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Creep Feed: Effects of Feed Flavor Supplementation on Pre- and Post-weaning Performance and Behavior of Piglet and Sow

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ABSTRACT : This study was conducted to evaluate the effects of flavor supplementation on pre- and post-weaning performance and behavior of piglets and sows. A total of 30 sows (Landrace×Yorkshire) and their litters were employed in this study. Sows were randomly assigned to 3 dietary treatments (10 replications per treatment). Dietary treatments included: i) CON, basal diet; ii) TRT1, CON+0.1% vanilla supplement; iii) TRT2, CON+0.1% cheese supplement. The behavior of sows (nursery, eating and standing) and piglets (eating, sleeping and fighting) in each treatment was monitored throughout experiment. Each piglet was weighted at 5, 10, 15 and 21 d after birth to evaluate the average daily gain. Sows and piglets were bled on the weaning d to evaluate the blood characteristics. Back fat and estrus interval were investigated. In this study, there were no differences ($p>0.05$) in diarrhea score and blood characteristics among treatments. Likewise, the behavior was not influenced ($p>0.05$) by the dietary flavor supplementation. However, administration of flavor increased ($p<0.05$) the pre-weaning feed intake, post-weaning average daily gain (ADG) and gain/feed (G/F) ratio. No significant difference was observed ($p>0.05$) on the blood characteristics, behavior, backfat loss and estrus interval among treatments. In conclusion, administration of flavor could increase creep feed intake pre-weaning and piglet ADG post-weaning, whereas inclusion of flavor had no influence on blood characteristics and performance in sow and piglets. (**Key Words :** Creep Feed, Flavor, Behavior, Piglet, Sow)

INTRODUCTION

Generally, creep feeding begins largely as an exploratory or social activity, and is then increasingly driven by nutrient demand as the piglets mature (Pajor et al., 1991). English (1981) have suggested that sufficient intake of creep feed during lactation created a gradual transition at weaning and reduced the occurrence of post-weaning disorders. Pajor et al. (1991) reported that difference in the absolute amount of creep feed consumption before weaning resulted in differences on the performance. Therefore, indentifying factors that can increase creep feed consumption may elicit positive effect of creep feed on nursery performance.

It is well suggested that organoleptic properties of the feed may be a dietary factor that can reduce feed neophobia and influence the creep feed consumption. Feed flavors are commonly used in nursery diets to improve diet acceptance and stimulate feed intake (McLaughlin et al., 1983; Sulabo et al., 2010). Various studies have showed nursery pigs have an innate preference for flavored diets during changes in dietary regimes (McLaughlin et al., 1983; Rohde Parfet and Gonyou, 1991). Langendijk et al. (2007) also found administration of flavor to the creep feed may enhance post-weaning responses when the same flavor is added to the nursery diets. Therefore, providing flavors to the creep feed may be a new method to improve pre- and post-weaning feed intake and performance.

Previous studies have suggested that various factors could influence the behavior of sow (standing and lying), such as environmental quality, food quality, and piglet behavior. For example, Foxcroft (1992) and Pajor et al. (2002) suggested the behavior and reproductive performance of sows could be influenced by the metabolic state of the sow and the suckling stimulus of the piglets, respectively. Tsuma et al. (1995) also noted that suckling and weaning of piglet could induce increases in the concentrations of peripheral plasma cortisol and endorphins, which were considered to be a valid indicator of stress in

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piglets (Smulders et al., 2006). Therefore, the effects of creep feed on sows' performance were investigated in this study, in consideration of its results on piglet behavior and nursing-associated vocalization.

The objectives of this study were i) to determine the effects of two flavor supplementation on the pre- and post-weaning growth performance and behavior of piglets and ii) to determine flavor supplementation of creep feeding on performance and behavior of sows.

