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Impact of phase feeding: effects on the growth performance of sows and their litter characteristics

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Abstract

A total of fourteen primiparous sows' (Landrace × Yorkshire) were used to determine the effects of two patterns of feed intake during early gestation on the growth performance and litter characteristics in sows. Daily feed intake from day 5 to 112 of gestation for parity 1 sows was 2.2 kg·d^{-1} of feed offered with the exception of seven sows who were offered 3.2 kg·d^{-1} from day 90 to 108 of gestation (TRT A) or 2.5 kg·d^{-1} (d 5 - 60) and 2 kg·d^{-1} (d 60 - 90) of feed with the exception of seven sows who were offered 3.5 kg·d^{-1} from day 90 to 108 of gestation (TRT B). The different feed intake patterns in early gestation did not have a significant effect on body weight, backfat thickness, or body condition score during, before, and after farrowing ($p > 0.05$) respectively. However, initial to d 60, backfat thickness difference was significantly improved by TRT B patterns of feed intake during early gestation. In addition, during the overall experiment, average daily feed intake was significantly enhanced for sows in the dietary TRT B group feed intake pattern ($p = 0.0001$). The fecal score during day 90 was significantly reduced ($p = 0.0132$) in sows fed with TRT B feed intake pattern. Litter size, litter survival rate, and initial weight showed no significant differences with different feed efficiency of gestating sows. In summary, the results indicate that the 2.5 kg·d^{-1} gestation intake pattern allowed gestating sows to obtain optimal performance.

Keywords: fecal score, feed intake, gestation, growth performance

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Introduction

Insufficient prenatal feeding can adversely affect both birth weight and subsequent development of progeny (Barker, 1998). The growth rate of piglets and reproduction of sows are considered to be the most important factors for the successful pigs' production. However, Changes in the diet schedule of sows during gestation can affect the growth rate of piglets (Bee, 2004; McNamara et al., 2011) as well reproductive performance of sows (Lawlor and Lynch, 2007). Sow need to consume adequate amoun--t of feed to maintain their physical condition, and to increase the milk production which will help to increase the efficiency of litters (Nichols et al., 2017; Lei et al., 2018). Beyer et al. (2007) study showed that the physical conditions of sow play an important role in early milk production and

due to this sow often get fatigued during lactation. To cope with this condition, sows needs to consume adequate amounts of feed. In Koketsu et al. (1997) noted that lactation process has been delayed due to over-feeding during the first few days of pregnancy and peak feed intake during early lactation. Furthermore, Malnutrition in pregnancy not only affects the growth and physiology of the progeny but also leads to organ weight loss. Furthermore, a sudden increase in feed intake of sow can affect the secondary muscle fibers of piglets. Therefore, it is recommended to slowly increase the daily supply of feed up to 7 - 10 days after farrowing and ad libitum was provided to avoid negligence of feed consumption during lactation (Eissen et al., 2000; Hansen et al., 2012). Everts et al. (1995) recommend that sows should be offered 2 kg diet at farrowing followed by a gradual rise of 0.5 kg of feed/day before the minimum feed intake is achieved. In addition, Thingnes et al. (2012) recommend that after 9 days of farrowing, the feed allowance was gradually increased up to 0.8 kg every 2 days and assumed that feed intake during early lactation may have an impact on the feed intake of sows in late lactation thereby, the performance of lactating sows and suckling pigs get impacted. Therefore, the present study was aimed to determine the effects of two different patterns of feed intake during early gestation on growth performance, litter characteristics in sows.

Materials and methods

The protocol of this experiment was reviewed and approved by the Animal Care and Use Committee of Dankook University (DK-2-1509) Cheonan, Republic of Korea.

This experiment was carried out at Dankook University "Experimental farm" (Gongju, Korea) for 115 days, with 14 primiparous sows [Landrace × Yorkshire] were randomly allocated to two treatments (TRT-A and TRT-B). The sows were individually housed in stalls from day 5 to 108 of gestation, which had partial slatted floors consisting of 0.80 × 1.05 m specific strips floor. During gestation sows were fed as by ad libitum feeding. Daily feed intake during the early gestation is illustrated in Fig. 1 and Fig. 2. The nutrient diets were formulated to meet or exceed the nutrition criteria (Table 1) of NRC (2012). The farrowing crate contained an air-conditioned for newborn pigs at the same time temperature of farrowing house was maintained at least 20℃ with additional ventilation generated by heat lamps. Within 24 h of birth, all piglets were treated with iron injection, ear notching, needle teeth clipping and tail docking. within 5 days of postpartum male piglets were castrated. Throughout the trail period sows were provided with free access to drinking water but the piglets did not get any creep meal.

