CHANGES IN SOW BACKFAT THICKNESS BEFORE AND AFTER FARROWING IN A LOCAL SWINE NUCLEUS BREEDING FARM

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ABSTRACT

This study aimed to investigate changes in backfat measurements before and after farrowing of 117 Landrace and 211 Large White sows producing 312 and 268 litters, respectively, and to assess whether they are associated with sow reproductive performance commonly recorded in a local swine nucleus breeding farm. Sow backfat thickness decreased by 3.06 mm, 2.76 mm, 3.00 mm, and 2.94 mm at the shoulder (BFT1), midback (BFT2), ham area (BFT3), and their average (AvBFT), respectively, when measured 15.5 ± 6.1 d before farrowing and 24.4 ± 4.1 d after farrowing. Reduction in backfat levels (due to greater backfat loss during lactation than backfat gain during gestation), was significantly associated with the number of stillbirths (r= +0.09 to +0.13) for BFT1, BFT2 and AvBFT, litter size at birth (r= -0.08 to -0.09) for BFT2 and AvBFT, and farrowing interval (r= -0.11) for BFT3. There was no significant association (*P*>0.05) between changes in backfat levels and parity, litter size at birth, mummified piglets, birth weight, weaning weight, farrowing index, and sow productivity index. Reduction in backfat thickness was significantly affected by breed especially when measured at the shoulder and midback area (*P*<0.05). Reduction in all backfat measurements was also significantly affected by month-year of farrowing (*P*<0.01).

Key words: backfat thickness before and after farrowing, reproductive performance, sow

INTRODUCTION

Measurement of backfat thickness in pig production has important applications in (a) carcass evaluation (Bondoc *et al*., 2017; Bondoc *et al*., 2019), (b) performance test programs for genetic improvement (Bondoc and Chua, 2017), and (c) sow breeding management programs (Dizon and Alcantara, 2017).

As the basic indicator of carcass fatness, backfat thickness is measured to determine carcass grade and to calculate percent muscle and carcass yield of lean red meat. In addition, backfat thickness not only comprises one of the breeding objectives actually measured in a local performance testing program for young boars and gilts but also provides a practical means of monitoring and maintaining optimal body condition of pigs to achieve adequate

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production levels (Maes *et al*., 2004). In the latter, backfat thickness has long been used to indicate fat reserves or nutritional deficiency, detect severely overfed or underfed sows, and check whether the currently applied feeding strategy is optimal (Mullan and Williams, 1990; Barnett *et al*, 2001). Measurement of backfat levels of sows also constitutes an objective and precise method to monitor health, welfare and productivity levels of sows (Barnett *et al*., 2001) and to assess fat and metabolic status of the sow related to sow reproductive performance (Houde *et al*., 2010), thus avoiding overweight and sometimes underweight sows at the time of parturition. While sows that are too fat have a higher risk to suffer from dystocia and associated stillbirth rate, agalactia, mastitis and metritis (Weldon *et al*., 1994), its effects on declining reproductive performance may not be seen for several months or parities (Maes *et al*., 2004).

In this regard, this study investigated the change in backfat thickness before and after farrowing (before weaning) in Landrace and Large White sows of a local nucleus breeding farm and its association with sow reproductive performance.

MATERIALS AND METHODS

A total of 177 Landrace and 211 Large White sows producing 312 and 268 litters, respectively from July 1, 2017 to October 26, 2018 at the International Farm Corporation (INFARMCO) nucleus breeding farm in Barangay San Isidro, Cabuyao City, Laguna, were used in the study (see Table 1).

Sows were housed individually during the gestation and lactation periods and were provided *ad libitum* access to water. Sows were fed manually twice a day during gestation (i.e. 3.0-3.5 kg feed/sow/day) and during lactation (i.e. 4.0-6.0 kg feed/sow/day).

Backfat thickness was measured using Amplitude mode (A-mode) ultrasonography Renco-Lean-Meter® Ultrasonic Back Fat Detector (Renco Corporation, Minneapolis, MN

Table 1. Number and distribution of purebred litters produced from July 1, 2017 to October 26, 2018, by breed and parity.

