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Effects of Creep Feed with Varied Energy Density Diets on Litter Performance

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ABSTRACT : This study was conducted to evaluate the effects of creep feed with different energy densities on litter performance. A total of 30 sows (Landrace×Yorkshire) and their litters were randomly assigned with 1, 2, or 3+parities into 1 of 3 treatments (10 sows). Dietary treatments were: i) CON (no creep feed), ii) LE (creep feed (DE 4,000 kcal/kg) from 5 d of age until weaning (21 d)), and iii) HE (creep feed (DE 5,000 kcal/kg) from 5 d of age until weaning). Each piglet was weighed at d 5, 10, 15, 21 (weaning), and d 7 post-weaning to determine ADG. Creep feeding reduced concentrations of epinephrine, norepinephrine, and cortisol compared with those in CON group (p<0.05). Creep feeding reduced (p<0.05) the weaning-to-oestrus interval in sows. Piglets in the HE groups evidenced greater ADG (p = 0.024) and ADFI (p = 0.001) post-weaning than those in CON treatments. Creep feeding decreased (p<0.05) the suckling time of piglet in this study. In conclusion, creep feeding increased growth and feed intake of pigs after weaning. It can decrease the oestrus interval of sows. There was no difference between providing a high energy or a low energy creep fed diet to the piglets. (**Key Words :** Creep Feed, Energy, Piglet)

INTRODUCTION

It is well suggested that creep feeding begins largely as an exploratory or social activity, and is then increasingly driven by nutrient demand as the piglets become mature and the sow's milk production declines (Pajor et al., 1991). English (1981) demonstrated that sufficient intake of creep feed during lactation may result in a more gradual transition at weaning and can reduce the occurrence of post-weaning disorders. Previously, study has suggest that piglets provided access to a high-complexity diet consumed more solid food than piglets fed on control diets pre-weaning (Fraser et al., 1994). Pajor et al. (2002) found a greater consumption in pigs fed the high complexity diet (high protein and fat) compared with a standard diet. Sulabo et al. (2008) also compared a simple creep diet with a complex creep diet, and observed that litters fed the complex creep diet consumed twice the total and daily creep feed intake of litters fed the simple creep diet. Therefore, creep diet composition could be a factor affecting piglet during lactation.

The reproductive performance of sow is known to be influenced by the metabolic state of the sow and the suckling stimulus of the piglets (Foxcroft, 1992). A variety of factors have been proposed to influence sow behavior, including environmental quality, food quality, and piglet behavior (Hauser and Fairbanks, 1988). Therefore, effects of creep feed on sow performance were investigated in this study, in consideration of its results on piglet behavior and nursing-associated vocalization.

Collectively, the objectives of this study were to determine the effects of creep feed with different energy density on the pre- and post-weaning growth performance of piglets.

MATERIALS AND METHODS

The experimental protocols employed in this study were approved by the Animal Care and Use Committee of Dankook University.

Animals and housing

A total of 30 sows (Landrace×Yorkshire) and their litters were used in this study. Sows and their offspring were assigned randomly to 1 of 3 creep feeding groups, with parities of 1, 2, or 3+. At d 107 of gestation, sows were moved to farrowing crates in an environmentally regulated farrowing house. The mean parity of the sows was 2.6±0.4.

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Sows were fed on a commercial gestation (2.5 kg) and lactation feed (7 kg) (Table 1), divided into 2 daily meals. Water was provided on an *ad libitum* basis. Dietary treatments were: i) CON (no creep feeding), ii), HE (high energy creep feed (DE 5,000 kcal/kg) from 5 d of age until weaning (21 d)), and iii) LE (low energy creep feed (DE 4,000 kcal/kg) from 5 d of age until weaning (21 d)) (Table 2). Sows and their offspring were individually housed in farrowing crates (2.4×1.8 m), which were constructed of 1.95 m^2 of solid floor and 2.37 m^2 of slatted floor. This space included a piglet nest equipped with an infrared lamp (500 W), a piglet drinking nipple, and a piglet feeder placed on a dimpled rubber matting to collect any spillage from the feed. The temperature in the farrowing house was maintained at a minimum of 20°C. Drinking nipples provided water *ad libitum* to the piglets. Litter size at birth varied from 7 to 14 piglets, and was standardized to 10 piglets per litter within 2 d after birth by cross-fostering within each batch. All piglets received injections of 1 ml of iron dextran and the males were castrated 2 d after birth. At weaning, the sows were relocated to a mating room, with the piglets remaining in the pen for 1 wk (weanling pigs). Piglets were provided with the creep feed until the end of the current study.