At the beginning of the experiment, before farrowing, and after farrowing period individual sows body weight and backfat thickness were measured using real-time ultrasound instruments (Pig lot 105, SFK Technology, Herlev, Denmark) gestation and early lactation periods on day 60, 90, and 113. After farrowing litter size was recorded according to numbers of alive piglets or dead litter to calculate survival ratio. Feed intake of sows were calculated by daily deference from feed consumption and residual were measured after feeding. During gestation the consumption of feed was recorded on each pen to calculate the average daily feed intake (ADFI). Body condition score was recorded on initial, day 60, 90, 113 and after farrowing of sows. Each piglet body weight was measured at initial birth weight. To determine the survival rate, piglets were recorded to report on farrowing day. Subjective fecal score of lactating sows was recorded on d 60, 90, and 113 per pen throughout the experiment by a single blinded observer, using the following score system described by Montagne et al. (2004). In short, scores were 0 for normal, firm feces; 1 for possible slight feces; 2 indicated definitely unformed, moderately fluid feces; or 3 in case of very watery and frothy feces. A cumulative fecal score per diet and day was further assessed.

Table 1. Ingredient composition of experimental diets as-fed basis.

Items	Gestation	
	TRT A	TRT B
Corn	40.9	48.2
Wheat	5.0	5.0
Rice	5.0	5.0
Wheat bran	15.0	-
Soybean bran	1.0	-
Beet pulp	5.0	1.0
Soybean meal	12.6	25.2
Canola meal	-	-
Corngluten	-	-
DDGS (corn)	5.0	2.0
Palm meal	1.0	1.0
Soybean oil	3.0	5.0
Molasses	3.0	3.0
Limestone	1.1	1.5
MDCP	0.9	1.3
Salt	0.5	0.5
Methionine (99%, DL form)	-	0.1
Lysine (24%)	-	0.2
Threonine	-	-
Tryptophan	-	-
Vitamin premix[y]	0.5	0.5
Mineral premix[z]	0.5	0.5
Protein	13.9	16.8
Fat	5.9	7.0
Fiber	3.9	2.1
Ash	5.8	6.3
DE swine	3,040.0	3,320.0
Ca	0.75	0.95
P	0.55	0.55
Lysine	0.65	1.00

DDGS, distillers dried grains; MDCP, mono-dicalcium phosphate; DL, dithiothreitol for molecular biology; DE, digestible energy.

[y] Provided per kilogram of complete diet: Vitamin A, 12,100 IU; vitamin D3, 2,000 IU; vitamin E, 48 IU; vitamin K_3, 1.5 mg; riboflavin, 6 mg; niacin, 40 mg; d-pantothenic, 17 mg; biotin, 0.2 mg; folic acid, 2 mg; choline, 166 mg; vitami n B6, 2 mg; and vitamin B12, 28 μg.

[z] Provided per kilogram of completediet: Fe (as $FeSO_4 \cdot 7H_2O$), 90 mg; Cu (as $CuSO_4 \cdot 5H_2O$), 15 mg; Zn (as $ZnSO_4$), 50 mg; Mn (as MnO_2), 54 mg; I (as KI), 0.99 mg; and Se (as $Na_2SeO_3 \cdot 5H_2O$), 0.25 mg. [Correction added on 26 October, 2015, after first online publication: The gestation diet and lactation diet for metabolizable energy, $MJ \cdot kg^{-1}$ in the table above have been corrected from '3.20' and '3.47' to '13.05' and '14.47', respectively].

Statistical analysis

All data were statistically analyzed using the student's t-test in SAS software SAS program (SAS Inst. Inc., Cary, NC, USA). The sow and the litter represented as an experimental unit. Results are significant at $p < 0.05$ level and $p < 0.10$ was considered as trend.