Parameters	Landrace	Large White	Total No. of Litters
Parity Number			
1	73	40	113
2	83	57	140
3	51	42	93
4	42	26	68
5	23	30	53
6	24	32	56
7	14	32	46
8	2	9	11
Total number of litters	312	268	580
No. of purebred sows	177	211	388
No. of litters/ sow	1.76	1.27	1.49

USA), at the shoulder area directly above the point of the elbow (BFT1), mid-back near the 10th or last rib (BFT2), and ham area or above the *gluteus medius* situated on the outer surface of the pelvis (BFT3), all taken 5 cm off the midline on the right side of the sow. Average backfat thickness (AvBFT) was computed based on backfat measurements from the 3 sites. Backfat measurements were taken by the same employee throughout the trial. Out of three sites, BFT2 according to the makers of Renco Ultrasonic Back Fat Detector, is commonly known to provide a more accurate reading of the third layer of fat that becomes thicker and more widespread over the body as they increase in weight and age. It also shows the best correlation with overall carcass yield.

Backfat thickness for each sow was measured at two different times, i.e. before farrowing - on entering the maternity unit or farrowing building (ideally 14 d before the expected date of farrowing) and after farrowing (before weaning). In the 4-week batch production system, backfat data were collected from all sows in the same farrowing building (each with about 22-30 farrowing crates) in one day and repeated 28 d later.

The change in backfat thickness (DiffBFT1, DiffBFT2, DiffBFT3, and DiffAvBFT) was calculated as BFT before farrowing minus BFT after farrowing. BFT before farrowing was taken when the sow is already transferred in the farrowing building, that is, 15.46 ± 6.14 d prior to farrowing while the other BFT was measured 24.37 ± 4.07 d after farrowing. Age of sow at the day of backfat measurement before farrowing (AgeBF) and after farrowing (AgeAF), number of days when backfat levels were measured before farrowing (DaysBF) and after farrowing (DaysAF), and the difference between DaysBF and DaysAF were also determined for each sow.

The reproductive performance parameters of purebred sows with up to 8 parities included litter size born alive (LSB, number of fully formed piglets without stillborn), stillbirths (SB, number of fully formed piglets born dead), mummified piglets (MUM, number of mummified fetuses), average piglet weight at birth (BWt, kg), litter size at weaning (LSW), average piglet weight at weaning (WWt, kg), farrowing interval (FInt, number of days between current and previous farrowing), farrowing index (FI, i.e. 365 ÷ FInt), and sow productivity index (SPI, number of piglets weaned per sow per year). Farrowing interval, farrowing index and SPI were computed for sows with more than 1 parity.

Simple descriptive statistics were initially determined for descriptive data on backfat thickness before and after farrowing, and corresponding sow reproductive performance using the MEANS procedure of SAS (2009) and are given in Table 2.

The Pearson product-moment correlation was used to determine the association between the change in backfat thickness (BFT1, BFT2, BFT3, and AvBFT) before and after farrowing and sow reproductive parameters using the CORR procedure of SAS (2009). Statistical significance was set at $P \leq 0.05$.

The general least squares procedures for unbalanced data were used to examine the principal sources of variation affecting the change in backfat thickness before and after farrowing. The following linear "fixed effects" model with covariates was used to perform an F-test (SAS, 2009) and compute the least square means and standard error for each level of the main effects:

$$y_{ijklmn} = \mu + \text{Breed}_i + \text{Mo-Year}_j + \text{SB}_k + \text{LSW}_l + \text{FInt}_m + e_{ijklmn}$$

where y_{ijklmn} is dependent variable (i.e. change in sow backfat thickness before and after

Table 2. Simple descriptive statistics for backfat thickness taken before and after farrowing and sow reproductive performance records.