MATERIALS AND METHODS

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

Preparation of the flavor

The flavors employed in the present study were provided by Lucta company (Lucta S.A., Barcelona, Spain) as a non-hygroscopic powder form. The flavor is characterized by the milky cheese, sweet and vanilla volatile note. The bio-active substance is promised at the levels of 13-15%. The thermal stability and aroma exposition duration is guaranteed no less than 70% of preservation and 70 days, respectively.

Animal and housing

A total of 30 sows (Landrace×Yorkshire) and their litters were used in this study. Sows were assigned randomly to 1 of 3 creep feeding groups, with parities of 1, 2, or 3+. At d 107 of gestation, the sows were relocated to farrowing crates in an environmentally regulated farrowing house, and allotted to 1 of 3 dietary treatment groups. The mean parity of the sows was 2.6±0.4. Sows were fed on a commercial gestation (2.6 kg) diet from d 107 to farrowing (Table 1), whereas the sow were provided a daily feed allowance increased gradually until *ad libitum* access to feed by wk 1. All diet were provided in meal form and divided into 2 daily meals, and sows were provided with free access to drinking water throughout the experimental period. Creep feeding was provided as a powder form initiated at d 5 until the end of the experiment (28 d). Dietary treatments were: i) CON, basal diet; ii) TRT1, CON +0.1% vanilla supplement; iii) TRT2, CON+0.1% cheese supplement. Water was provided on an *ad libitum* basis. The 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, sows were relocated to a mating room, with the piglets remaining in the pen for one week (weanling pigs).

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, 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
Analyzed composition		
GE (MJ/kg)	3.33	3.58
CP (%)	12.95	16.89
Ca (%)	0.84	0.83
P (%)	0.75	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 $FeSO_4 \cdot 7H_2O$), 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.

Measurements

Individual piglet body weight (BW) was assessed on d 0, 7, 14 and 21 (weaning), and 7 d after weaning to calculate the average daily gain (ADG), average daily feed intake (ADFI) and gain/feed (G/F) ratio. 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). The incidence of diarrhea in piglets was observed and recorded 3 times daily throughout the study. In order to assess the severity of diarrhea, feces from each pig were scored by determining the moisture content according to the method described by Hart and Dobb (1988). In brief, the scores were as follows: 0, normal, firm feces; 1, possible slight diarrhea; 2, definitely unformed, moderately fluid feces; or 3, very watery and frothy diarrhea. A cumulative diarrhea score per diet and d was then assessed (Montagne et al., 2004).

To assess blood characteristics, the sows were bled via puncture of the vena cava at weaning (21 d) to determine the concentrations of epinephrine, norepinephrine and cortisol. Two piglets from each offspring were selected randomly and bled via jugular venipuncture to investigate the IgG, epinephrine, norepinephrine and cortisol concentration at the end of the experiment. Blood samples 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. IgG concentration was subsequently determined using an automatic biochemistry blood analyzer (HITACHI 747, Hitachi, Tokyo, Japan). The serum were 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 (Shimadzu Scientific Instruments, Inc., Colombia, MD, USA) 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 d from weaning onward, at 08:30 and 16:00 every d. 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.

Table 2. Piglet diet composition (as-fed basis)

Items	
Ingredients (%)	
Digestible corn	22.62
Soybean meal	8.00
Soy oil	4.50
Whey	24.16
Fish meal	2.50
Fermented soybean meal	10.00
Coconut oil	4.17
Lactose	8.00
Plasma powder	4.00
Sugar	3.05
Isolated soybean protein	6.15
Dicalcium phosphate	1.25
DL-methionine	0.38
L-lysine·HCl	0.41
Threonine, 98%	0.13
Zinc oxide	0.30
Choline Cl, 50%	0.10
Vitamin premix[1]	0.10
Mineral premix[2]	0.18
Analysis composition (%)	
DE (MJ/kg)	16.74
CP	22.00
Lys	1.74
Met	0.70
Ca	0.81
P	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.

