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**Non-ruminants**

# Creep feeding improves growth performance of suckling piglets

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**ABSTRACT** - The present study evaluated the optimal duration of creep feeding that improves the growth performance and fecal score of piglets and the performance and estrus interval of sows. Sixteen sows (Yorkshire × Landrace) and their litters were used in this 24-day trial. Dietary treatments were: Treatment 1, in which creep feed was not provided; treatment 2, in which creep feed was provided at the 7th day of life (day 7 to weaning); treatment 3, in which creep feed was provided at the 14th day of life (day 14 to weaning); and treatment 4, in which creep feed was provided at the 21st day of life (day 21 to weaning). There was no difference in body weight or loss, backfat thickness or loss, or estrus interval among treatments in the sows. Piglets in treatment 2 had higher body weight (BW) than pigs of treatments 1, 3, and 4. In addition, piglets in treatment 3 had higher BW than those of treatments 1 and 4. From birth to weaning, piglets of treatments 2 and 3 had higher average daily gain than those of treatments 1 and 4. There was no difference in fecal score of piglets among treatments. Piglets fed creep feed initiated from the first week have higher BW and average daily gain at weaning compared with those initiated from the second and third weeks, indicating that a longer duration of creep feeding improves the growth performance of piglets.

Key Words: creep feeding, growth performance, sow, suckling piglets

## Introduction

The birth and weaning weights are critically important in the life of pigs because the weight of piglets at birth and weaning determines their post-weaning performance and the time needed to reach market weight (Mahan, 1993). Many researchers have tried to increase pig weight during pre-weaning by using a sow feeding program during the lactation period (Kim et al., 2008; Plante et al., 2011; Walsh et al., 2012; Sun et al., 2015). In addition to sow feeding programs during lactation, piglet feeding programs such as milk replacers and creep feed have been used to increase weight during pre-weaning (Yan et al., 2011a, 2011b, 2011c).

Creep feed has been used to fill the gap between the increasing nutrient requirements of suckling pigs and the nutrients supplied by the lactating sow and to adapt feedstuffs after weaning. It has been reported that creep feeding improves the post-weaning growth performance of piglets (Pajor et al., 1991; Yan et al., 2011b). In addition, creep feeding influences reproductive performance of piglets, nutritional load, body weight (BW), as well as the weaning-to-estrus interval of lactating sows (Foxcroft, 1992).

The duration of creep feeding is important for the performance of piglets and sows (Klindt, 2003; Sulabo et al., 2010). It has been reported that creep feeding two weeks before weaning resulted in greater pre-weaning daily gains than did creep feeding two days before weaning in piglets (Klindt, 2003). However, in another report, longer durations of creep feeding increased feed intake, but did not affect growth performance during pre-weaning (Sulabo et al., 2010). There is a limited amount of evidence on the effect of the optimal duration of creep feeding on the growth performance, fecal score of piglets, performance, and estrus interval of lactating sows. Thus, in the present study, we evaluated the optimal duration of creep feeding in the improvement of growth performance and fecal score of piglets, as well as the performance and estrus interval of sows.

## Material and Methods

The animal care and protocol used in this study were approved by the Animal Care and Use Committee (ACUCDU1302406).

Sixteen sows (Yorkshire × Landrace) and their litters were used in this 24-day trial. Sows were assigned randomly to one of four creep feeding groups, with average parities of

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3.2±0.5. At day 107 of gestation, the sows were moved to farrowing crates in an environmentally regulated farrowing house. Dietary treatment and feed were as follows: treatment 1, in which creep feed was not provided; treatment 2, in which creep feed was provided at the 7th day of life (day 7 to weaning); treatment 3, in which creep feed was provided at the 14th day of life (day 14 to weaning); and treatment 4, in which creep feed was provided at the 21st day of life (day 21 to weaning). Sows were fed a lactation feed program that increased to 7 kg and the weaning of piglets occurred at day 24 (Table 1).

Sows and their offspring were individually housed in farrowing crates (2.4 × 1.8 m) that were constructed with 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 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 both sows and the piglets. All piglets received injections of 1 mL of iron dextran and the males were castrated two days after birth. At weaning, the sows were relocated to a mating room, with the piglets remaining in the pen for three days; the number of weanling piglets was recorded.

