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Slaughter indicators and carcass traits as related to changes in body weight during lactation and post-weaning period of primiparous sows*

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A total of 70 primiparous sows slaughtered after the weaning of piglets, were divided into three groups – A (n=16), B (n=42) and C (n=12) differing in body weight loss (mean of 3.53, 6.95 and 12.53% of sow's body weight, respectively) during a 21-day lactation. The sows' body weight loss was not affected by the litter size, but was significantly different in groups A, B and C (mean of 0.60, 1.25 and 2.14 kg per piglet, respectively). Mean warm carcass weight in A, B, and C sows was 123.34, 119.90 and 114.10 kg, respectively (P<0.05). Mean meat content of carcass (52.13, 51.60 and 53.55%) and mean backfat thickness (2.28, 2.33 and 1.96 cm) were not affected by the group. The weight of ham and weight of meat of ham were both lower in group C than in group A (P<0.05).
During the weaning-to-slaughter period (mean of 9-10 days), sows showed different live weight gain being a basis of dividing them into three further groups (A_1, B_1 and C_1). No weight gain or even small weight loss (mean of -1.60 kg) was found in A_1, a moderate gain (2.63 kg) in group B_1 and a high (mean of 9.44 kg) in group C_1. Significant inter-group differences that were expected in carcass muscling and fatness traits were not statistically confirmed. Presumably, the realimentation period was too short to affect carcass characteristics.

KEY WORDS: carcass / primiparous sows / reproductive performance / slaughter quality

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The slaughter use of first-litter (primiparous) sows offers an opportunity for reducing the cost of pork production because valuable slaughter material and piglets are both obtained at the same time. Earlier evaluation of carcass value and meat quality in primiparous sows points to favourable characteristics of the carcass and meat [Kapelańska *et al.* 2002, Kapelański and Grajewska 2005]. Compared to regular fatteners, primiparas are older and heavier at slaughter, and their carcasses are less fatty and better muscled [Wajda *et al.* 2005, 2006].

The reasons for the lower carcass fatness of primiparous sows can be ascribed to their very high expenditure of energy and nutrients during lactation. In sows, the lactation leads to a considerable loss in body weight, mainly fat, protein and water [Jones and Stahly 1999, King and Dunkin 1986, Noblet and Etienne 1989]. The post-weaning period in sows can be viewed as a certain form of compensatory growth, accompanied by the restoration of energy reserves and a considerable body weight gain. Both periods involve a high incidence of metabolic (catabolic or anabolic) changes, which induce considerable changes in body weight.

The present study was carried out to determine whether periodic changes in the body weight of sows occurring from litter birth to litter weaning and from litter weaning to sows slaughter can affect carcass traits of the latter. It accounted for the body weight loss in sows during lactation and their subsequent body weight gain after weaning as factors affecting ultimate meat and fat traits of carcass.

Material and methods

The study was carried out using 70 primiparous sows. Housing and feeding maintained in accordance with the rearing standards for replacement animals [Feeding Standards for Pigs 1993]. The age and weight of sows were recorded at mating, farrowing, weaning and slaughter, as well as litter size (number of piglets born), and litter weight at birth and at weaning. The body weight loss in sows per one suckling piglet was calculated.

Based on their body weight loss during lactation (per cent lactational loss – LL) all sows were divided into three groups – A, B and C.

LL(%) was calculated as follows:

$$\text{Lactational loss} = \frac{\text{BWF - BWW}}{\text{BWW}} \times 100$$

where:

BWF – body weight after farrowing (kg);

BWW – body weight at weaning (kg).

Another criterion of sows assignment was their body weight gain from weaning to slaughter (compensatory gain – CG) in groups A_1, B_1 and C_1, calculated as follows:

Compensatory gain (kg) = BWS - BWW
where:
BWS – body weight at slaughter (kg);
BWW – body weight at weaning (kg).