Activity in the farrowing crates was recorded by 24 h time-lapse video recording. The video camera was positioned to provide a view of the entire farrowing crate. Behavior was recorded from the commencement of partitioning to weaning. All behavior of the litter was continuously recorded to determine the time spent by piglets at the creep feeder, sleeping, and fighting during lactation. The time spent by sows on eating, and standing was also determined. Nursing was considered to have begun with the sow lying in the nursing posture with at least 80% of the litter in contact with the udder.

Statistical analysis

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 AND DISCUSSION

Performance and behavior of piglet evaluated in this

study is shown in Table 3. There were no differences (p>0.05) in diarrhea score and blood characteristics among treatments. Likewise, the behavior was not influenced (p>0.05) by the dietary flavor supplement. However, the inclusion of flavor increased (p<0.05) the pre-weaning feed intake, post-weaning ADG and G/F ratio. It is previously suggested that addition of milky flavor to the starter diet improved daily gain and feed intake compared with pigs fed unflavored diets in weanling pigs (Roura et al., 2008). McLaughlin et al. (1983) and Sulabo et al. (2010) reported feed flavors could improve diet acceptance and stimulate feed intake. Therefore, we hypothesized a beneficial effect could be observed with the flavor supplementation. However, results were out of anticipation, no difference was detected for the pre-weaning performance, although the feed intake was increased with the supplemental flavors. In agreement with our study, Millet et al. (2008) and Sulabo et al. (2008) did not observe any improvements in pre-weaning performance with the addition of feed flavors to the creep feed, and explained the potential reason was likely to be age-related differences or greater individual variation in palatability perception. Therefore, the flavor properties of the creep feed may not be sufficient to positively affect pre-weaning feed intakes. The lack of response to flavor in this study may be explained by i) the duration of creep feeding, ii) the role of feed flavors in diets of suckling pigs, iii) variation among individual replication and other systematic experimental errors. However, the inclusion of flavor increased the post-weaning ADG and G/F ratio in the current study, which is in agreement with Langendijk et al. (2007), who found administration of flavor to the creep feed enhanced post-weaning responses when the same flavor is added to the nursery diets. It is previously suggested that creep-fed pigs have a better development of gut maturity because of the oral tolerance to a solid diet. Sohn and Maxwell (1995) reported that ingestion of solid food during lactation can speed up the induction of amylase and protease enzymes (de Passille et al., 1989), stimulate acid production (Cranwell et al., 1976) and modify the gut flora. Therefore, improving feed intake (numerical) of weaned pigs during this transition period may be critical in improving post-weaning growth.

In the current study, no difference was observed (p>0.05) on the blood characteristics, back fat loss, the estrus and behavior of sow among treatments (Table 4). It is reported that a variety of factors could influence the behavior, such as environmental quality, food quality and piglet behavior in some species (Berger, 1979; Hauser and Fairbanks, 1988). Foxcroft (1992) and Pajor et al. (2002) suggested the behavior and reproductive performance of sows could be influenced by the metabolic state of sow and piglets, respectively. Previous studies have suggested that creep feed could enhance the solid food consumption of piglets and hence vocalize less when nursing frequency declines, which weakens the sow's responses to such vocalizes (Weary et al., 1999; Pajor et al., 2002). Tsuma et al. (1995) noted that suckling and weaning of piglet induced increases in the concentrations of peripheral plasma cortisol and

Table 3. Effects of creep feeding flavor on piglet performance and blood characteristics

Items[1]	CON	TRT1	TRT2	SE[2]
Suckling pigs				
ADG (g)	224	226	228	12
ADFI (g)	17[b]	19[ab]	21[a]	1.56
Weaning pigs (0-7 d)				
ADG (g)	184[b]	208[a]	215[a]	10
ADFI (g)	210	228	234	17.6
G/F	0.876[b]	0.915[ab]	0.920[a]	0.021
Suckling[4], (times)	42.28	43.64	40.28	2.20
Lying[5] (times)	40.21	41.58	42.15	2.35
Fighting[6] (times)	17.87	18.35	19.41	1.68
Diarrhea score[3]	1.6	1.7	1.5	0.17
Corisol (μg/dl)	2.27	2.20	1.90	0.30
Epinephrine (pg/ml)	284.1	286.5	268.1	15.53
Norepinephrine (pg/ml)	887.7	875.9	848.4	44.21
IgG (mg/dl)	428.8	432.6	422.6	12.15

