The influence of gestational vitamin supplementation on sow and piglet performance

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INSIGHT FOR PRODUCERS

Gestation is a physiologically stressful period; support of sow health through vitamin supplementation may provide a low-input and cost-effective approach to improving sow productivity and piglet health.

SUMMARY

Past research has shown that increased supplementation of certain vitamins can enhance parameters such as conception rates, litter size, and the passage of maternal immunoglobulins; these experiments generally include increased provision of one or two vitamins. To understand the impact that supplementation of all vitamins beyond industry standards would have on sow productivity, we developed two experimental diets formulated to either NRC (2012) recommendations (Control, CTR), or beyond industry standard (High Vitamin, HiVit). Utilizing the same gilts and sows, the experimental gestation diets were fed over two consecutive reproductive cycles. Factors such as litter size, weight, and survival were considered. Analysis of maternal blood serum, colostrum, and piglet serum was done to gain insight into the passage of maternal immunity. The high vitamin diet did not improve aspects of maternal performance and passage of maternal immunity over all, but interesting effects were detected. In the second reproductive cycle, second-parity HiVit gilts had significantly heavier litters than their CTR counterparts and both treatments in the first cycle, with no difference in litter size. No consistent differences were seen regarding the impact of diet on maternal antibody measures. The findings related to gilt performance in the second cycle are of great interest due to current concerns about second parity syndrome and sow lifetime performance. Further research into vitamin supplementation in gilt diets, with the possibility including precision feeding, is pertinent.

INTRODUCTION

Gestation is an undeniably important stage of swine production, generating the ultimate product of the industry. Sow mortality is currently a point of great concern, with removals at a rate higher than ever before. Support of maternal health during this period ensures that sows reach their reproductive potential and that their piglets have a healthy start to life. Larger litter sizes as a result of selection for highly prolific sows have come at the expense of individual piglet weight and survivability. Neonatal piglets also face challenge by disease, though some protection is provided through the passage of maternal antibodies via colostrum and milk.

Vitamins are known to play an important role in many physiological systems. Previous research has found that supplementation of certain vitamins beyond minimum requirement can enhance certain aspects of productivity. For example, increased supplementation of vitamins A and E are reported to improve conception rates while also enhancing antibody transfer. Though the culmination of previous research covers all vitamins individually or in subsets, none have assessed the influence of increased supplementation of all vitamins commonly included in swine premixes at once. With the relatively low cost of vitamin premix, the idea of an increase of supplementation leading to improved reproductive performance and piglet health is attractive.

The following study endeavors to determine if feeding vitamins at a rate greater than industry inclusion practices can enhance sow and piglet performance as well as passage of maternal immunity. Supplementation over two reproductive cycles with the utilization of multiple parities will hopefully reveal any additive effect that may not be seen in one cycle, especially in younger dams.

"Improving lifetime performance of sows is important... a low-cost solution such as vitamin supplementation is worth research."

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EXPERIMENTAL METHODS

Animals used in this study were selected from the Centre de Développement du Porc du Québec inc. (CDPQ) and followed over two reproductive cycles. Gilts (n=32) and sows (n=34) were assigned to either a control (CTR) diet formulated to NRC (2012) recommendations or a high vitamin (HiVit) diet formulated beyond current industry standards (Table 1). Diets were fed from breeding (D0) to farrowing (D113-117). During gestation, sows were group housed with electronic sow feeding stations; feed distribution and intake were controlled and tracked using Gestal 3G2 feeding stations (JYGA Technologies, St-Lambert-de-Lauzon, QC). Dams were vaccinated using ProSystem RCE (Merck Animal Health, Kirkland CQ) to manufacturer instruction (D80 and 100 in gilts, D100 in sows). Cross-fostering occurred within treatment groups but between parities.

Table 1. Dietary vitamin concentrations.

Diet Component	CTR diet	HiVit diet
Vitamin A (IU/kg)	4,000	15,000
Vitamin D (IU/kg)	800	** 2,800 **
Vitamin E (mg/kg)	40	135
Vitamin K (mg/kg)	0.5	5.0
Thiamine (mg/kg)	1	2.5
Riboflavin (mg/kg)	3.75	10.0
Niacin (mg/kg)	10	45
Pantothenic acid (mg/kg)	12	40
Pyridoxine (mg/kg)	1	5.5
Biotin (mg/kg)	0.2	0.8
Folic acid (mg/kg)	1.3	5.5
Vitamin B12 (ug/kg)	15	50
Vitamin C (mg/kg)	0	300

***Note: In the HiVit diet, the 2800 IU of vitamin D will consist of 800 UI of vitamin D3 and the necessary amount of HyD to supply the equivalent of 2000 IU.*

Litter characteristics

In the farrowing room, litter characteristics were recorded. The total number of piglets born, total born alive, mummified, and stillborn were counted. On day 2 post-farrowing, litters were processed and piglets were weighed individually. Piglet removals were recorded. On day 21 post-farrowing, piglets were weighed before weaning.

Sample collection

Blood and colostrum samples were collected for analysis of total and specific IgG measures. From dams, blood was collected on days 0, 100 (prior to vaccination), and 110. Blood was also collected from two average weight piglets from each litter on days 2 and 21. Blood samples were processed to separate the serum, which was then frozen until analysis. Colostrum was collected within 12h of farrowing, utilizing the first three pairs of teats. The fat portion was separated via centrifugation then removed and the whey portion was frozen until analysis.