Lactation lasted 21 days, and the weaning-to-slaughter period about 10 days. The latter was not exactly the same in all sows because of some slaughter restrictions (the group of slaughtered animals had to include at least 15 gilts). For this reason, daily weight gain was calculated in different groups by dividing the compensatory gain by the number of days from weaning to slaughter, as follows:

$$\text{Daily gain (kg/day)} = \frac{\text{Compensatory gain (kg)}}{\text{Number of days}}$$

After slaughter, the carcasses were measured and dissected to determine their muscling and fatness according to Polish Standard [1986]. The meat content of carcass (%) was also estimated using an ULTRA-FOM 100 apparatus.

The results obtained were evaluated statistically using STATISTICA 7.1 PL software [2007]. One-way analysis of variance was performed. The analysed factors were the relative weight loss during lactation (group A – from 0.01 to 5.0%, n = 16; group B – from 5.0 to 10%, n = 42; group C – above 10% body weight; n = 12) and the body weight gain in sows from weaning to slaughter (group A_1 – negative or zero weight gain, n=15; group B_1 – from 0.5 to 5.0 kg, n = 37; group C_1 – from 6.0 to 16.0 kg; n = 18). The significance of differences was estimated using Duncan's test.

Results and discussion

Lactational loss (LL) of body weight in sows

Each sow was assigned to one of three groups (A, B, C) according to the body weight loss during lactation (LL) – Table 1. No significant differences were found between group means for body weight of sows during mating, before farrowing, after farrowing and at weaning. The differences in LL between sows appeared large. The LL averaged 4.91, 11.11 and 20.58 kg in A, B and C sows, respectively, which was 3.53, 6.95 and 12.53% of sow body weight ($P<0.01$). These differences were not caused by the different numbers of piglets per litter, as LL per piglet was significantly different in each group of sows

The groups of sows showed marked differences in the expenditure of energy and body components on feeding a piglet. It was 0.60 kg dam's body weight per piglet in group A, 1.25 in group B, and 2.14 in group C ($P<0.01$). The reasons for the differences in energy metabolism and expenditure on suckling piglets between the individual sow groups are unknown. When feeding failed to meet the requirements of lactating sows, Jones and Stahly [1999] showed a significantly greater body weight

Table 1. Means and their standard deviations (SD) for reproductive traits in primiparous sows as related to lactational losses of their body weight

Trait	Lactational loss of body weight (%) in sows					
	Group A 0.01-5.0 kg (n=16)		Group B 5.0-10.0 kg (n=42)		Group C ≥10.0 kg (n=12)	
	mean	SD	mean	SD	mean	SD
Age of sows at mating (days)	196.6	17.6	194.1	18.8	198.9	15.4
Body weight at mating (kg)	103.7	8.8	104.6	8.4	102.5	9.4
Body weight before farrowing (kg)	173.1	12.8	178.4	18.7	187.2	17.5
Body weight after farrowing (kg)	157.0	12.4	160.4	18.0	162.7	18.2
Body weight at weaning (kg)	152.1	12.1	149.3	17.3	142.1	14.8
Body weight loss during lactation (kg)	4.91^{A}	4.08	11.11^{B}	2.28	20.58^{C}	4.49
Lactational loss of body weight per piglet (kg)	0.60^{A}	0.51	1.25^{B}	0.32	2.14^{C}	0.65
Lactational loss of body weight (%)	3.53^{A}	1.45	6.95^{B}	1.33	12.53^{C}	3.19
Body weight gain post-weaning (kg)	4.82	4.16	2.77	4.30	3.96	4.65
Body weight at slaughter (kg)	156.9	13.6	152.4	16.7	145.9	15.4
Litter characteristics						
No. of piglets born alive	8.47^{a}	1.50	9.55	2.10	10.25^{b}	1.91
Litter weight at birth (kg)	11.91^{a}	1.83	13.16	3.41	14.71^{b}	3.97
No. of piglets weaned	8.35^{a}	1.46	9.14	1.86	9.67^{b}	1.37
Litter weight at weaning (kg)	47.91^{Aa}	9.54	53.75^{b}	8.21	56.83^{B}	6.64
Piglet weight at weaning (kg)	5.77	0.80	6.01	0.92	5.95	0.86

$^{aA...}$Within rows means bearing different superscripts differ significantly at: small letters – $P<0.05$; capitals – $P<0.01$.

loss compared to ample feeding. In the present study, all the sows were fed and maintained in the same way.