[1] CON = basal diet; TRT1 = basal diet+0.1% vanilla supplement; TRT2 = basal diet+0.1% cheese supplement.
[2] Pooled standard error.
[3] Diarrhea score: 0, normal, 1, firm feces, 2, possible slight diarrhea 3, definitely unformed, moderately fluid feces; or 4, very watery and frothy diarrhea; Data were measured by average total diarrhea score during 7 d post-weaning.
[4] Suckling movements with a teat in the mouth or with the nose in contact with udder.
[5] Lying on the side or belly without performing any other described behavior. [6] Fighting with others.
[a,b] Within a row, means with different superscripts differ (p<0.05).

Table 4. Effect of creep feed flavor on lactating sow performance

Items[1]	CON	TRT1	TRT2	SE[2]
Estrus interval (d)	5.33	5.50	5.10	0.215
Back fat (mm)				
Lactation	23.8	23.1	23.3	0.36
Weaning	19.8	19.7	19.6	0.61
Back fat loss	4.0	3.4	3.7	0.30
Eating diet[3]	18.2	17.4	19.6	2.02
Lying[4] (times)	76.4	72.4	74.4	2.18
Standing[5] (times)	23.5	24.6	21.2	2.54
Epinephrine (pg/ml)	34.16	36.12	33.32	2.35
Norepinephrine (pg/ml)	190.8	210.8	186.7	23.58
Cortisol (μg/dl)	6.51	6.88	5.94	0.62

[1] CON = basal diet; TRT1 = basal diet+0.1% vanilla supplement; TRT2 = basal diet+0.1% cheese supplement.
[2] Pooled standard error. [3] Eating from the food trough or chewing food.
[4] Lying on the side or belly without performing any other described behavior. [5] Standing from the floor with 4 feet.

endorphins, which were considered to be a valid indicator of stress in piglets (Smulders et al., 2006). Therefore, we hypothesized there would be some effects on the sow performance with the flavor supplementation in the current study, However, our results suggested the inclusion of flavor did not affect the sow performance in this study, which to some extent indicated the flavored diet of piglets will not affect the sow performance.

CONCLUSION

In conclusion, administration of flavor increased feed intake pre-weaning and piglet ADG post-weaning, whereas inclusion of flavor had no influence on any other measured aspect of blood characteristics and performance in sow and piglets. Therefore, application of flavor in creep feed could be considered as a good method to improve the growth performance of piglet post-weaning with less cost in feedstuff technology when economically justified.

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REFERENCES

Berger, J. 1979. Weaning conflict in desert and mountain bighorn sheep (Ovis Canadensis): an ecological interpretation. Z Tierpsychol. 50:188-200.

Cranwell, P. D., D. E. Noakes and K. T. Hill. 1976. Gastric secretion and fermentation in the sucking pig. Br. J. Nutr. 36: 71-86.

de Passillé, A. M., B. Pelletier, G. Menard and J. Morisset. 1989. Relationships of weight gain and behavior to digestive organ weight and enzyme activities in piglets. J. Anim. Sci. 67:2921-2929.

English, P. R. 1981. Establishing the early weaned pig. Pig Vet. Soc. Proc. 7:29-37.

Foxcroft, G. R. 1992. Nutritional and lactational regulation of fertility in sows. J. Reprod. Fertil. 45:113-125.

Hart, G. K. and G. J. Dobb. 1988. Effect of a fecal bulking agent on diarrhoea during enteral feeding in the critically ill. J. Parenter. Enteral Nutr. 12:465-468.