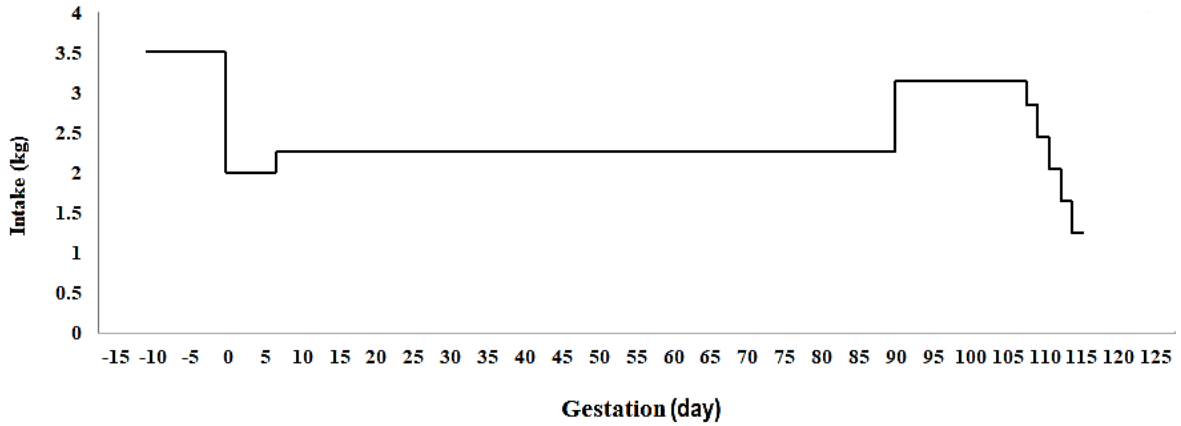

Fig. 1. Daily feed intake from day -10 to 113 of early gestation for parity 1 sows. Each sow was offered 2.2 kg·d^{-1} of feed with the exception of 7 sow who were offered 3.2 kg·d^{-1} from day 90 to 108 of gestation.

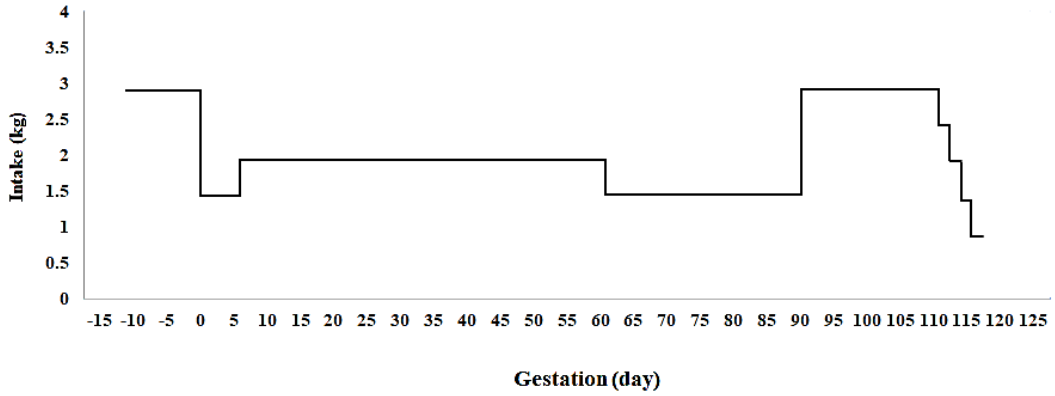

Fig. 2. Daily feed intake from day -10 to 113 of early gestation for parity 1 sows. Each sow was offered 2.5 kg·d^{-1} (d 5 - 60) and 2 kg·d^{-1} (d 60 - 90) of feed with the exception of 7 sow who were offered 3.5 kg·d^{-1} from day 90 to 108 of gestation.

Results and Discussion

Feed restriction is one of the important factors associated with the production of stereotypic behavior in gestating sows (Terlouw et al., 1991). Ad libitum feeding is very effective to minimize the stereotypic actions by gestating sows (Bergeron et al., 2000). In the present study sows allowed ad libitum access to feed during gestation, consumed feed was offered to sows. Daily feed intake during the early gestation is illustrated in Fig. 1 and Fig. 2. The importance of feeding phase during gestation has been highlighted in early research that the ideal body condition of farrowing sows was calculated through body weight (BW), backfat thickness (BFT), and body condition score (BCS) (Young et al., 2004; Foxcroft et al., 2005). Previously, Thomas et al. (2018) observed that estimates of feed efficiency during gestation can be used to determine ideal weight gain during gestation. Although there were some significant correlations observed between feed intake, BW gain, and backfat depth with litter size, these correlations were very weak and likely of little practical significance. The different feed intake patterns in early

gestation had no significant effect on sows BW, BFT, and BCS during pre-and post-farrowing ($p > 0.05$) respectively, during initial to d 60 BFT was significantly improved by TRT B patterns of feed intake (early gestation). In addition, during the overall experiment average daily feed intake was significantly enhanced in sows belongs to TRT B group ($p = 0.0001$). The fecal score was significantly reduced ($p = 0.0132$) at day 90 in TRT B group feed intake pattern (Table 2). Previously, Weldon et al. (1994) stated that total feed intake reduced during gestation (final 40 days) and lactation (28 day) had no effect in the feed intake among treatment groups. Changes in the number of meals consumed over a given time are usually known to reflect a change in appetite, whereas variations in the amount of meals consumed are assumed to be the influences of regulate satiety (Sclafani and Kirchgessner, 1986). In addition, Sureshkumar et al. (2021) reported that dietary inclusion of betaine supplementation had no significant effect of feed intake in sows. Although the number of meals was influenced by the amount of gestation feeding rather than the size of the meal, our results suggest discrepancies in appetite rather than the stage at which sows achieved satiety.