Parameters	N	Average ± SD	Range
Backfat thickness measured before farrowing (BF)			
Age of sow before farrowing (AgeBF), days	580	743.80 ± 337.1	323 – 1,750
No. of days before farrowing (DaysBF)	580	15.50 ± 6.1	0 – 30
BF-BFT1, mm	580	27.08 ± 8.80	10 – 47
BF-BFT2, mm	580	25.70 ± 6.67	4 – 45
BF-BFT3, mm	580	24.47 ± 7.26	10 – 44
BF-AveBFT, mm	580	25.75 ± 4.97	9.33 – 39.67
Backfat thickness measured after farrowing (AF), before weaning			
Age of sow after farrowing (AgeAF), days	580	783.60 ± 337.3	360 – 1,782
No. of days after farrowing (DaysAF)	580	24.40 ± 4.10	9 – 30
AF-BFT1, mm	580	24.02 ± 7.47	9 – 45
AF-BFT2, mm	580	22.95 ± 6.29	4 – 40
AF-BFT3, mm	580	21.46 ± 6.98	4 – 44
AF-AveBFT, mm	580	22.81 ± 4.59	8.67 – 36.33
Difference in backfat thickness before and after farrowing (before weaning)			
Day difference (DaysBF - DaysAF), days	580	39.80 ± 6.20	26 – 57
DiffBFT1, mm	580	-3.06 ± 10.48	-32 – 27
DiffBFT2, mm	580	-2.76 ± 7.91	-36 – 25
DiffBFT3, mm	580	-3.00 ± 8.85	-30 – 26
DiffAvBFT, mm	580	-2.94 ± 5.83	-24.00 – 12.00
Sow reproductive performance records			
Parity	580	3.37 ± 2.00	1 – 8
Litter size born alive (LSB)	580	10.06 ± 3.11	1 – 17
No. of stillbirths (SB)	580	0.40 ± 0.87	0 – 5
No. of mummified piglets (MUM)	580	0.34 ± 0.94	0 – 9
Pig weight at birth (BWt), kg	576	1.50 ± 0.29	0.76 – 2.60
Litter size at weaning (LSW)	575	8.91 ± 3.03	1 – 16
Pig weight at weaning (WWt), kg	573	8.02 ± 1.61	4.10 – 14.00

Table 2. Continued...

Parameters	N	Average ± SD	Range
Farrowing interval (FInt), days	466	163.60 ± 37.4	123 – 583
Farrowing index (FI)	467	2.28 ± 0.28	0.63 – 2.87
Sow productivity index (SPI)	467	20.59 ± 5.88	2.35 – 35.70

AgeBF - age of sow at the day of backfat measurement before farrowing
AgeAF - age of sow at the day of backfat measurement after farrowing
DaysBF - number of days when backfat levels were measured before farrowing
DaysAF - number of days when backfat levels were measured after farrowing

farrowing), μ is overall mean, $Breed_i$ is fixed effect of the i^{th} breed of sow (i.e. Landrace, Large White), Mo-$Year_j$ is fixed effect for the j^{th} month-year of farrowing, and SB_k is covariate effect of k^{th} number of stillbirths, LSW_l is covariate effect of l^{th} litter size at weaning, $FInt_m$ is covariate effect of m^{th} farrowing interval (in days), and e_{ijklmn} is error term assumed to be normally distributed with variance of errors as constant across observations. Changes in backfat levels were investigated as absolute numbers (mm backfat).

RESULTS AND DISCUSSION

Table 2 shows the change (reduction) in backfat levels before and after farrowing (before weaning), for a 39.8 ± 6.2 day-difference between measurements. On the average, backfat thickness decreased by 3.06 mm, 2.76 mm, 3.00 mm, and 2.94 mm at the shoulder (BFT1), midback (BFT2), ham area (BFT3), and average (AvBFT), respectively, when measured 15.5 ± 6.1 d before farrowing and 24.4 ± 4.1 d after farrowing. The reduction in backfat levels is a result of (a) backfat gain expected during gestation (i.e. before farrowing) and (b) backfat loss expected during lactation (i.e. after farrowing). The reduction in backfat levels is a reflection of the mobilization of fat and protein reserves as voluntary feed intake is often insufficient to meet the high energy requirements for maintenance especially during the last third of gestation and during lactation (Aherne *et al*., 1999).