Hay, M. and P. Mormède. 1997. Determination of catecholamines and methoxycatecholamines excretion patterns in pig and rat urine by ion-exchange liquid chromatography with electrochemical detection. J. Chromatogr. B 703:15-23.

Hauser, M. D. and L. A. Fairbanks. 1988. Mother-offspring conflict in vervet monkeys: variation in response to ecological conditions. Anim. Behav. 36:802-813.

Langendijk, P., J. E. Bolhuis and B. F. A. Laurenssen. 2007. Effects of pre- and post-natal exposure to garlic and aniseed flavor on pre- and post-weaning feed intake in pigs. Livest. Sci. 108:284-287.

Millet, S., M. Aluwé, D. L. De Brabander and M. J. van Oeckel. 2008. Effect of seven hours intermittent suckling and flavour recognition on piglet performance. Arch. Anim. Nutr. 62:1-9.

McLaughlin, C. L., C. A. Baile, L. L. Buckholtz and K. Freeman. 1983. Preferred flavors and performance of weaned pigs. J. Anim. Sci. 56:1287

Montagne, L., F. S. Cavaney, D. J. Hampson, J. P. Lalle and J. R. Pluske. 2004. Effect of diet composition on postweaning colibacillosis in piglets. J. Anim. Sci. 82:2364-2374.

Pajor, E. A., D. Fraser and D. L. Kramer. 1991. Consumption of solid food by suckling piglets: Individual variation and relation to weight gain. Appl. Anim. Behav. Sci. 32:139-155.

Pajor, E. A., D. M. Weary, C. Caceres, D. Fraser and D. L. Kramer. 2002. Alternative housing for sows and litters part 3. Effects of piglet diet quality and sow-controlled housing on performance and behaviour. Appl. Anim. Behav. Sci. 76:267-277.

Rohde Parfet, K. A. and H. W. Gonyou. 1991. Attraction of newborn piglets to auditory, visual, olfactory and tactile stimuli. J. Anim. Sci. 69:125-133.

Roura, E., I. R. Ipharraguerre and D. Torrallardona. 2008. Dose

response trials of an enhanced milky flavor in a pig nursery program 2: benefits of flavoring water up to 14 d. J. Anim. Sci. 85(Suppl. 1):78-79. (Abstr.)

Smulders, D., G. Verbeke, P. Mormède and R. Geers. 2006. Validation of a behavioral observation tool to assess pig welfare. Physiol. Behav. 89:438-447.

Sohn, K. S. and C. V. Maxwell. 1995. The effect of creep feeding on postweaning performance in early-weaned pigs. Kor. J. Anim. Sci. 37(1):73-78.

Sulabo, R. C., M. D. Tokach, E. J. Wiedmann, J. Y. Jacela, J. L. Nelssen, S. S. Dritz, J. M. DeRouchey and R. D. Goodband. 2008. Effects of varying creep feeding duration on pre-weaning performance and the proportion of pigs consuming creep feed. J. Anim. Sci. 85(Suppl. 2):198 (Abstr.).

Sulabo, R. C., M. D. Tokach, J. M. DeRouchey, S. S. Dritz, R. D. Goodband and J. L. Nelssen. 2010. Influence of feed flavours and nursery diet complexity on pre-weaning and nursery pig performance. J. Anim. Sci. 88:3918-3926.

Tsuma, V. T., S. Einarsson, A. Madej and N. Lundeheim. 1995. Hormone profiles around weaning in cyclic and anoestrous sows. J. Vet. Med. Series A 42:153-163.

Weary, D. M., E. A. Pajor, M. bonnenfant, S. K. Ross, D. Fraser, and D. L. Kramer. 1999. Alternative housing for sows and litters. Part 2. Effect of a communal piglet area on pre-and post-weaning behavior and performance. Appl. Anim. Behav. Sci. 65:123-135.