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ACTIVATED IGF-I SUPPLEMENTATION DURING LATE GESTATION AND LACTATION PERIOD AFFECTS SOW AND PIGLET PERFORMANCE

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ABSTRACT

The study was conducted to determine the effects of supplementing activated IGF-I (aIGF-I) in lactating diets on sow and piglet performance. Fifty-nine crossbred female pigs (average parity 1.91 ± 0.30) were randomly assigned to two dietary treatments following randomized complete block design with parity as blocking factor. Treatments were basal lactation diets added with 0 (n=30) or 3 kg/ ton aIGF-I (n=29). The feeding trial started from day 100 of gestation until weaning. Dietary supplementation of aIGF-I reduced backfat loss of sows associated to reproduction (1.35 vs 3.87 mm, P<0.05). Piglets from sows fed diets with aIGF-I have higher body weight gain at 24 hours post-farrowing (0.12 vs 0.08 kg, P<0.05) and adjusted 30-day weaning weight (7.86 vs 7.16 kg, P<0.01); while preweaning mortality was reduced by 50.12% (4.08 vs 8.18%, P<0.05). Results demonstrated the potential of supplementing aIGF-I during late gestation and lactation in reducing backfat thickness loss at lactation of sows associated to reproduction and increasing growth and survivability of piglets.

Keywords: Activated IGF-I, IGF-I, performance, swine

INTRODUCTION

In general, piglets only achieve less than half of its growth potential when constrained by endocrine status as well as poor nutrition (Boyd *et al*., 1995). In addition, lack of nutrition contributes to 20-30% of preweaning mortality (King'ori, 2012; Foisnet *et al*., 2014). Increasing milk yield and/ or improving its nutrient quality can increase growth rate as well as survivability of young pigs. Recent studies have shown the effects of insulin-like growth factor I (IGF-I) in porcine colostrum and milk in enhancing immunity by stimulating T-lymphocytes and natural killer cells (Brocardo *et al*., 2001; Smith, 2010), gastrointestinal maturation (Xu *et al*., 1994; Hartke *et al*., 2005), nutrient and electrolyte absorption (Alexander and Carey, 1999) and growth performance (Dauncey *et al*., 1994; Dunshea *et al*., 2002) of neonatal pigs.

The test material, activated IGF-I (aIGF-I) is a product of proprietary technology that "liberates" the IGF-I into its functional form thereby improving its utilization in the body. In its raw form, the starting material of activated IGF-I contains less than 5% free IGF-I in porcine plasma, but upon subjecting it to the "activation" process, it was increased to more than 50%. Activated IGF-I has undergone a patented double pass electron beam irradiation (29 kGy) process to ensure product safety. Supplementation of activated IGF-I in lactating diets claimed to increase IGF-I level in milk which improves growth and viability of neonatal pigs (Casebolt, 2014).

Previous trials have shown that dietary supplementation of aIGF-I in sows have shortened the length of dry period and improved the weaning weight and survival of piglets (Song *et al*., 2014a and 2015b). However, no local data has been generated yet on the use of aIGF-I in lactating sow's diet and the corresponding effect on its performance. In addition, the previous trials have not measured the effect of aIGF-I supplementation on backfat loss of sows during lactation. Earlier studies have proven the relationship of backfat thickness loss during lactation and reproductive performance (Clowes *et al.*, 2003; Roongsitthichai and Tummaruk, 2014). Therefore, the objective of this study is to determine the effect of supplementing aIGF-I during late gestation and lactation on sow and piglet performance.

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MATERIALS AND METHODS

Fifty-nine crossbred female pigs (average parity 1.91 ± 0.27) were randomly assigned to treatments following randomized complete block design (RCBD), with parity as blocking factor. The dietary treatments were basal lactating diet (Table 1) with 0 (n=30) or 3 kg aIGF-I (n=29).