Table 3 shows that the reduction in backfat thickness (BFT1, BFT2, BFT3 and AvBFT) was found to be significantly (P<0.05) and negatively correlated with backfat levels measured before farrowing (i.e. gestation), i.e. r = -0.71 to -0.11 (P<0.05); and positively correlated with backfat levels measured after farrowing (i.e. during lactation), i.e. r = +0.08 to +0.60 (P<0.05). This implies that the reduction in backfat levels is due to the greater backfat loss during lactation (up to 24 days after farrowing) than the backfat gain during gestation (up to 15 days before farrowing). On the other hand, a gain in backfat thickness suggests lower backfat loss during lactation than the increase in backfat thickness observed during gestation just before farrowing.

Table 3 shows a significant positive correlation between the reduction in backfat levels (particularly DiffBFT1, DiffBFT2 and DiffAvBFT) and number of stillborn piglets (r = +0.09 to +0.13), implying that sows producing stillbirths are anticipated to have higher reductions in BFT before and after farrowing. Our data also showed low correlations (P<0.05) for number of stillbirths with BF-BFT2 (r= -0.10) and with BF-AveBFT (r= -0.09). This may imply that sows with limited backfat levels at parturition should be avoided. A similar recommendation was given by Maes *et al*. (2004) who reported that the number of

Table 3. Pearson correlation coefficients of changes in sow backfat thickness with backfat thickness before and after farrowing and sow reproductive data.

Parameters	Changes in sow backfat thickness BF and AF			
	DiffBFT1	**DiffBFT2**	**DiffBFT3**	**DiffAvBFT**
DiffBFT1	-	0.10*	0.08*	0.68**
DiffBFT2	-	-	0.17**	0.60**
DiffBFT3	-	-	-	0.63**
Day difference BF and AF	ns	ns	-0.09*	-0.10*
Age of sow before farrowing	ns	ns	ns	ns
No. of days before farrowing	ns	ns	-0.10*	-0.08*
BF-BFT1, mm	-0.71**	ns	-0.11**	-0.49**
BF-BFT2, mm	ns	-0.64**	ns	-0.35**
BF-BFT3, mm	ns	-0.13**	-0.64**	-0.41**
BF-AveBFT, mm	-0.47**	-0.37**	-0.40**	-0.65**
Age of sow after farrowing	ns	ns	ns	ns
No. of days after farrowing	ns	ns	ns	ns
AF-BFT1, mm	0.56**	0.11*	ns	0.38**
AF-BFT2, mm	ns	0.58**	0.14**	0.38**
AF-BFT3, mm	ns	0.08*	0.60**	0.37**
AF-AveBFT, mm	0.37**	0.36**	0.36**	0.57**
Parity	ns	ns	ns	ns
Litter size born alive	ns	ns	ns	ns
No. of stillbirths	0.13**	0.09*	ns	0.13*
No. of mummified piglets	ns	ns	ns	ns
Pig weight at birth	ns	ns	ns	ns
Litter size at weaning	ns	-0.08*	ns	-0.09*
Pig weight at weaning	ns	ns	ns	ns
Farrowing interval	ns	ns	-0.11*	ns
Farrowing index	ns	ns	ns	ns
Sow productivity index	ns	ns	ns	ns

ns - correlation coefficient (r) is not significantly different from zero ($P>0.05$)

*r is significantly different from zero ($P<0.05$)

**r is significantly different from zero ($P<0.01$)

stillborn piglets increased with decreasing backfat thickness at the end of gestation. On the other hand, Zaleski and Hacker (1993) suggested that sows with excessive body fat at the end of gestation may have farrowing difficulties and give birth to more stillborn piglets. Significant negative correlations (*P*<0.05) were also found between the reduction in backfat levels and LSW (r = -0.08 to -0.09) for DiffBFT2 and DiffAvBFT, and Fint (r = -0.11) for DiffBFT3. The greater decrease in backfat during lactation implies that higher backfat losses were observed in sows that weaned more pigs. This is because more energy is required for milk production in case of larger litter sizes (Aherne *et al*., 1999). Moreover, this study has shown that loss of backfat during lactation is associated with longer farrowing interval, similar to the reports by De Rensis *et al*. (2005) and Serenius *et al*. (2006).

