowed statistically the heaviest piglets compared to group C. After 7 days of rearing, piglets from group A sows were still significantly heavier than piglets farrowed by group C sows.

Table 7. Chemical composition of colostrum and milk in sow groups divided based on the difference in body weight of the sows between mating and weaning

Item	Group		
	A	B	C
	Difference in body weight		
	12 kg and less	13 kg to 35 kg	36 kg and over
Colostrum:	15.33 a	14.86	14.35 b
protein (%)	4.56 a	5.40	5.18 b
fat (%)	1.90	1.93	2.00
lactose (%)	4.71	4.78	4.90
Milk on day 7 of lactation:(%)			
protein (%)	7.81	7.59	7.33
fat (%)	5.64	5.63	5.60
lactose (%)	4.69	4.94	4.97
Milk on day 21 of lactation:(%)			
protein (%)	7.21 a	6.86 b	7.08
fat (%)	5.73	5.79	5.89
lactose (%)			

a, b - means with different small letters differ significantly at $P<0.05$.

The differences in chemical composition of colostrum and milk presented in Table 7 show that colostrum samples obtained from different experimental groups differed markedly. When compared to group C, sows from group A produced colostrum with bigger protein and lower fat content. Milk produced by group A sows was reported to contain significantly more fat than milk of group B sows, but this was true only for day 21 of lactation. Going further, milk of sows from group A contained less protein than milk of sows from groups B and C, but the differences reported on the days of lactation subjected to analysis were not confirmed statistically.

Presentation of results

The diversification of sows in terms of body weight differences at mating, farrowing and weaning usually has genetic background or is provoked by the sow feeding regime. The present study analysed the results obtained for sows kept in the same farm and fed with the same diet. The body weight differences observed in sows in the period from mating to farrowing, from farrowing to weaning and in the entire reproductive period, i.e. from mating to weaning, were considerable, suggesting that other determinants may be relevant, such as the sows' age or

weight at first mating (Matysiak et al., 2007). One possible reason behind the material variability in weight gains during the reproductive cycle may be its considerable loss during the previous lactating period and the animal's inability to smoothly regenerate (Bergsma et al., 2009).

The reproductive performance of sows with the biggest weight gain between mating and farrowing showed that such sows farrowed and reared more piglets. Nevertheless, the average weight of piglets in the rearing period was comparable in all experimental groups. This, in turn, was attributed to the quality of milk produced by the sows, which had the same content of individual nutrients. The only thing that sticks out is the significantly higher fat content in milk on day 7 of lactation in sows with the smallest live body weight gain. A much more pronounced tendency is observed in sows divided by weight losses during lactation. Sows with the greatest weight losses (group A) farrowed and reared significantly the biggest number of piglets. Also, the body weight of piglets from such sows on day 21 of life was the biggest, a fact linked to the quality of milk. The interrelatedness above has been confirmed in research by Eissen et al. (2003) who observed that sows whose weight dropped during lactation had the most numerous litters. However, Hoving et al. (2012) and De Bettio et al. (2016) proved the opposite, i.e. that litters of sows with high and low weight losses when lactating did not differ significantly in terms of the number of farrowed and reared piglets. The present study showed that fat and lactose content in colostrum produced by sows in individual experimental groups did not differ significantly. It was only showed that protein content in colostrum from sows with moderate weight loss during lactation was slightly higher. The differences in content of individual milk ingredients on days 7 and 21 of lactation between the experimental groups are difficult to determine. In addition, research by Park at al. (2010) did not reveal any significant differences in protein, fat and lactose content in colostrum of sows with greater and lower body weight losses. What they observed, however, was that sows with greater weight losses produced milk which, on the 10^{th} day of lactation, had noticeably lower protein and fat content, a finding not confirmed by the present study.

Reproductive performance of sows divided into experimental groups by body weight differences at weaning and mating, as well as the quality of their colostrum and milk, are the resultant of the already discussed divisions, i.e. differences in body weight at farrowing and mating and at weaning and farrowing. In general, sows whose body weight in that period increased by 12 kg at most farrowed a comparable number of piglets, yet with significantly bigger body weight, than sows with notably greater gains (group C). Additionally, colostrum obtained from such sows was richer in protein and less fatty, which probably contributed to the significantly bigger body weight of piglets reared by such sows until day 7 of lactation. On subsequent days of lactation, the growth of piglets was additionally enhanced by the forage they were fed. The results of the present research confirm the hypothesis formulated by Rekiel et al. (2008), Bergsma et al. (2009) and Patterson et al. (2010) stating that good reproductive performance of sows may be

determined by their ability to quickly restore a good condition during the entire reproductive cycle.

To sum up the results obtained, it can be concluded that changes in sows' body weight in the period from mating until farrowing had no significant impact on the number of farrowed and reared piglets or on content of basic ingredients of their colostrum and milk, and, thus, was insignificant for the body weight of reared piglets. Changes in the sows' body weight in the period from farrowing until weaning were of greater significance. The sows that lost the most weight when lactating farrowed and reared the biggest number of piglets, and their piglets were reported to have the biggest body weight on day 21 of life. No obvious impact of weight loss during lactation on the content of individual ingredients of colostrum and milk was observed. It was only showed that protein content in colostrum from sows with moderate weight loss was higher. Findings show that sows with weight gain of up to 12 kg within the reproductive cycle, i.e. from mating to weaning, are the most valuable. They farrowed piglets with significantly greater body weight and their colostrum was richer in protein and less fatty when compared to sows with body weight gains by 36 kg or more. As a result, piglets reared by such sows had significantly greatest body weight until day 7 of lactation.

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Effect of body weight changes in sows during the reproductive cycle on rearing of piglets and chemical composition of milk

SUMMARY

The aim of the study was to analyse reproductive performance of sows depending on body weight changes in the sows during mating, farrowing and weaning. The effect of body weight changes on chemical composition of the colostrum and milk was also analysed. The study was performed with 41 Polish Large White and 52 Polish Landrace sows. The first three parities were considered. Sows were divided into 3 experimental groups according to differences in body weight between farrowing and mating days, weaning and farrowing days, and weaning and mating days. The study accounted for the number of piglets per litter and their weight at 1, 7 and 21 days of age. The chemical composition of colostrum and of milk at 7 and 21 days of lactation were also evaluated. The results show that sows with the highest weight gain from mating to farrowing, gave birth to and reared the largest number of piglets. No differences were observed in colostrum and milk quality between the groups of sows with different weight gains. Only the level of fat in colostrum was highest in fastest growing sows. The analysis of the lactation period demonstrated that sows with the highest body weight loss were mothers which gave birth to and reared the largest number of piglets. No significant differences were found in colostrum and milk quality between the groups of the sows. The sows with intermediate body weight loss showed slightly higher levels of protein and fat in colostrum and of fat on day 21 of lactation. In turn, sows with the smallest difference in body weight between mating and weaning gave birth to and reared the largest number of piglets, and showed the best chemical composition of the colostrum and milk.

Key words: body weight change, reproductive performance, chemical composition of colostrum and milk