Lactating diets were provided at 14 days before the expected date of farrowing, after sows were moved to the farrowing house until the next insemination after weaning. Sows were fed 3 kg feed daily after being transferred to farrowing stalls until the predicted date of farrowing (1.5 kg feed). Sows received increasing amounts of feed after farrowing, from 1.5 kg on the 1st day to 3 kg on the 3rd day. From the 4th day of lactation onwards, the sows were fed *ad libitum*. At weaning until they were bred, sows received 3 kg of feed daily. Water was always provided *ad libitum*.

Sows were transferred to individual farrowing stalls measuring 2.90 x 0.85 m and were equipped with slatted floor. One row of farrowing stalls was assigned per treatment. Each farrowing stall has a feeding trough measuring 0.13 x 0.13 m, with an opening of 0.14 m wide and 0.09 m deep.

Sows in heat were detected by daily boar exposure. Gilts identified in heat were inseminated immediately, while sows were inseminated 12 hours after heat was detected. Artificial insemination was done twice at 12-hour interval.

Neonates born alive and dead were recorded at farrowing. Percent mummified and stillborn piglets were also determined. Percent mortality at 24 hours after farrowing and at weaning was determined. Piglets were weighed (kg) at birth, at 24-hours post-farrowing and at weaning. Fostering of piglets was standardized at 10-12 piglets per sow at 24 hours after farrowing. Dry period (days) was the interval between weaning day and the day of insemination after weaning. Females that died, with dry period longer than 30 days, farrowed less than 8 piglets/ litter or greater than 14 piglets/ litter were not included in the analysis.

Backfat thickness of sows was determined using an ultrasound scanner (Renco lean meter®, Minneapolis, MN, USA) following the "Stamboek" method. Measurement was done at six points of the sow's back, 6-8 cm from the marked midline from the shoulder blade to the last rib. These points are areas where fat tissue is the only tissue between the skin and bones (Venneboer, 2012). Points 5 and 6 (P5 and P6) were scanned at the last rib, while points 1-4 (P1, P2, P3 and P4) were measured at equally divided locations between the shoulder and the last rib, each 1/3 of the total length. Backfat was measured two weeks before expected date of farrowing and at weaning. Backfat loss was measured by subtracting the average value obtained at weaning from the value obtained two weeks before expected date of farrowing.

Gathered data were checked for outliers, normality (Wilk-Shapiro test) and equality of variance (F-test). Count data expressed in percentage namely stillbirth, mummified fetus and preweaning mortality were transformed using arcsin function. Data that did not satisfy the assumptions of analysis of variance (ANOVA) were subjected to T-test; while data that passed were subjected to ANOVA following a completely randomized design

(CRD) because initial analysis detected no significant differences among parities. All the data gathered were subjected to general linear model (GLM) analysis using Statistical Analysis Software and MS Excel. In all analyses done, a probability of less than 0.05 was considered significant.

Table 1. Ingredient composition and nutrient analysis of basal diet for sows and piglets.

Ingredients	Amount, %
Yellow corn	44.30
Soybean meal	21.40
Hard pollard	15.00
Rice bran D1	5.00
Copra cake	5.00
Coconut oil	2.35
Molasses	2.00
Vitamin premix[1]	0.03
Mineral premix[2]	0.03
Other micro-ingredients	4.89
Total	100.00
Calculated Analysis:	
Metabolizable energy, kcal/kg	3,435.76
Crude Protein, %	16.10
Crude Fat, %	5.00
Crude Fiber, %	2.66
Calcium, %	1.20
Total Phosphorus,%	0.73
Available Phosphorus, %	0.50
Total Lysine, %	0.97
Total Met + Cys, %	0.58
Total Threonine, %	0.63
Total Tryptophan, %	0.21

[1]Supplied per kg of diet: Vitamin A (12, 500 IU), Vitamin D_3 (2,250 IU), Vitamin E (50 mg), Vitamin K_3 (2.25 mg), Vitamin B_1 (50 mg), Vitamin B_2 (2.25 mg), Vitamin B_6 (3.5 mg) Vitamin B_{12} (0.025 mg), Niacin (37.50 mg), Pantothenic Acid (17.50 mg), Folic Acid (2.5 mg), Biotin (0.25 mg), Antioxidant (25 mg); [2]Supplied per kg of diet: Iron (125 mg), Manganese (25 mg), Iodine (0.175 mg), Selenium (0.30 mg), Zinc (125 mg), Copper (7.50 mg).