No significant correlations (*P*>0.05) were found between the decrease in backfat levels and parity, LSB, MUM, BWt, WWt, FI and SPI. Although sows with higher reductions in backfat thickness before and after weaning (i.e. higher backfat losses leading to excessive fat and protein mobilization during lactation) tended to have a reduction in reproductive efficiency (Maes *et al*., 2004; Houde *et al*., 2010), no significant associations were demonstrated in this study (*P*>0.05). This may be due to the adequate management and feeding practices employed in the local nucleus breeding farm. Changes in backfat during lactation were too subtle to have an effect on sow reproductive performance.

Table 4 shows the significant effect of breed on the reduction in backfat thickness for DiffBFT1 and DiffBFT2 (*P*<0.05), but not on DiffBFT3 and DiffAvBFT (*P*>0.05). This implies that the reduction in backfat levels during lactation (i.e. mobilization of fat and protein reserves) is manifested more in the decrease in backfat thickness at the shoulder and midback area rather than the ham area. Figure 1 shows the reduction in backfat levels at the shoulder area (BFT1) which was significantly greater in Landrace sows (-3.54 ± 0.81 mm) than Large White sows (-1.47 ± 0.82 mm). On the other hand, the reduction in backfat levels at the midback area (BFT2) was significantly lower in Landrace sows (-1.03 ± 0.66 mm) than Large White sows (-2.79 ± 0.67 mm). This suggests that breed differences in changes in backfat thickness are more pronounced at the shoulder and midback area (and not on the ham area). Although not significantly different (*P*>0.05), the reduction in backfat levels for Landrace and Large White sows are -2.95 ± 0.72 mm and -3.73 ± 0.74 mm for BFT3,

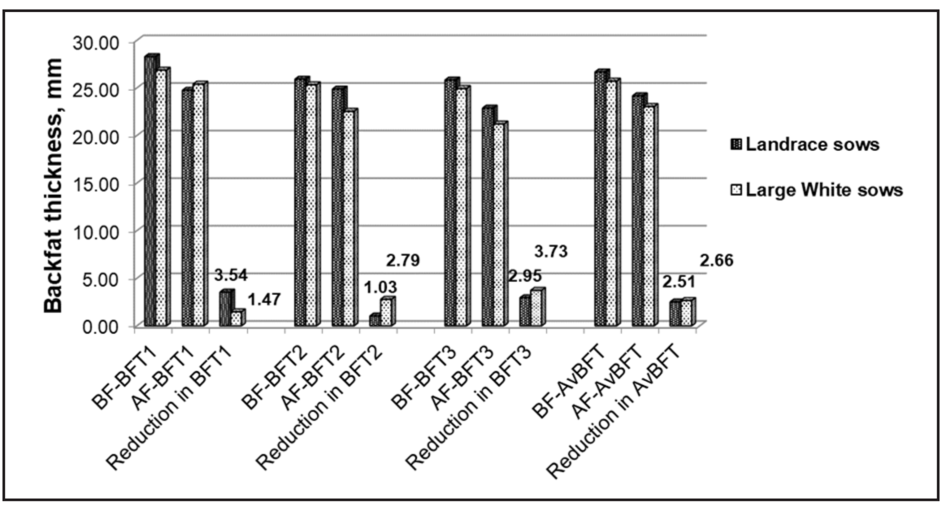

Figure 1. Reduction in backfat thickness in Landrace and Large White sows.

Table 4. Mean square F-tests for the effects of breed, month-year of farrowing on changes in backfat thickness before and after farrowing (before weaning).