The complex nature of metabolic processes and the effect of sows' physiological condition (early pregnancy, late pregnancy, lactation, subfertility) on nutrient requirement, digestibility and absorption have been reported by many authors [Barteczko *et al*. 2006, Fandrejewski *et al*. 1994, Le Goff and Noblet 2001]. Nevertheless, the inter-individual differences observed in the present study in the metabolic and catabolic rate in suckling sows were never reported in the literature.

It is worth noting that the groups of sows differing in body weight LL also differed in other reproductive traits. Those from group C, characterized by the greatest LL of body weight, gave birth to largest litters (10.25 *vs*. 9.55 in group B and 8.47 piglets in group A; $P< 0.05$). As a result of the greater number of piglets born per litter, the number of piglets weaned was significantly greater ($P<0.05$), as was litter weight at birth ($P<0.05$) and weaning ($P<0.01$). On the other hand, however, the body weights of piglets at weaning were similar in all groups. This fact and the earlier statement that the expenditure of energy and body components of sows body weight per piglet during suckling was significantly different in different groups of sows, show the considerable inter-individual differences to appear in the rate and extent of metabolic changes of body weight components in sows from groups A, B and C.

Table 2. Means and their standard deviations (SD) for slaughter traits in primiparous sows as related to lactational losses of their body weight

Trait	Group A 0.01-5 (n=16)		Group B 5.0-10 (n=42)		Group C ≥10 (n=12)	
	mean	SD	mean	SD	mean	SD
Warm carcass weight (kg)	123.34[a]	10.74	119.90	13.70	114.10[b]	12.98
Dressing percentage	78.63	1.47	78.65	2.17	78.18	1.92
Mean backfat thickness from 5 measurements (cm)	2.28	0.65	2.33	0.55	1.96	0.54
Loin eye area (cm^2)	53.36	6.60	54.34	8.54	54.44	8.47
UFOM, LD muscle thickness (mm)	56.35	6.85	51.59	6.30	51.25	8.26
UFOM, backfat thickness (mm)	17.71	5.21	17.34	5.44	15.33	3.96
UFOM, meat content of carcass (%)	52.13	5.56	51.60	6.04	53.55	5.71
Weight of ham (kg)	13.71[a]	1.24	13.04	1.54	12.51[b]	1.38
Weight of meat of ham (kg)	9.25[a]	0.86	8.89	1.04	8.45[b]	1.08
Weight of ham backfat without skin (kg)	2.29	0.59	2.11	0.73	1.99	0.60

[aA...] Within rows means bearing different superscripts differ significantly at $P<0.05$.

Because after rearing their first litters, sows were intended for slaughter, their slaughter value was determined in detail and the differences in carcass traits were estimated between the sow groups compared (Tab. 2). The significant differences in carcass traits were only observed for the extreme groups of sows characterized by the lowest and highest LL of body weight. Warm carcass weight was highest in sows A characterized by the lowest LL of body weight, and decreased progressively in B and C sows ($P<0.05$). The lowest mean backfat thickness was characteristic of the carcasses of C sows (1.96 *vs*. 2.28 and 2.33 cm). Meat content of carcass measured using an ULTRA-FOM 100 apparatus appeared satisfactory and was similar in all the groups (51.60 to 53.55%). Sows with the highest LL of body weight also showed a lower weight of ham ($P<0.05$) and a lower weight of meat of ham (8.45 *vs*. 9.25 kg; $P < 0.05$), as well as thinner LD muscle when measured using an ULTRA-FOM 100. The decrease in carcass fatness resulting from of increased catabolic processes during suckling is considered beneficial, while the protein loss and the resulting decrease in carcass meat weight are undesirable. Probably the muscle protein loss could be reduced by increasing the dietary levels of protein and lysine, as Jones and Stahly [1999] showed that sows offered a high-protein diet and 59 g lysine/day used their reserve fat for milk production and did not lose any muscle proteins.