RESULTS AND DISCUSSION

The effects of dietary supplementation of aIGF-I during lactation on sow and litter performance are shown in Table 2. There were no differences (P>0.05) on pregnancy parameters (number of piglets born, percentage of litter size born alive and dead, and average birth weight of piglets) between treatments. Recruitment of pre-ovulatory follicles occurs at day 14 to 16 of estrus cycle (Renteria-Flores *et al.*, 2008). In addition, the effects of IGF-I on increasing uterine capacity (number of embryos or fetuses the uterus can accommodate) of a sow by increasing the size and vascular strength of uterus as well as enhancing fetal-maternal diffusion of nutrients, which enhances embryo growth and survival, happen mainly during first trimester of gestation period (Dauncey *et al*., 1994). Supplementation of aIGF-I was done at day 100 of gestation until piglets were weaned from the sow. The period of exposure of sows to aIGF-I may not be enough to improve growth and survivability of fetuses during gestation.

There were no treatment differences (P>0.05) on mortality of piglets at 24 hours post-farrowing. On the other hand, piglets from sows that received aIGF-I supplementation had lower mortality at weaning (P<0.05). In addition, dietary supplementation of aIGF-I in sows increased body weight gain of piglets at 24 hours post-farrowing (P<0.05) and adjusted 30-day weaning weight (P<0.01). The advantage of piglet weight gain at 24 hours-post farrowing is one of the major contributors for increased survivability and growth performance of piglets during suckling stage. Heavier piglets starting on day 1 of lactation tend to consume more milk compared to lighter piglets (King'ori, 2005). This can indicate higher colostrum intake which is critical for the growth and survivability of neonatal pigs.

The improvement in piglet performance supports the claim of Casebolt (2014); that aIGF-I supplementation increases IGF-I level in sow's milk which improves growth and viability of neonatal pigs. A sample study on the effect of high levels of IGF-I in sow's milk on performance of piglets was the experiment of Monaco *et al*. (2005); wherein piglets from transgenic sows that over express IGF-I in milk (increased IGF-I level in colostrum by 26 folds while 50-90 folds in mature milk) resulted to improved intestinal maturation and growth performance of piglets. It has been shown in studies that IGF-I is stable and

Table 2. Effect of aIGF-I supplementation on sow and litter performance.

Variable	Control	aIGF-I	S.E.M	P-value
Parity	2.40	2.79	0.30	0.5200
Litter size (heads)	11.50	11.59	0.35	0.5832
Litter size born alive (%)	97.49	95.70	0.82	0.1594
Mummified (%)	1.33	1.01	0.49	0.6163
Stillbirth (%)	1.58	2.45	0.51	0.1659
Average birth weight (kg)	1.56	1.57	0.03	0.7631
Body weight gain after 24 hours (kg)	0.08	0.12	0.01	0.0242
Adjusted 30-day weaning weight (kg)	7.16	7.86	0.13	0.0078
Mortality at 24 hrs post-farrowing (%)	3.64	2.51	0.75	0.1483
Preweaning mortality (%)	8.18	4.08	0.61	0.0145
Length of dry period (days)	6.39	6.00	0.33	0.5749
Average daily feed intake (kg)	5.02	4.74	0.06	0.1234

Table 3. Effect of aIGF-I supplementation on backfat thickness of sows.

