EFFECT OF DIETARY FOLIC ACID ADDITIONS ON SOW PERFORMANCE THROUGH TWO PARITIES[1]

R.C. Thaler, J.L. Nelssen,
R.D. Goodband, and G.L. Allee

Summary

A total of 153 gilts from three breeding groups were fed gestation/lactation diets supplemented with either 0, 1.5, or 6.0 g of folic acid/ton of complete feed for two consecutive parities. Serum folate levels were linearly increased by dietary additions of folic acid throughout gestation and lactation, but serum glucose and urea levels were unaffected by treatment. Stage of life cycle also had an effect on serum folate level. Generally, folate levels decreased from breeding to day 60 of gestation in parity 1 for all treatments, then increased through lactation. In parity 2, folate levels decreased up to day 90 of gestation, then increased through lactation. Number of pigs born alive, on day 14, and on day 21 were all quadratically increased by folic acid additions. Individual pig weights were similar on day 0 and day 14 of lactation, though less on day 21 for pigs from sows receiving 1.5 g/ton treatment. Total litter weights were quadratically increased on day 0 and day 14 by folic acid supplementation. Sow weight change and backfat thickness loss were unaffected by treatment during gestation, but quadratically decreased during lactation. Fewer sows receiving folic acid supplementation exhibited estrus by day 7 postweaning in parity 1; however, no differences were observed between treatments by day 14 nor were any observed by day 7 in parity 2. Also, conception rate was unaffected by folic acid additions. Based on these results, folic acid supplementation improves sow performance by increasing number of pigs born alive by 1 pig, and 1.5 g of folic acid/ton elicited the optimum response.

(Key Words: Folic Acid, Sow, Gestation, Lactation.)

Introduction

Folic acid, one of the B-complex vitamins, is an essential vitamin for swine. It is involved metabolically in many enzyme systems requiring the transfer of single carbon units, most notably those dealing with amino acid and nucleotide synthesis. The pig's folic acid requirement is met through dietary sources and, to a lesser extent, intestinal bacterial synthesis. Until recently, it has been thought that these sources adequately met the pig's need for this water-soluble vitamin. However, researchers from Canada have demonstrated that a folic acid deficiency exists in sows between weaning and mating and also during early gestation. They observed that the deficiency could be overcome with intramuscular injections of folic acid, which elevated serum folate levels and improved sow reproductive performance. The objective of this study, therefore, was to determine if dietary additions of folic acid would result in the same beneficial effect on sow reproductive performance.

[1]We gratefully acknowledge the support of Hoffmann-LaRoche, Inc., Nutley, NJ, for this study.

Procedures

A total of 153 gilts from three groups were utilized for two consecutive parities in this trial. Folic acid additions of either 0, 1.5, or 6.0 g/ton of complete feed were made to a .63% lysine, corn-soybean meal basal diet (Table 1). These levels were maintained in both gestation and lactation diets. Dietary treatments were initiated on day 0 postbreeding in parity 1 and were continued through day 21 of lactation in parity 2. All sows received 1.81 kg/head/day of the experimental diet from day 0 to day 108 of gestation, 2.27 kg/head/day from day 108 to farrowing, and 4.54 kg/head/day during lactation. Litter size was equalized within treatment group by 48 hours postpartum. The following criteria were measured at the designated times:

	Day of Gestation	Day of Lactation
Sow weight	0 & 108	0, 14, & 21
Sow backfat thickness	0 & 108	21
Litter weight		0, 14, & 21
Pig numbers		0, 14, & 21
Serum folate levels	0, 30, 60, 90, & 108	14 & 21

Also, all gilts were bled on day 15 and day 4 prebreeding, and serum was analyzed for progesterone to determine if gilts had previously cycled.

During breeding, females were checked by a boar for estrus twice daily. Twelve hr after being detected in heat, sows were artificially inseminated with pooled semen from 2 or more boars. This was then repeated 12 hours later. Sows were housed in individual stalls in a gestation barn until approximately 35 day postbreeding, and then moved to dirt lots. At day 108 of gestation, females were moved into farrowing crates in a farrowing house, where they stayed until being moved back to the gestation barn following weaning.

Since no treatment x parity interactions existed, values reported for sow and litter criteria are the pooled values from parities 1 and 2. Values for serum folate, glucose, and urea levels are not pooled and are presented by their respective parity.