Table 2. The effect of different feeding phase on reproduction performance in early gestation sows.

Items	TRT A	TRT B	SEM	p-value
Parity	3.9	4.0	0.3662	0.6331
Number of sows	7.0	7.0	-	-
Body weight (kg)				
Initial	224.1	226.0	6.4777	0.8634
Before farrowing	270.0	269.0	6.9736	0.7742
After farrowing	244.9	245.0	6.2873	0.9150
Body weight difference	45.8	43.1	2.6753	0.2490
Body weight loss difference	25.1	24.0	1.9985	0.5070
Backfat thickness (mm)				
Initial	19.8	19.4	0.3007	0.1804
Backfat thickness, days 60	20.0	20.1	0.2407	0.6284
Backfat thickness, days 90	20.2	20.3	0.2663	0.5123
Backfat thickness, days 113	20.4	20.7	0.3288	0.2912
After farrowing	20.1	20.4	0.3486	0.3191
Backfat thickness difference				
Initial to days 60	0.2	0.7	0.2269	0.0261
days 60 to d 90	0.2	0.2	0.1740	0.7375
days 90 to d 113	0.2	0.4	0.2201	0.4286
After farrowing	-0.3	-0.3	0.1611	1.0000
Body condition score				
Initial	3.1	2.9	0.087	0.1022
Body condition score, days 60	3.1	3.1	0.0713	0.6827
Body condition score, days 90	3.0	3.1	0.056	0.3029
Body condition score, days 113	3.0	3.0	0.0429	1.0000
After farrowing	3.0	3.0	0.0429	1.0000
Average daily feed intake	2.18	2.28	0.000	0.0001
Fecal score				
Initial	2.99	2.98	0.0192	0.3643
day 60	2.98	2.96	0.0285	0.6827
day 90	2.96	2.92	0.0202	0.0132
day 113	2.95	2.92	0.0248	0.1641

Values are represented by seven sows per treatment.

SEM, standard error of means.

Fan et al. (2016) stated that farrowing sows were not provided with any feed on farrowing day, whereas the feed provision was gradually increased to 1.1 kg per day for the first 5 days after farrowing, followed by ad libitum feeding. The current study was designed to determine the effects of different feed intake patterns in early gestation performance of sows. Van der Peet-Schwering et al. (2004) reported that sows daily feed intake through ad libitum has increased from wk 2 to 6 of gestation and then decreased to wk15 of gestation. Earlier study, Tummaruk (2013) stated that reduced backfat thickness loss has helped the sows to keep the reproductive efficiency after weaning. In addition to other parameters, backfat thickness as an evidence of body condition, has been used to help feeding recommendation in gestating sows (Quiniou, 2014). Houde et al. (2010) demonstrated that backfat thickness of sows less than 17, 19 and increased than 21mm fat condition. However, in this present study, no significant effects were observed on backfat thickness during the overall experiment. Similarly, Li et al. (2015) reported that during gestation sow fed with L-arginine treatment group had a no significant effect on backfat thickness. Previously many researchers demonstrated the importance of gestation feeding strategies focused on female backfat and BW at breeding as conflicting the body condition score in an attempt to achieve ideal body condition at farrowing (Young et al., 2004; Foxcroft et al., 2005). An increased litter size response to the high gestation feed intake occurred in four of five parities. The improvement in litter size was attributed to the flushing effect from a higher energy intake initiated at the time of weaning, most probably from the carbohydrate fraction. In the present, litter size, survival rate, and initial weight were not influenced with a difference feed efficiency of gestating sows (Table 3).

In summary, the finding of this research indicated that the feed intake during early gestation could be used to assess optimal weight gain during gestation. While, there were some significant improvements observed on backfat thickness, average daily feed intake and reduced fecal score when sows fed 2.5 $kg \cdot d^{-1}$ diet during gestation. However, further research is need for various standards of dietary feed intake pattern to obtain optimal performance.

Table 3. The effect of different feeding phase of feeding during early gestation on the performance of litters.

Items	TRT A	TRT B	SEM	p-value
Number of total piglets at birth/litter	12.7	11.6	1.2914	0.3460
Number of live piglets at birth/litter	11.7	10.7	1.0889	0.3120
Survival rate at birth (%)	93.2	93.1	2.5134	0.9076
Initial piglets birth weight (kg)	1.36	1.39	0.0943	0.7434

Values are represented by seven sows per treatment.

SEM, standard error of means.

Conflict of Interests

No potential conflict of interest relevant to this article was reported.

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