Variable	Control	aIGF-I	S.E.M	P-value
Backfat thickness at farrowing (mm)				
P1-P6	16.43	15.96	0.47	0.8367
P1-P2	19.23	19.62	0.77	0.7647
P3-P4	15.68	14.79	0.53	0.5796
P5-P6	14.48	13.47	0.46	0.5063
Backfat thickness loss at weaning (mm)				
P1-P6	3.87	2.35	0.62	0.1132
P1-P2	6.84	4.20	1.19	0.1754
P3-P4	3.66	1.50	0.68	0.0625
P5-P6	3.87	1.35	0.58	0.0249

can be absorbed in gastrointestinal tract of piglets (Shen and Xu, 2000; Xu and Wang, 1996). Experimental evidences have also shown that oral infusion of IGF-I in piglets increased cell proliferation in intestinal crypts (Xu *et al*., 1994), increased intestinal weight and mucosal growth, protein and DNA contents, villous height, and disaccharidase activity (Hartke *et al*., 2005), had higher nutrient and electrolyte absorption (Alexander and Carey, 1999), and improved growth performance of piglets (Dauncey *et al.,* 1994; Alexander and Carey, 1999; Dunshea *et al*., 2002). Moreover, IGF-I also has an effect on stimulating the production of T lymphocytes and natural killer cells (Brocardo *et al*., 2001), hence enhancing immunity. However, measurement of milk IGF-I at different time intervals was not done in the present study. Measurement of IGF-I in milk at different time intervals can be done to test if IGF-I increases in colostrum and/ or mature milk, and relate this to the improvement in piglet performance. In addition, IGF-I level in blood of sows can also be measured to correlate it with uterine capacity, ovarian characteristics and performance of sows.

The current study conformed to the results of previous trials which showed that dietary supplementation of aIGF-I in sows increased survival and weaning weight of piglets (Song *et al*., 2014a and 2014b); but did not affect (P>0.05) length of dry period of sows; which is in contrast to the previous studies. The response on length of dry period from present experiment on lactating sows cannot be directly compared with the data from previous studies because the duration of feeding trial of the latter started from day 3 of gestation until weaning. The duration of the feeding trial may not be enough to influence this parameter. Similarly, aIGF-I supplementation did not affect (P>0.05) feed intake of sows, which also agrees to the experiments conducted by Song *et al*. (2014a and 2014b).

Average backfat thickness measurement for the six points and each of the mean 2 points were similar for both treatments (P>0.05) at the first measurement (Table 3). According to Venneboer (2012), P1 to P4 are considered depot fat which is used as energy reserve for maintenance and production of sows. P5 and P6 consist mainly of target fat, which is used for reproductive processes. Backfat loss that is allocated for maintenance and production (P1-P2, P3-P4) did not differ (P>0.05) between treatments. However, backfat thickness loss associated to reproduction (P5-P6) was higher (P<0.05) in sows that did not receive IGF-I supplementation. Quesnel *et al*. (1998) reported a strong positive correlation between circulating IGF-I and backfat loss in sows. Negative consequences brought by severe backfat loss can be observed at next cycle of sows. These include

poor uterine development, poor follicular maturation, low farrowing rate and low embryo survival (Clowes *et al*., 2003; Roongsitthichai and Tummaruk, 2014). However, IGF-I level in blood of sows was not measured in the present study. In addition, a feeding trial on gestating and lactating stage for at least one cycle must be conducted to confirm if aIGF-I supplementation has an effect in reducing backfat loss of sows during lactation.

CONCLUSION AND RECOMMENDATION

The results suggest that addition of 3 kg/ ton activated IGF-I in lactating diets prevented backfat loss associated to reproduction in sows. Additionally, dietary supplementation of activated IGF-I in sows resulted to increased growth and survivability of piglets. In future studies, it is recommended to measure IGF-I in blood and milk of sows, and to conduct a trial on gestating-lactating sows for more than one cycle.

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