Table 1. Sow diet composition (as-fed basis)

Items	Gestation diet	Lactation diet
Ingredients (%)		
Corn	57.10	51.12
Soybean meal, 46% CP	10.65	24.61
Wheat bran	12.00	4.00
Rapeseed meal	3.70	2.50
Rice bran	6.00	5.00
Tallow	3.59	6.05
Molasses	3.60	3.50
Dicalcium phosphate	1.52	1.64
Limestone	0.99	0.76
Salt	0.60	0.50
L-lysine HCl, 98%	0.05	0.12
Vitamin premix[1]	0.10	0.10
Mineral premix[2]	0.10	0.10
Calculated composition		
ME (MJ/kg)	3.19	3.44
CP (%)	13.10	17.10
Crude fat (%)	6.89	9.10
Lys (%)	0.65	1.00
Ca (%)	0.87	0.85
P (%)	0.76	0.73

[1] Provided per kilogram of complete diet: vitamin A, 10,000 IU; vitamin D_3, 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; vitamin B_6, 2 mg; and vitamin B_{12}, 28 μg.

[2] Provided per kilogram of complete diet: Fe (as $FeSO_4·7H_2O$), 90 mg; Cu (as $CuSO_4·5H_2O$), 15 mg; Zn (as $ZnSO_4$), 50 mg; Mn (as MnO_2), 54 mg; I (as KI), 0.99 mg; and Se (as $Na_2SeO_3·5H_2O$), 0.25 mg.

Sampling and measurements

Individual piglet BW was assessed on d 0, 5, 10, 15 and 21(weaning), and 7 d after weaning to calculate ADG, ADFI, and G:F. Creep feed residuals and general health was checked daily. The backfat thickness of the sows (6 cm off the midline at the 10th rib) was measured within a few hours after farrowing and on the day of weaning (21 d) using a real-time ultrasound instrument (Piglot 105, SFK Technology, Herlev, Denmark). To assess blood characteristics, the sows were bled via puncture of the vena cava before weaning (21 d) to determine the concentrations of epinephrine, norepinephrine, and cortisol. Blood samples

Table 2. Creep feed composition (as-fed basis)

Items	High	Low
Ingredients (%)		
Digestible corn	2.75	22.40
Soybean meal	8.00	8.00
Soy oil	4.50	4.50
Whey	21.59	24.16
Fish meal	2.50	2.50
Fermented soybean meal	10.00	10.00
Coconut oil	21.59	4.17
Lactose	10.00	8.00
Plasma powder	4.00	4.00
Sugar	3.05	3.05
Isolated soybean protein	9.08	6.15
Dicalcium phosphate	1.25	1.25
DL-methionine	0.39	0.38
L-lysine·HCl	0.33	0.41
L-threonine, 98%	0.12	0.13
Zinc oxide	0.30	0.30
Choline Cl, 50%	0.10	0.10
Vitamin premix[1]	0.10	0.10
Mineral premix[2]	0.18	0.18
Probiotics	0.12	0.12
Antibiotics, 9.75%	0.10	0.10
Analysis composition (%)		
DE, kcal/kg	5,000	4,000
CP	22.00	22.00
Lys	1.74	1.74
Met	0.70	0.70
Ca	0.80	0.81
P	0.74	1.00

[1] Provided per kilogram of complete diet: vitamin A, 1,298 IU; vitamin D_3, 260 IU; vitamin E, 2.4 IU; menadione (sodium bisulfate form), 143 μg; vitamin B_{12}, 3.3 μg; riboflavin, 880 μg; d-pantothenic acid, 2.6 mg; niacin, 4.4 mg.

[2] Provided per kilogram of complete diet: Ca, 849 mg; Zn, 150 mg; Fe, 132 mg; Mn, 20 mg; Cu, 12 mg; Se, 0.31 mg; I, 0.79 mg.

were collected into non-heparinized tubes (Becton Dickinson Vacutainer Systems, Franklin Lakes, NJ, USA) to obtain serum, which was separated via 30 min of centrifugation at 4,000×*g* at 4°C, the aliquot was stored at -4°C. The serum was removed and stored at -20°C until being used in cortisol analysis. Serum concentrations of cortisol were determined with a standardized solid phase radioimmunoassay kit (Diagnostic Products Corporation, Los Angeles, CA). Norepinephrine (NE) and epinephrine (EPI) were assayed using an ion-exchange purification procedure followed by liquid chromatography with electrochemical detection, as described previously by Hay and Mormède (1997). In brief, the samples were loaded onto cationic columns, and the catecholamines were eluted with boric acid. The eluates were assayed via HPLC with electrochemical detection with an oxidizing potential of + 0.65 V. The intra- and interassay CV were 7.0% and 7.1% for NE and 6.5% and 11.6% for EPI, respectively.