Results and Discussion

Folic acid supplementation to sow gestation/lactation diets did affect sow performance and serum folate levels. Folate concentrations were affected both by dietary treatment and stage of life cycle. As shown in Figure 1, at most of the time periods measured, serum folate levels were linearly increased by dietary folic acid supplementation, indicating the sow's ability to utilize increasing amounts of dietary folic acid. During the first parity, folate levels decreased up to day 60 of gestation, and then greatly increased to day 108 for all treatment groups. In the following lactation, folate concentrations in the control sows continued to rise, but dropped slightly on day 14 in the sows receiving additional folic acid. However, these sows exhibited elevated folate levels on day 21. In parity 2, folate concentrations in all treatment groups decreased until day 90 of gestation and then rose through day 21 of lactation. Since folic acid plays an intricate role in DNA and RNA metabolism, it would appear logical that serum folate level would be affected by the amount of protein synthesis occurring at a particular moment. During early and mid-gestation, the fetus is growing at a very rapid rate, requiring a substantial amount of protein synthesis. With an increase in protein metabolism, a greater amount of folic acid is utilized, causing a depression of serum folate to occur.

Although the number of pigs born dead was unaffected by treatment (Figure 2), there was a quadratic increase (P<.02) in number of pigs born alive with sows receiving the 1.5 g/ton level of folic acid having an extra pig per litter when compared to sows receiving no supplemental folic acid (8.8 vs 7.8 pigs). This extra pig per litter increase was maintained through days 14 and 21 of lactation (P<.001). Since developing embryos undergo rapid protein synthesis during early and mid-gestation, a folic acid deficiency limiting protein synthesis would increase embryonic mortality and decrease litter size at farrowing. This would explain the increase in number of pigs born alive for sows receiving supplemental folic acid.

Individual pig weight was not affected by treatment on days 0 and 14 (Table 2); however, there was a quadratic decrease (P<.003) in pig weight on day 21 with pigs from sows receiving the 1.5 g/ton of folic acid diet having the lightest pig weights. Since there was an extra pig in those litters, milk production may have limited individual pig growth because less total nutrients may have been available for pigs nursing sows receiving the 1.5 g/ton of folic acid treatment.

Total litter weights on days 0 and 14 of lactation were heaviest for sows on the low level of folic acid supplementation (P<.04 & P<.01, respectively) but not different on day 21. This would again indicate that milk production was affecting pig performance during the latter stages of lactation.

Sow gestation weight gain and backfat thickness loss were unaffected by dietary treatment. However, lactational weight and backfat thickness losses were greatest for sows consuming diets fortified with 1.5 g/ton of folic acid (P<.06). This could be expected since sows with larger litters would be more likely to milk heavier, and if the 4.54 kg of feed/sow/day during lactation did not meet the sow's nutrient requirements, she would catabolize tissue to try to meet those needs.

Table 3. shows the effects of dietary folic acid on sow reproductive performance. Conception rate was unaffected by dietary treatment and was approximately 74% in parity 1 and 71% in parity 2. There were also no differences in percentage of gilts bred on their first heat cycle. However, it took sows receiving supplemental folic acid longer to return to estrus in parity 1. By day 7 postweaning, 91.4% of the control sows had exhibited estrus, while only 61.3% of the sows on the 1.5 g/ton treatment and 74.2% of the sows on the 6.0 g/ton treatment had returned to estrus by day 7. These differences were not observed by day 14 in parity 1 and did not exist in parity 2. The delay in return to estrus can be explained by sow condition. Since sows receiving supplemental folic acid had larger litters, they "milked down" more and lost more weight and backfat during lactation. This loss of condition has been shown to affect the number of days to return of estrus. However, this decrease in condition may have been alleviated if the sows were fed ad libitum during lactation.

Dietary additions of folic acid elevated serum folate levels and resulted in the same beneficial response in sow performance as seen in sows injected with folic acid. Since only two levels were investigated, no exact level of folic acid supplementation can be recommended until dose-titration studies are completed. However, it can be seen from this study that folic acid additions do enhance sow performance and should be considered when formulating sow diets.

Table 1. Diet Composition

Ingredient	Percentage	
	Gestation	Lactation
Corn	80.45	80.74
Soybean meal (44% CP)	15.55	15.40
Monocalcium phosphate (21% P, 18.5%Ca)	2.05	1.87
Limestone	1.10	1.25
Salt	.50	.45
Vitamin premix	.25	.20
Trace mineral mix	.10	.09
	100.00	100.00
Calculated Analysis, %		
Crude Protein	14.00	14.00
Lysine	.63	.63
Calcium	.90	.91
Phosphorus	.75	.71

Table 2. Effect of Folic Acid on Sow and Litter Performance[a]

Item	Folic Acid Level (g/ton)		
	0	1.5	6.0
Pig Weight, lb			
d 0	3.42	3.37	3.33
d 14	9.96	9.66	9.57
d 21[b]	13.14	12.41	12.96
Litter Weight, lb			
d 0[c]	26.41	28.88	26.79
d 14[b]	76.28	81.13	74.96
d 21	100.49	103.88	101.10
Gestation			
Weight gain, lb	87.52	89.29	88.85
Backfat loss, in	.07	.03	.02
Lactation			
Weight loss, lb[d]	24.18	29.32	26.43
Backfat loss, in[c]	.08	.12	.10

[a]Parities 1 and 2 combined.
[b]Quadratic effect (P<.01).
[c]Quadratic effect (P<.05).
[d]Quadratic effect (P<.06).