ELISA

To understand if there was any dietary influence on the passage of maternal immunity, ELISAs for both total IgG concentration (ELISA Flex: Porcine IgG (HRP), Mabtech Inc., Cincinnati OH) and specific IgG titres were completed. For specific IgG titres, ProSystem RCE (Merck Animal Health, Kirkland QC) was used as the coating antigen in an indirect ELISA. Serum and colostrum samples were tested in duplicate for both assays.

RESULTS

Sow and piglet performance

In the first cycle HiVit sows weaned more piglets than CTR sows (P=0.039), though this difference was not seen in the second cycle, with HiVit sows tending to wean less piglets than their CTR counterparts (Table 2., P=0.060). Gilts fed the control diet weaned fewer piglets than HiVit gilts in both cycles (P=0.014), though they also had smaller litters after cross fostering (Table 3., P=0.047). Litter sizes before cross-fostering were not statistically different. In the second cycle, HiVit gilt litters on D2 post-farrowing were significantly heavier than CTR gilt litters in the same cycle and the litters of both groups in the first cycle, though litter sizes were not significantly different (Table 4., P=0.037). This weight difference was not seen at weaning. Treatment did not alter sow litter weight at day 2 or 21.

Immunological results

Consistent differences based on treatment or treatment and cycle interaction did not influence total IgG concentrations in gilt or sow serum, colostrum, or piglet serum. The only difference related to treatment was seen in the first cycle, where CTR sows had higher total IgG concentrations in D100 serum compared to HiVit sow samples from the same day (P=0.040); this difference was also seen in CTR sow colostrum in the first cycle (P=0.012); no difference was detected on D110, in piglet serum, or in specific IgG titres. HiVit gilts had higher specific IgG titres at D100 in the first and second cycles compared to CTR gilt serum (P=0.038). This difference was not seen in D110 serum, colostrum, or associated piglet serum titres in either cycle. Diet did not influence sow specific IgG titres in serum, though HiVit sow colostrum tended to have higher titres in the second reproductive cycle compared to CTR samples where no difference was seen in the first cycle (P=0.062). This difference was not reflected in associated piglet serum samples.

IMPLICATIONS

While the findings of this study are mixed, the implication that high vitamin supplementation in gilt gestation diets over two reproductive cycles can improve second litter weights by an average of 3 kilograms is very interesting. Improving lifetime performance of sows is important, and the possibility of a low-cost solution such as vitamin supplementation is worth research. Given the influence was only seen in dams fed the diet through their first parity, there may be some link between vitamin supplementation and the physiological development of the gilt herself which allows for improved performance in the second cycle, rather than the oft expected dip.

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Table 2. Average litter size of sows which farrowed in both reproductive cycles, before and after cross-fostering and at weaning.

	Sows								
	Cycle 1			Cycle 2			P value		
Piglets, mean (min, max)	HiVit (n=12)	CTR (n=11)	SEM	HiVit (n=12)	CTR (n=11)	SEM	Treatment	Cycle	Interaction
Before cross-fostering	15.25 (10, 19)	15.18 (7, 18)	0.57	14.75 (12, 18)	14.55 (9, 19)	0.57	0.89	0.37	0.91
After cross-fostering	14.50 (12, 17)	13.82 (12, 15)	0.25	12.85 (11, 14)	12.91 (11, 15)	0.25	0.67	0.0001	0.10
Weaning	13.33 (11, 15)	12.73 (11, 15)	0.34	11.17 (6, 13)	12.18 (10, 15)	0.34	0.72	0.0032	0.060

Note: SEM = standard error of the mean, HiVit = high vitamin diet, CTR = control diet

Table 3. Average litter size of gilts which farrowed in both reproductive cycles, before and after cross-fostering and at weaning.

	Gilts								
	Cycle 1			Cycle 2			P value		
Piglets, mean (min, max)	HiVit (n=8)	CTR (n=10)	SEM	HiVit (n=8)	CTR (n=10)	SEM	Treatment	Cycle	Interaction
Before cross-fostering	14.13 (12, 17)	15.00 (9, 19)	0.57	13.75 (9, 18)	12.60 (6, 17)	0.83	0.912	0.074	0.18
After cross-fostering	15.00 (14, 16)	14.10 (11, 16)	0.27	13.88 (12, 15)	13.30 (12, 14)	0.21	0.047	0.014	0.65
Weaning	14.38 (13, 16)	13.30 (10, 16)	0.34	13.75 (12, 15)	12.60 (11, 14)	0.25	0.014	0.15	0.93

Note: SEM = standard error of the mean, HiVit = high vitamin diet, CTR = control diet

Table 4. Average litter weights of gilts which farrowed in both reproductive cycles, before and after cross-fostering and at weaning.

	Gilts						
	Cycle 1		Cycle 2		P value		
Average litter weight, kg (±SD)	HiVit (n=8)	CTR (n=10)	HiVit (n=8)	CTR (n=10)	Treatment	Cycle	Interaction
Before cross-fostering	19.27 (2.40)	19.90 (2.69)	23.02 (2.80)	19.68 (4.38)	0.34	0.060	0.037
After cross-fostering	20.87 (2.97)	18.70 (3.34)	23.66 (3.80)	20.99 (2.51)	0.097	0.0064	0.76
Weaning	85.81 (10.72)	77.79 (14.32)	85.33 (17.73)	82.77 (8.08)	0.37	0.49	0.40

Note: SD = standard deviation, HiVit = high vitamin diet, CTR = control diet