Individual piglet BW was obtained on days 0, 7, 14, 21, and 24 at weaning, and on days 7, 14, 21, and 24 after birth to calculate the average daily gain (ADG). Creep feed residuals and general health was checked daily. Sow body weights were checked within a few hours after farrowing and on the day of weaning, after which the backfat thickness of the sows (6 cm off the midline at the 10th rib) was measured using a real-time ultrasound instrument (Herlev, Denmark).

Fecal score in piglets was observed and recorded three times per day throughout the study. To assess the fecal score, feces from each pig was scored by estimating the moisture content (Hart and Dobb, 1988). In brief, the scores were as follows: 1, hard and dry pellet; 2, firmly formed stool; 3, soft and moist stool that retains shape; 4, soft and unformed stool that assumes the shape of the container; and 5, watery liquid that can be poured. A cumulative fecal score per diet and day was then calculated (Montagne et al., 2004). Fecal scores of piglets were recorded at days 7, 14, 21, and at weaning.

Table 1 - Composition of experimental diets (as-fed basis)

| Diet for sows | | Diet for piglets | |
|---|---|---|---|
| Ingredient (%) | | Ingredient (%) | |
| Corn | 51.00 | Corn | 22.62 |
| Soybean meal (48% CP) | 26.73 | Soybean meal (48% CP) | 8.00 |
| Wheat bran | 1.00 | Soy oil | 4.50 |
| Rice bran | 5.00 | Whey | 24.16 |
| Rapeseed meal (43% CP) | 3.50 | Fish meal | 2.50 |
| Tallow | 6.05 | Fermented soybean meal | 10.00 |
| Molasses | 3.50 | Coconut oil | 4.17 |
| Dicalcium phosphate | 1.64 | Lactose | 8.00 |
| Limestone | 0.76 | Plasma powder | 4.00 |
| Salt | 0.50 | Sugar | 3.05 |
| L-lysine-HCl (78%) | 0.12 | Isolated soybean protein | 6.15 |
| Vitamin[1] | 0.10 | Dicalcium phosphate | 1.25 |
| Mineral[2] | 0.10 | DL-methionine | 0.38 |
| Total | 100 | L-lysine•HCl (78%) | 0.41 |
| | | Threonine (98%) | 0.13 |
| Calculated composition (%) | | Zinc oxide | 0.30 |
| Metabolizable energy (kcal/kg) | 3,456 | Choline Cl (50%) | 0.10 |
| Crude protein | 18.34 | Vitamin[1] | 0.10 |
| Crude fat | 9.16 | Mineral[2] | 0.18 |
| Lysine | 1.08 | Total | 100.00 |
| Calcium | 1.06 | | |
| Phosphorus | 0.73 | Calculated composition (%) | |
| | | Digestible energy (kcal/kg) | 4,000 |
| | | Crude protein | 22.00 |
| | | Lysine | 1.74 |
| | | Methionine | 0.70 |
| | | Calcium | 0.81 |
| | | Phosphorus | 1.00 |

CP - crude protein.
[1] Provided per kg of complete diet: vitamin A, 11,025 IU; vitamin D3, 1,103 IU; vitamin E, 44 IU; vitamin K, 4.4 mg; riboflavin, 8.3 mg; niacin, 50 mg; thiamine, 4 mg; pantothenic acid, 29 mg; choline, 166 mg; and vitamin B12, 33 µg.
[2] Provided per kg of complete diet: Cu, 12 mg; Zn, 85 mg; Mn, 8 mg; I, 0.28 mg; and Se, 0.15 mg.

Detection of estrus was conducted twice per day from weaning onward. A sow was considered in estrus when it exhibited a standing response induced by a backpressure test in the presence of a boar.

All data in this experiment were analyzed in accordance with a completely randomized design using the GLM procedure of SAS (Statistical Analysis System, version 9.4). The individual sow or litter of piglets was used as the experimental unit. Differences among treatment means were determined via Duncan's multiple range tests regarded as significant at a probability level of $P<0.05$.