Detection of estrus was conducted twice per day from weaning onward, at 0830 and 1600 every day. A sow was considered to be in estrus when exhibiting a standing response induced by a back pressure test when in the presence of a boar.

Statistical analyses

All data in this experiment were analyzed in accordance with a completely randomized design using the GLM procedure (SAS Inst. Inc., Cary, NC). The individual sow or litter of piglets was used as the experimental unit. For the blood profile data, the initial data was used as a covariate. Differences among treatment means were determined via Duncan's multiple range test, and a probability level of $p<0.05$ was regarded as statistically significant.

RESULTS

Effect of creep feed on piglet performance

No differences were observed among the treatment groups on preweaning growth performance (Table 3). The greater ADG and ADFI ($p<0.05$) was noted in HE treatment postweaning compared with the CON treatment. No difference ($p>0.05$) was observed on piglet performance between different energy density diet.

Effect of creep feed on sow

In this study, creep feed reduced ($p<0.05$) the weaning-to-oestrus interval in sows (Table 4). No difference was observed on the backfat loss during lactation in this study. Creep feeding ($p<0.05$) in piglets increased the concentrations of epinephrine, norepinephrine, and cortisol in comparison to the piglets not subjected to creep feeding.

DISCUSSION

Previously, Sohn and Maxwell (1995) reported that creep feeding increased ADG and feed conversion values

Table 3. Effect of creep feed with different energy density on growth performance and diarrhea score in weaning pigs

Items[1]	CON	HE	LE	SE[2]	p-value
Initial BW (kg)	1.21	1.18	1.15	0.120	
5 d BW (kg)	2.10	2.09	2.10	0.215	0.552
10 d BW (kg)	3.15	3.24	3.25	0.324	0.438
15 d BW (kg)	4.37	4.46	4.58	0.381	0.224
Pig weaned BW (kg)	5.78	5.83	6.10	0.468	0.216
Post-weaning BW (kg)	7.131	7.419	7.57	0.435	0.125
ADG (kg)					
0 to 5 d	0.177	0.182	0.190	0.016	0.354
5 to 10 d	0.210	0.230	0.230	0.013	0.425
10 to 15 d	0.243	0.244	0.266	0.020	0.387
15 to 21 d	0.235	0.229	0.254	0.028	0.271
overall	0.217	0.222	0.236	0.013	0.138
21 to 28 d	0.193[b]	0.227[a]	0.210[ab]	0.015	0.024
Feed intake					
5-10 d (g/d)	0	7.26	8.11		
10-15 d (g/d)	0	13.63	16.31		
15-21 d (g/d)	0	25.46	23.82		
Total 5-21 d (g)	0	257.21	265.02		
21-28 d/day	205[b]	243.1[a]	251.4[a]	18.24	0.001

[1] CON = No creep feeding; HE = High energy creep feed from 5 of age until weaning (21 d); LE = Creep feed from 5 d of age until weaning (21 d). Values represent the mean of litter from 10 sows per treatment.

[2] Pooled standard error. [a,b] Means in the same row with different superscripts differ ($p<0.05$).

Table 4. Effect of creep feed with different energy density on blood characteristics and backfat in sow

Items[1]	CON	HE	LE	SE[2]	p-value
Oestrus interval[3] (d)	5.50[a]	4.87[b]	4.98[b]	0.243	0.015
Epinephrine[4] (pg/ml)	30.24[a]	16.11[b]	22.13[ab]	3.550	0.005
Norepinephrine[4] (pg/ml)	184.56[a]	101.74[b]	139.68[ab]	20.726	0.021
Cortisol[4] (μg/dl)	540.40[a]	350.20[b]	379.20[b]	72.949	0.002
Backfat (mm)					
Parturition	25.4	26.0	25.75	2.22	0.485
Weaning	21.1	23.2	22.6	2.21	0.235
Difference	4.3	2.8	3.15	1.02	0.152

[1] CON = No creep feeding; HE = High energy creep feed from 5 of age until weaning (21 d); LE = Creep feed from 5 d of age until weaning (21 d). Values represent the mean of 10 sows per treatment. Parity of sow for CON, HE and LE treatments were 2.7, 2.6 and 2.4, respectively.