Paramaters	Main Effects		Covariates			CV, %
	Breed	Mo-Yr Farro-wing	No. of Stillbirths	Litter Size at Weaning	Farrowing Interval	
Backfat thickness measured before farrowing (BF)						
BF-BFT1, shoulder area	ns	**	ns	ns	ns	29.69
BF-BFT2, mid-back area	ns	**	ns	ns	ns	25.89
BF-BFT3, ham area	ns	**	ns	ns	ns	26.82
BF-AveBFT	*	**	ns	*	ns	17.00
Backfat thickness measured after farrowing (AF), before weaning						
AF-BFT1, shoulder area	ns	**	ns	ns	ns	29.40
AF-BFT2, mid-back area	**	**	ns	ns	ns	26.96
AF-BFT3, ham area	**	**	ns	ns	*	28.67
AF-AveBFT	**	**	ns	ns	*	17.65
Difference in backfat thickness before and after farrowing (before weaning)						
DiffBFT1	*	**	ns	ns	ns	(79.46)
DiffBFT2	*	**	(P=0.05)	ns	ns	(82.81)
DiffBFT3	ns	**	ns	ns	(P=0.01)	(77.91)
DiffAvBFT	ns	**	ns	(P=0.07)	(P=0.08)	(70.56)

ns - no significant effect of independent variable (P>0.05)
*highly significant effect of independent variable (P<0.05)
**highly significant effect of independent variable (P<0.01)
Percent coefficient of variation (CV,%) in parenthesis was computed based on the absolute values of the change in backfat levels.

respectively, and -2.51 ± 0.45 mm and -2.66 ± 0.46 mm for AvBFT, respectively.

The reduction in backfat levels was significantly affected by the month-year of farrowing (P<0.01), implying the effect of the environment such as the level of feeding and feed intake in different months of the year. The level of feed intake and appetite, in turn, may have been influenced by the ambient temperature which usually peaks during the hot dry summer months from March to May and starts to decrease during cooler wet rainy months from June to September. Figure 2 shows the reduction in all backfat levels (i.e. absolute values of least square means), as affected by month-year of farrowing.

Table 4 also shows the significant covariate effect of SB on DiffBFT2 (P=0.05), LSW on DiffAvBFT (P=0.07), FInt on DiffBFT3 (P=0.01) and FInt on AvBFT (P=0.08). The