Body weight gain of sows after weaning of piglets – compensatory gain

To estimate the effect of increased anabolic processes (evaluated by the body weight gain of sows after weaning) on the carcass slaughter value, three groups of sows were formed – A_1, B_1 and C_1 differing in post-weaning growth rate. Comparative analysis of the evaluated traits was performed.

Table 3. Means and their standard deviations (SD) for traits of primiparous sows as related to their post-weaning body weight loss or gain

Trait	Post-weaning changes in body weight of sows					
	Body weight loss		Body weight gain			
	Group A_1 0-5.0 kg (n=15)		Group B_1 0.5-5.0 kg (n=37)		Group C_1 6-16 kg (n=18)	
	mean	SD	mean	SD	mean	SD
Age of sows at mating (days)	199.9^{a}	21.03	197.9^{a}	16.23	186.8^{b}	16.21
Body weight at mating (kg)	104	9.44	108.7^{a}	8.36	101.8^{b}	10.20
Body weight before farrowing (kg)	175.1	24.76	178.0	17.28	179.0	7.97
Body weight after farrowing (kg)	158.8	24.04	160.7	16.56	159.4	9.22
Body weight at weaning (kg)	146.5	23.81	149.9	14.20	148.3	11.35
Body weight loss during lactation (kg)	12.23	4.01	10.86	6.29	11.17	7.52
Lactational loss of body weight per piglet (kg)	1.53	0.46	1.15	0.65	1.22	0.75
Lactational loss of body weight (%)	7.83	2.59	6.81	2.99	7.00	4.56
Body weight at slaughter (kg)	144.9^{a}	23.72	152.5	14.42	157.77^{b}	10.66
Days from weaning to slaughter	9.0		9.8		9.4	
Daily gain after weaning (kg)	-0.205^{A}	0.240	0.303^{B}	0.190	1.171^{C}	0.60
Body weight gain post-weaning (kg)	-1.60^{A}	1.72	2.63^{B}	1.34	9.44^{C}	3.11
Litter characteristics						
No. of piglets born alive	8.53	2.39	9.79	2.15	9.33	0.91
Litter weight at birth (kg)	11.27^{a}	3.94	13.93^{b}	3.39	12.94	1.54
No. of piglets weaned	8.33	2.35	9.29	1.69	9.11	0.96
Litter weight at weaning (kg)	52.83	10.99	52.83	8.61	53.00	7.32
Piglet weight at weaning (kg)	6.57^{A}	1.17	5.74^{B}	0.66	5.85^{B}	0.80

$^{aA...}$Within rows means bearing different superscripts differ significantly at: small letters – $P<0.05$; capitals – $P<0.01$.

Table 3 shows the data characterizing sows during the observations from mating to slaughter, as well as characteristics of their litters. Not all the sows gained weight after weaning. Similarly to lactation time, some of them showed a slight loss of body weight (-1.60 kg in group A_1), while a moderate weight gain (mean of 2.63 kg) was observed in sows from group B_1 and a high (mean of 9.44 kg) in sows from group C_1. Daily gain in the respective groups was -205, 303 and 1171 g ($P< 0.01$).

The increased growth rate observed in this study in sows after weaning their litters could roughly be compared with the increased weight gain during compensatory fattening, occurring after the restriction of feeding ration [Fandrejewski *et al.* 1994; Skiba *et al.* 2002; Skiba 2005; Therkildsen *et al.* 2002]. It should, however, be noted that there were considerable differences in the magnitude and nature of metabolic changes in the sows from different groups. In A_1 group, within approximately 9 post-weaning days, catabolic processes typical of the lactation period dominated, while in B_1 and C_1 anabolic processes dominated favouring the body weight restoration.

Litter traits given in Table 3 show that the sows from group A_1 had litters slightly lighter at birth ($P<0.05$) and smaller, although the weaning weight of these piglets

was significantly higher compared to those from the other groups of sows ($P < 0.01$). This may suggest that the expenditure of energy and body weight components on milk production in A_1 group of sows was greater than in B_1 and C_1 and that catabolic processes in A_1 group were continued post-weaning and lasted practically until the slaughter of sows.