[2] Pooled standard error. [3] Value represent the mean of 10 sows per treatment. [4] Blood samples were collected before weaning (21 d)

[a,b] Means in the same row with different superscripts differ ($p<0.05$).

compared with non-creep-fed animals, and suggested that this was likely attributable to the ingestion of solid food during lactation, which stimulates acid production (Cranwell et al., 1976), or speeds the induction of amylase and protease enzymes (De Passille et al., 1989). In this study, greater ADG values were observed only during the first wk post-weaning in HE treatment, which to some extent suggested that the effects of creep feeding are clearer post-weaning than pre-weaning. These results are consistent with Schoenherr and Pollmann (1993), who suggested that creep feeding improved the post-weaning performance of young piglets. The reason is likely to be the development of oral tolerance to a solid diet in creep-fed pigs, which eases the transition from milk to solid feed during weaning. Moreover, it is well accepted that that high-complexity diet pre-weaning could increase the feed intake, weight gains and feed conversion efficiency post-weaning compared with the lower complexity diets (Fraser et al., 1994; Pajor et al., 2002). Sulabo et al. (2008) also suggested that a complex creep diet consumed twice the daily creep feed intake of litters fed the simple creep diet. Therefore, we hypothesized the different nutrient may results in different performance in piglet. However unfortunately, our results suggested that there were no difference between the high energy and low energy density in the current study. Thus it could be concluded form the current study that different energy density could not be a factor to affect the creep feed effect in piglets.

Generally, social stress can cause deteriorations of reproductive functions in humans and farm animals because of its activity on the hypothalamic-pituitary-adrenal axis and the sympathetic-adrenal-medullary axis, which may induce an elevation of catecholamines in the peripheral blood (Axelrod and Reisine, 1984; Ehrhart-Bornstein and Borstein, 2008). Study has demonstrated the relationship between acute environmental and psychological challenges in farm animals and the levels of these hormones (Dantzer and Mormède, 1983). Becker et al. (1985) and Smulders et al. (2006) also reported that increased cortisol secretion and higher basal levels of NE and EPI is a valid indicator of stress in pigs. In this study, creep feeding resulted in reductions in the concentrations of cortisol, epinephrine, and norepinephrine in sows, which could be considered a reflection of the reduced stressful effects of the suckling stimulus and nutrient loss during lactation. It is previously demonstrated that creep feed may cause piglets to consume more solid food and hence vocalize less when nursing frequency declines (Pajor et al., 2002), which weakens the sow's responses to such calls (Weary et al., 1996). Tsuma et al. (1995) have noted that suckling and weaning induced increases in the concentrations of peripheral plasma cortisol and endorphins. Kuller et al. (2004) also suggested that creep feed intake decreased suckling stimulate during lactation. Therefore, the reduction in the concentration of cortisol, epinephrine, and norepinephrine may be attributed to decreased suckling stimulus resulted from higher creep feed consumption in this study. However, to the best of our knowledge, this is the first study conducted to evaluate the effect of creep feeding on sows. There are no available studies with results that would allow for a clear comparison to the results of this study; therefore, further study will clearly be required to determine with more accuracy the effects of piglet stimulation on sows.

In this study, the oestrus interval were decreased by the creep feed diet, which to some extent suggested that the reproductive performance of sow is affected by piglet. It is well known that cortisol and catecholamines may exert some effect on reproduction performance by influencing the excretion of hormones. Turner et al. (1999a, b) reported previously that sustained elevations of plasma cortisol concentration impaired the LH surge, oestrus, and ovulation in female pigs, and inhibited the secretion of LH in ovariectomized gilts. Dobson and Smith (2000) and Foxcroft (1992) had documented that stress (suckling) stimulated the adrenal axis and, in severe cases, inhibits LH secretion, which ultimately lead to an-ovulation and infertility. Therefore, the reason for the decreased estrus interval could be: i); the decreased nutrient loss (milk) of sows because of the reduced suckling times of piglets. ii); the different cortisol and catecholamines in sows because of the different suckling stimulus of the piglets (Foxcroft, 1992). However, to the best of our knowledge, studies concerning the effects of creep feeding on sow performance are somewhat limited, and no comparisons could be made to the results of this study. Further studies are required to investigate the effects of creep feeding in sows.

CONCLUSION

In conclusion, creep feeding increased growth and feed intake of pigs after weaning. It can decrease the oestrus interval of sows. There were no difference between providing high energy and low density creep fed diet to the piglet and sows.

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