Table 3. Effect of Folic Acid on Reproductive Performance

Item	Folic Acid Level (g/ton) 0	1.5	6.0
Conception Rate			
Parity One	76.5	72.5	72.5
Parity Two	71.8	70.3	70.3
% Returned to Estrus			
Parity one			
By day 7[a]	91.4	61.3	74.2
By day 14	100.0	100.0	96.8
Parity two			
By day 7	100.0	100.0	100.0
Average Days to Estrus			
Parity one	6.20	7.45	6.85
Parity two	4.96	4.72	4.88
Gilts Bred at First Estrus	1	4	5

[a]Treatment effect (P<.01).

Joe Carpenter, research assistant, modifies a sow lot.

Figure 1. Serum Folate Concentrations

Parities One and Two

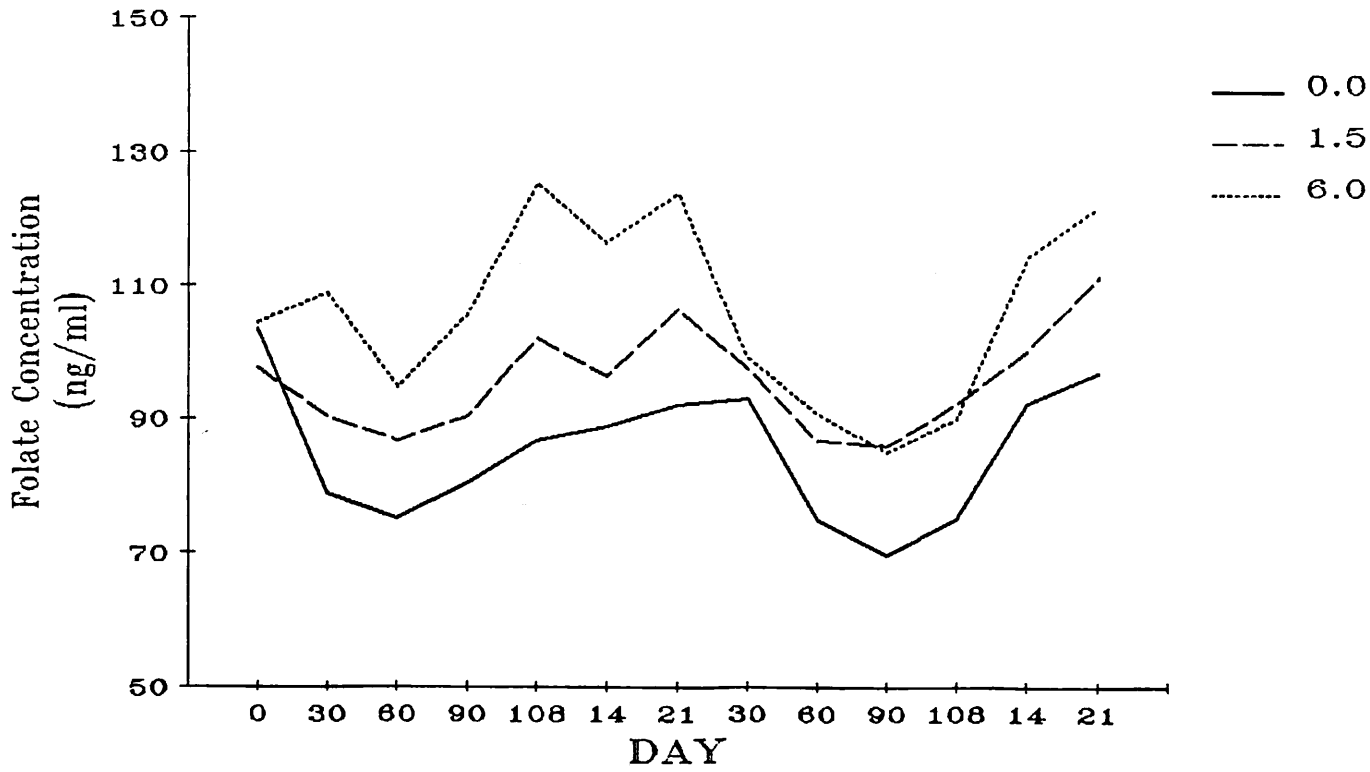

Figure 2. Litter Criteria-Number of Pigs