## Results

There was no difference in BW or BW loss, backfat thickness or backfat loss, or estrus interval of sows among treatments ($P>0.05$; Table 2). No difference was observed in BW initially and at one week ($P>0.05$; Figure 1). Piglets in treatment 2 had higher BW than those in treatments 1, 3, and 4 at the second week ($P<0.05$). At the third week and weaning, piglets in treatment 3 had higher BW than those in treatments 1 and 4; piglets in treatment 2 had higher BW than pigs in treatments 1, 3, and 4 ($P<0.05$). No difference was observed in ADG at the first week ($P>0.05$). Piglets in treatment 2 had higher ADG than those in treatments 1, 3, and 4 at the second week ($P<0.05$). Diets of treatments 2 and 3 resulted in higher ADG than treatments 1 and 4 at the third week ($P<0.05$). At weaning, piglets in treatments 2, 3, and 4 had higher ADG than those in treatment 1 ($P<0.05$). From birth to weaning, piglets in treatments 2 and 3 had higher ADG than those in treatments 1 and 4 ($P<0.05$). There were no differences in birth and weaning number, still birth and piglet survival rate, or fecal score of piglets among treatments (Table 3).

Table 2 - Effects of different initiation of creep feeding on growth performance of sows

| Item | Treatment[1] | | | | SEM |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| Body weight (kg) | | | | | |
| Before farrowing | 224.35 | 221.70 | 236.53 | 243.03 | 8.108 |
| After farrowing | 197.68 | 201.15 | 217.93 | 213.25 | 8.723 |
| After weaning | 175.65 | 177.33 | 195.05 | 185.90 | 10.077 |
| Body weight loss (kg) | | | | | |
| After farrowing | 26.68 | 20.55 | 18.60 | 29.78 | 3.422 |
| After weaning | 22.03 | 23.83 | 22.88 | 27.35 | 2.034 |
| Average daily feed intake (kg) | | | | | |
| Farrowing | 1.07 | 0.96 | 1.02 | 1.06 | 0.154 |
| Farrowing to weaning | 6.86 | 6.84 | 6.82 | 6.89 | 0.036 |
| Backfat thickness (mm) | | | | | |
| Before farrowing | 20.92 | 17.17 | 17.34 | 18.92 | 2.237 |
| After farrowing | 18.42 | 16.67 | 16.66 | 18.33 | 1.068 |
| After weaning | 11.75 | 11.84 | 13.08 | 12.83 | 0.802 |
| Backfat loss (mm) | | | | | |
| After weaning | 6.67 | 4.83 | 3.58 | 5.50 | 0.946 |
| Estrus interval (days) | 4.75 | 4.50 | 4.50 | 4.75 | 0.270 |

SEM - standard error of mean.
[1] Treatment 1: creep feed was not provided; treatment 2: creep feed was provided from seven days to weaning; treatment 3: creep feed was provided from 14 days to weaning; treatment 4: creep feed was provided from 21 days to weaning.

## Discussion

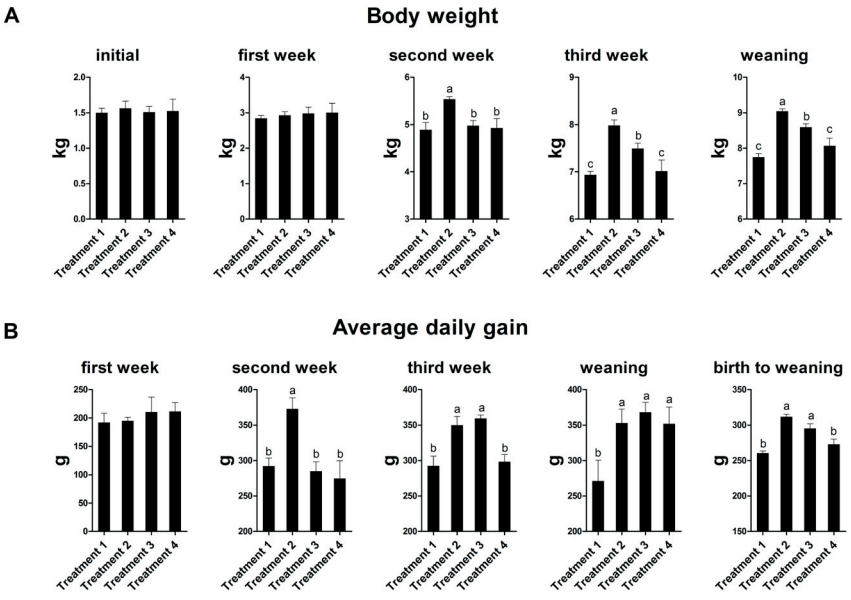
Weaning weight is important for determining post-weaning performance, such as weight at the final age and yield of marketable pork (Mahan, 1993). A number of studies have been performed to improve the weight of piglets at weaning, focusing on nutrition during gestation and gestation of sows and suckling piglets (Yan et al., 2011a, 2011b, 2011c). Focusing on piglet nutrition, Heo et al. (1999) demonstrated that a milk replacer feeding system utilized in the early suckling period can maximize pig growth performance and that ADG, average daily feed intake, and gain-to-feed ratio were affected by different ambient temperatures within milk replacer-fed pigs. In the present study, we focused on the nutrition of suckling piglets to improve growth performance from birth to weaning by using creep feeding.