Considerable differences in carcass fatness and muscling traits were therefore expected to appear between the groups of sows compared, but significance of the differences was not statistically confirmed (Tab. 4). Presumably, the realimentation period was too short to reveal the increased anabolic processes in the carcass characteristics.

Table 4. Means and their standard deviations (SD) for slaughter and carcass traits of primiparous sows as related to their post-weaning body weight loss or gain

Trait	Body weight changes in sows post-weaning					
	Body weight loss		Body weight gain			
	Group A_1 (n=15)		Group B_1 0.5-5.0 kg (n=37)		Group C_1 6-16 kg (n=18)	
	mean	SD	mean	SD	mean	SD
Warm carcass weight (kg)	115.7	18.53	120.0	12.29	122.4	9.09
Dressing percentage	78.63	1.97	78.98[a]	1.83	77.65[b]	2.03
Mean backfat thickness from 5 measurements (cm)	2.12	0.66	2.16	0.57	2.33	0.54
Loin eye area (cm^2)	51.63	6.72	55.47	8.42	53.18	7.79
UFOM, LD muscle thickness (mm)	50.79	7.08	52.50	7.04	54.56	6.81
UFOM, backfat thickness (mm)	17.57	6.39	16.63	5.16	17.67	4.21
UFOM, meat content of carcass (%)	51.43	7.09	52.53	5.87	51.57	4.86
Weight of ham (kg)	12.69	2.11	13.13	1.35	13.41	1.12
Weight of meat of ham (kg)	8.49	1.31	8.98	0.92	9.05	0.94
Weight of ham backfat without skin (kg)	2.14	0.86	2.07	0.69	2.26	0.50

[ab...]Means bearing different superscripts differ significantly at $P<0.05$.

In conclusion, the study showed considerable inter-individual differences in the body weight loss of primiparous sows during a 21-day lactation. These differences did not result from the different number of suckling piglets. The lactational loss (LL) of body weight per piglet was 0.60, 1.25 and 2.14 kg in groups A, B and C, respectively. This shows that the contribution of body weight tissue metabolism to milk production differed during the lactation of sows. An important result of this process was the low fatness and high meatiness of the carcasses of primiparous sows.

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Wartość rzeźna loszek jednorazówek na tle zmian masy ich ciała zachodzących podczas laktacji i po odsadzeniu miotu

S t r e s z c z e n i e

Badania przeprowadzono na 70 loszkach pierwiastkach ubijanych po odsadzeniu odchowanych przez nie prosiąt. Loszki podzielono na trzy grupy (A, n=16; B, n=42 i C, n=12) różniące się ubytkiem masy ciała podczas 21-dniowej laktacji, wynoszącym średnio 3,53, 6,95 i 12,53% masy ciała loszek. Ubytek masy ciała loszek nie był zależny od liczby karmionych prosiąt. Średnia utrata masy ciała była istotnie różna w grupach A, B i C i wynosiła odpowiednio 0,60, 1,25 i 2,14 kg na jedno odsadzone prosię. Masa tuszy ciepłej w kolejnych grupach wyniosła średnio 123,34, 119,90 i 114,10 kg ($P<0,05$), zawartość mięsa w tuszy – 52,13, 51,60 i 53,55%, a średnia grubość słoniny – 2,28, 2,33 i 1,96 cm (różnice między grupami nieistotne). Masa szynki (kg) i masa mięsa w szynce (kg) okazały się istotnie mniejsze w grupie C niż w grupie A.

W okresie od odsadzenia prosiąt do uboju loch (9-10 dni) stwierdzono wyraźne zróżnicowanie przyrostów ubijanych zwierząt. Wystąpił brak przyrostu, a nawet ubytek masy ciała (średnio -1,60 kg w grupie A_1), przyrost umiarkowany (2,63 kg w grupie B_1) i przyrost wysoki (średnio 9,44 kg w grupie C_1). Spodziewano się znacznego zróżnicowania w cechach umięśnienia i otłuszczenia tuszy, co nie zostało jednak potwierdzone statystycznie. Prawdopodobnie okres żywienia realimentacyjnego był zbyt krótki by wpłynąć na charakterystykę tuszy.