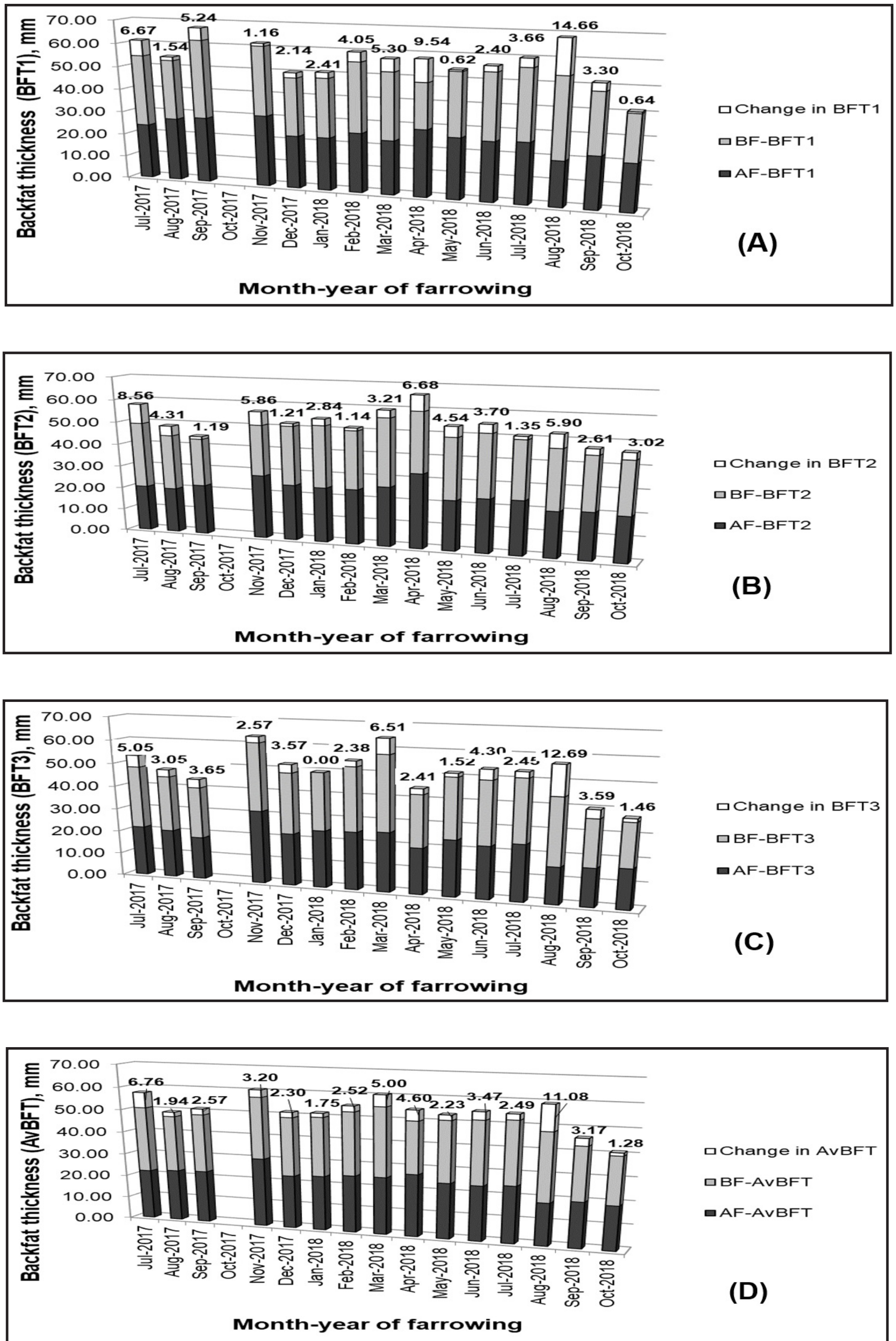

Figure 2. Reduction in backfat thickness (i.e. absolute values of least square means), as affected by month-year of farrowing: (A) Backfat thickness, shoulder area - BFT1, (B) Backfat thickness, midback area - BFT2, (C) Backfat thickness, ham area - BFT3, and (D) Average backfat thickness - AvBFT.

SB, LSW and FInt had no significant effect on DiffBFT1 (P>0.05).

In summary, when measured about 15 d before farrowing and 24 d after farrowing, sow backfat thickness decreased by 3.06 mm, 2.76 mm, 3.00 mm, and 2.94 mm at the shoulder, midback, ham area, respectively. The reduction in backfat levels (as a result of greater backfat loss during lactation than backfat gain during gestation), was positively associated with the number of stillbirths (r = +0.09 and r= +0.13 for BFT at the shoulder and midback area, respectively), but negatively associated with litter size at birth (r = -0.08 to -0.09 for BFT at midback area), and farrowing interval (r = -0.11 for BFT at midback area). The changes in backfat levels before and after farrowing were not related to litter size at birth, number of mummified piglets, piglet birth weight and weaning weight, farrowing interval, and sow productivity index.

Landrace sows had a higher reduction in backfat thickness at the shoulder area but a lower reduction in backfat thickness at the mid-back area than Large White sows. The reduction in backfat thickness varies significantly across the month-year of farrowing, perhaps due to differences in sow feed intake and appetite as influenced by the changing ambient temperature. While higher backfat losses only tended to reduce a few reproductive performance traits, it is recommended that backfat losses should be limited in the lactating sow to achieve optimal reproductive results after weaning. However, the results of the present study and their association with declining reproductive performance after weaning and subsequent reproductive cycle cannot be validated because sows were culled or moved to other facilities.

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