It is known that creep feeding can improve growth performance during the suckling period by filling the gap between the increasing nutrient requirement of suckling pigs and the nutrients supplied by the lactating sow; it has also been used to adapt feedstuffs after weaning of suckling piglets (Pajor et al., 1991; Sulabo et al., 2010; Yan et al., 2011a, 2011b, 2011c). A number of reports has focused

Table 3 - Effects of different initiation of creep feeding on birth and weaning number, still birth and piglet survival rate, and fecal score of piglets

| Item | Treatment[1] | | | | SEM |
|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | |
| Birth (n) | 11.75 | 10.25 | 10.5 | 12.25 | 1.11 |
| Weaning (n) | 10.75 | 9.5 | 9.75 | 10.5 | 1.19 |
| Still birth (%) | 0 | 0 | 1 | 0.5 | 0.38 |
| Piglet survival (%) | 92.72 | 92.22 | 89.58 | 87.09 | 6.48 |
| Total creep feed intake (kg) | | 7.49a | 4.82b | 1.56c | 0.67 |
| Fecal score[2] | | | | | |
| 1st week | 4.3 | 4.9 | 4.1 | 4.4 | 0.66 |
| 2nd week | 3 | 3 | 3 | 3 | 0.00 |
| 3rd week | 3 | 3 | 3 | 3 | 0.00 |
| Weaning | 3 | 3 | 3 | 3 | 0.00 |

SEM - standard error of mean.
[1] Treatment 1: creep feed was not provided; treatment 2: creep feed was provided from seven days to weaning; treatment 3: creep feed was provided from 14 days to weaning; treatment 4: creep feed was provided from 21 days to weaning.
[2] The scores were as follows: 1, hard and dry pellet; 2, firmly formed stool; 3, soft and moist stool that retains shape; 4, soft and unformed stool that assumes the shape of the container; and 5, watery liquid that can be poured.
a,b,c - Within a row, means with different letters differ ($P<0.05$).




A - body weight; B - average daily gain.
Treatment 1: creep feed was not provided; treatment 2: creep feed was provided from 7 days to weaning; treatment 3: creep feed was provided from 14 days to weaning; treatment 4: creep feed was provided from 21 days to weaning.
Differences among treatment means were determined using the Duncan's multiple range tests. Statements of statistical significance were based on $P<0.05$.
Error bars indicate the standard error of analyses (n = 40).
a,b,c - Within a row, means with different letters differ ($P<0.05$).

