Does providing high vitamin diets in gestation improve performance and passive immunity?

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Introduction

The importance of vitamin supplementation in preventing deficiencies is well understood and widely accepted. Therefore the provision of vitamins in livestock diets reduces production losses due to performance issues. Increased vitamin supplementation has been reported to enhance immune response to maternal vaccination, supporting the passage of maternal immunoglobulins, better protecting neonates from disease. In addition, increased vitamin supplementation can enhance reproductive performance. In an industry facing challenges related to sow performance and piglet survivability, the prospect of straightforward support coming from an existing aspect of production is welcome.

Numerous studies have approached the influence of increasing a subset of vitamins during gestation on both performance and immune factors in sows and piglets. However, no published works have looked at increasing the concentrations of all vitamins normally included in vitamin premixes.

This study set out to examine if how a high vitamin diet, containing concentrations of all vitamins beyond industry standard, would perform relative to diets formulated to NRC (2012) recommendations, which are below what is generally fed. We assessed reproductive and piglet performance, and concentrations and titres of immunoglobulin G, an important factor to passive immunity.

> "Overall there were no consistent significant differences between control and high vitamin diets."

What did we do?

Initially, sixty-six dams (32 primiparous gilts and 34 multiparous sows) were selected (Centre de Développement du Porc du Québec inc. (CDPQ) maternity barn) and randomly assigned to a control (CTR) or high vitamin (HiVit) diet in equal numbers. They were followed over two consecutive reproductive cycles. Sows and gilts were housed in breeding stalls before being transferred to electric sow feeder (ESF) group gestational housing, and transferred into farrowing room approximately 5 days prior to farrowing. The CTR diet was formulated to NRC (2012) recommendations, while the HiVit diet was formulated beyond industry standard for vitamin supplementation (Table 1). Feeding of the experimental diets began after insemination, regarded as day 0 (D0) and halted on the day of farrowing (D113-117). Feed distribution and intake were controlled and recorded, and sows vaccinated according to the farm's health protocol. Cross-fostering occurred between parities within treatment groups.

Body weight and backfat thickness were measured on days 0, 80, 100, 110, at weaning, day 134-137. For analysis of antibody titres in response to vaccination, blood was collected from all dams on days 0, 100, and 110 (collection occurred prior to vaccination on day 100). Colostrum was also collected, with samples being taken immediately before, after, or during farrowing; the first three pairs of teats were used for collection, avoiding underdeveloped or damaged teats. Litter characteristics were recorded over the course of lactation, with piglets being weighed on days 2 and 21 after birth. Blood was also collected from two average weight piglets from each litter on day 2 after birth, then from the same piglets on the day of weaning.

Our findings

Overall, there were no consistent significant differences between the CTR and HiVit diets in any measures assessed. Sow and gilt body conditions were not altered by allocated diet. 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 (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 (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 (P=0.037, treatment x cycle interaction). This weight difference was not carried through to weaning. Treatment did not alter sow litter weights at day 2 or 21.

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), though no difference between treatment groups was detected on D110. These differences were not detected in piglet serum, nor were they mirrored in specific IgG titres. Regarding specific IgG titres, HiVit gilts had higher serum 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.

Table 1. Vitamin premix composition

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
Choline (mg/kg)	1250	800
Copper (mg/kg) as CuSO4	25	25
Iron (mg/kg) as FeSO4	100	100
Iodine (mg/kg) as Ca (IO3)2	0.5	0.5
Manganese (mg/kg) as MnO	40	40
Selenium (mg/kg) as Na2SeO4	0.3	0.3
Zinc (mg/kg) as ZnO	120	120

** 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.
Note. HiVit = high vitamin diet, CTR = control diet

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What does this mean?

Though it has been reported that increased vitamin supplementation can enhance sow reproductive performance and passage of maternal immunity, the current study did not find consistent evidence that a high vitamin diet provides any advantage. While HiVit sows weaned more piglets in the first cycle, the inverse outcome was seen in the second cycle. Though HiVit gilts weaned more piglets than CTR gilts in both cycles, they also had more piglets added to their litters, which were initially the same size as CTR gilt litters. Initial live litter weight was higher for HiVit gilt litters in the second cycle, though this difference did not persist to weaning. The possible role of enhanced vitamin nutrition promoting piglet robustness as birth is promising.

Our immunological findings mirror our performance findings; differences were seen, but not consistently or in meaningful ways. In the first cycle, HiVit gilt serum collected on D100 displayed higher specific IgG titres than that of CTR gilts, suggesting an enhanced response to initial vaccination on D80 of gestation. This difference was not seen on D110, following the second dose given to gilts. There was also no difference detected in gilt colostrum samples or associated piglet serum samples. The same pattern was seen in the second reproductive cycle, with vaccine administration only occurring on D100 following blood collection. The assay used to determine specific IgG titres utilized antigens from pathogens that dams may have been exposed to, but not fallen sick from, so it must be stated that there is cross-over with circulating antibodies not associated with vaccination. Additionally, no differences were detected in gilt colostrum samples or associated piglet samples. For sow samples, specific IgG titres were not different in serum samples at any time point, but HiVit sow colostrum tended to increase in the second cycle, with a treatment and cycle interaction. Ultimately, this increase in colostral titres was not translated into piglet serum.

The Bottom Line

In this context, vitamin supplementation beyond industry standard did not provide any consistent advantage over supplementation at NRC 2012 standards, which are below what is normally fed. Ultimately, the findings of the current study indicate that current industry practices for gestational vitamin supplementation are sufficient, but that further research into vitamin supplementation in swine production is needed to optimize costs and production value. Extended studies on the impact of increased vitamin supplementation through both gestation and lactation could provide relevant findings, especially if considering precision feeding systems.

Acknowledgements

This project was completed with support from the Saskatchewan Agriculture Development Fund, Agriculture and Agri-Food Canada, the Centre de Développement du Porc du Québec inc., Manitoba Pork, DSM-Firmenich, and the Western College of Veterinary Medicine.

Over the past number of years Prairie Swine Centre has been successful securing funding (African Swine Fever Preparedness) to develop extension materials for small-scale pig producers throughout Canada. This project benefits the commercial pork industry by increasing engagement with this sector, reducing the ASF risk for Canada.