Figure 1 - Effect of creep feeding on growth performance.

on the duration of creep feeding to improve the growth performance of suckling piglets (Klindt, 2003; Sulabo et al., 2010; Yan et al., 2011c). Klindt (2003) demonstrated that creep feeding two weeks before weaning resulted in greater pre-weaning daily gains of piglets compared with creep feeding two days before weaning. Sulabo et al. (2010) demonstrated that longer durations of creep feeding increased feed intake, but did not show positive effects on growth performance during suckling. In another report, varying the duration of creep feeding had no effect on the growth performance of pre- and post-weaning piglets (Yan et al., 2011c). From these reports, we hypothesized that the duration of creep feeding is important for improving the growth performance of suckling piglets. In addition, there is a limited amount of evidence regarding the effect of the optimal initiation of creep feeding on the growth performance of suckling piglets. Thus, in the present study, we evaluated the optimal initiation of creep feeding to improve the growth performance and fecal score of piglets, as well as the performance and estrus interval of sows. In the present study, suckling piglets that were fed creep feed, initially provided seven days after birth, had higher BW and ADG than those fed 14 and 21 days after birth. We suggest that the early initiation of creep feeding can improve the growth performance of sucking piglets at weaning.

In this study, varying the initiation of creep feeding had no effect on growth performance, BW, average daily feed intake, backfat thickness and backfat loss, or estrus interval in sows. Inconsistent with the present study, Foxcroft (1992) reported that creep feeding in piglets influences the reproductive performance, nutritional load, BW, and weaning-to-estrus interval of lactating sows. In addition, creep feeding in sows significantly reduced their weaning-to-estrus interval and concentrations of cortisol, epinephrine, and norepinephrine and did not affect their nursing, eating, standing times, backfat loss, or BW loss (Yan et al., 2011c). However, Yan et al. (2011a) reported that creep feeding made no difference in blood characteristics, backfat loss, estrus, or behavior of sows. To the best of our knowledge, studies on the effects of creep feeding on sow performance are somewhat inconsistent. Therefore, further study is required to clarify the effects of creep feeding on piglets and sows because there are no studies that can be compared to the present study.

In our previous study, creep feeding was initiated on days 5, 10, and 15 from birth to weaning (21 days) and varying the duration of creep feed had no effect on pre-weaning piglet growth performance or on suckling, sleeping, fighting, and mortality. In addition, creep feeding initiated from days 5 and 10 reduced the post-weaning diarrhea score. However, in disagreement with that study,

creep feeding initiated on days 7 and 14 in the present study had positive effects on pre-weaning growth performance. Indeed, the effect of creep feeding on the pre-weaning growth performance of suckling pigs is inconsistent in previous studies (Klindt 2003; Sulabo et al., 2010; Yan et al., 2011b). Klindt (2003) suggested that creep feeding from five days of age resulted in greater pre-weaning daily gain than creep feeding from two days prior to weaning (17 days). However, Sulabo et al. (2010) demonstrated that varying creep feeding duration had no effect on pre-weaning gain and weaning weight. Even in our previous studies, different energy and duration of creep feeding did not affect the pre-weaning growth performance (Yan et al., 2011a, 2011b). The reason for this significant difference between our present and previous studies is unknown; it may have occurred due to seasonal effects and birth weight differences. The previous study evaluating different energy and durations of creep feeding was performed after farrowing in the summer, whereas the present study was performed in the winter. It is well accepted that the farrowing season is one of the most important environmental factors directly affecting reproductive performance, such as litter size, piglet survival after birth, and piglet birth weight (Peltoniemi and Virolainen, 2006; Knecht et al., 2015). In the present study, the BW of piglets was 1.52±0.11 kg, which is higher than the 1.18±0.12 kg of the previous study. It has been reported that birth weight affects weight, growth performance, backfat, and *longissimus* muscle area from pre-weaning to slaughter (Skorjanc et al., 2007; Fix et al., 2010). Skorjanc et al. (2007) reported that high-birth-weight piglets had higher BW at weaning and low-birth-weight piglets had 17 to 22% lower ADG when compared with heavy and intermediate-birth-weight piglets. However, it is not sufficient to explain the difference in results for creep feeding in our studies. In addition to difference in birth weight according to season, the effect of creep feeding may be affected by many factors such as condition, parity, and the nutritional condition of sows and the birth weight of their litters and piglets. Thus, further investigation is necessary to evaluate the effect of creep feeding, considering the many factors that affect it.

## Conclusions

Suckling piglets fed creep feed, initially provided seven days after birth, have higher body weight and average daily gain than those fed 14 and 21 days after birth. We suggest that a longer duration of creep feeding can improve the growth performance of sucking piglets at weaning.

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