# Dietary Folic Acid Needs of High Lean Growth Pigs

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**Summary and Implications**

Twelve sets of five littermate barrows were utilized to determine the folic acid needs of a high lean genetic strain of pigs experiencing a low level of immune system activation. Pigs were penned individually and given ad libitum access to a corn, soybean meal, 27% milk product diet containing dietary concentrations of folic acid equivalent to 100, 200, 300, 400, and 500% of the current NRC (2) estimated requirement for 11 to 22 lb pigs. Pigs were started on test when the average litter weight reached 19 pounds and were taken off test as individual pigs reached a body weight of 51 pounds. Dietary folic acid concentration did not alter daily body weight gain, daily feed intake, feed:gain ratio, or rates of body protein and fat accretion.

Based on these data, a dietary folic acid concentration of 0.14 mg per pound of feed is adequate to support optimal growth and body nutrient accretion in high lean growth pigs fed corn-soybean meal-milk product diets from 19 to 51 pounds.

**Introduction**

The capacity of pigs for lean tissue has increased dramatically in recent years via the development of improved genetic strains and health management schemes (3,5). These high lean growth pigs also have a greater capacity for lean tissue growth which increases the animals need for nutrients required for lean tissue synthesis. High lean growth pigs have recently been shown to need up to 470% of the current NRC (2) estimated requirement for one or more of five B vitamins to optimize pig growth (4). However, the design of this study did not allow the determination of which of these B vitamins were actually needed in greater amounts.

Folic acid is involved in the transfer of single carbon units. These carbon units are then used in the synthesis of purine and pyrimidine bases for incorporation into nucleic acids. Nucleic acids are essential for muscle cell proliferation and protein synthesis. Muscle cell number is determined prenatally in pigs; however, it has been shown that 50 to 63% of the total muscle DNA is synthesized by satellite cells postnatally (1). Therefore, it was hypothesized that pigs with a high rate of protein accretion may need increased levels of folic acid for nucleic acid synthesis and ultimately protein synthesis.

The objective of this study was to determine the folic acid needs of high lean growth pigs fed from 19 to 51 pounds of body weight.

**Materials and Methods**

Pigs with a high genetic capacity for lean growth were placed in a sanitized, isolated nursery unit at Iowa State University. Upon arrival these 8 to 14-day-old pigs were treated with Ceftiofur (Naxcel) at days 0, 1, and 2 postarrival (2 mg/lb of body weight) and Ivermectin on day 1 postarrival. Pigs were penned individually and allowed to consume feed and water ad libitum. Ambient room temperature was initially maintained at 86°F and then lowered by 1°F every 4 days until a room temperature of 74°F was reached. Pigs were fed a milk diet for 8 days postarrival and then fed a basal diet (Table 1) low in folic acid until the average litter weight reached 19 lb of body weight. Twelve sets of 5 littermate barrows were used in this study. When the average pig weight in a litter reached 19±2 lb, pigs were randomly allotted within litter to one of the five dietary folic acid concentrations (0.14, 0.27, 0.41, 0.55, 0.68 mg/lb of the basal diet). These concentrations are equivalent to 100, 200, 300, 400, and 500% of current NRC (2) folic acid requirements for 11 to 22 pound pigs. All other vitamins were supplemented to provide 600% of estimated NRC (2) requirements. Test diets were pelletted through a 3/16" die.

**Table 1. Basal Diet Composition**.

| Ingredient | % |
|---|---|
| Corn | 41.69 |
| Soybean Meal, dehulled | 19.25 |
| Casein | 12.00 |
| Lactose | 15.00 |
| Corn oil | 5.00 |
| Tryptosine | 0.42 |
| L-Threonine | 0.25 |
| DL-Methionine | 0.32 |
| Dicalcium Phosphate | 3.45 |
| Limestone | 0.69 |
| Salt | 0.40 |
| Trace mineral-vitamin premix[a] | 0.54 |
| Choline chloride | 0.29 |
| Folic acid carrier(starch) | 0.20 |
| Antimicrobial agent[b] | 0.50 |

[a]Contributed the following per lb of diet: biotin, .14 mg; niacin, 41 mg; pantothenic acid, 27 mg; riboflavin, 10 mg; pyridoxine, 4 mg; thiamin, 3 mg; vitamin $B_{12}$, 0.048 mg; vitamin E, 43 IU; vitamin A, 6,000 IU; vitamin $D_3$, 601 IU; vitamin K, 1.4 mg; vitamin C, 136 mg; Fe, 111 mg; Zn, 116 mg; Mn, 38 mg ; Cu, 11 mg; I, 1.3 mg; Se, .14 mg.

[b]Contributed the following per lb of diet: chlortetracycline, 50 mg; sulfathiazole, 50 mg; penicillin, 25 mg.

Pig weights and feed consumptions were measured at 4-day intervals until the pigs reached 51±2 pounds body weight. Pigs were injected intravenously with deuterium oxide at the beginning and end of the study and bled 2 hours post-injection via orbital sinus. The blood samples

were sublimated to obtain the water-deuterium oxide mixture component in the blood. Sublimates were then analyzed by infrared spectroscopy to estimate body water in the pigs. Equations were then applied to estimate protein and fat from body water.

To quantify the immune status of the pigs all pigs were bled via orbital sinus at the initiation and end of the study to determine serum concentrations of the acute phase protein alpha-1-acid glycoprotein (AGP). Serum folic acid concentrations also were evaluated on six replications at body weights of 19, 34, and 51 pounds.

Data were analyzed as a completely randomized block design. The pig was considered the experimental unit. Least square means are reported. Pig gains and feed utilization at different pig body weights were analyzed as a repeated measure.

## Results and Discussion

The experimental animals exhibited a high rate of lean growth and a low level of immune system activation. Pooled across all diets the pigs daily body weight gain and feed:gain ratio averaged 1.45 lb/day and 1.23, respectively. Serum AGP concentrations averaged 656 and 552 μg/ml at the start and end of the study. From previous research done at our station, this serum AGP concentration would indicate that the pigs experienced a low level of anitgen exposure.

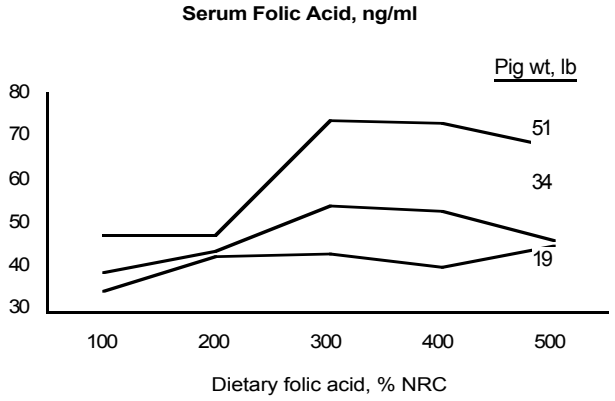



**Figure 1. Effect of dietary folic acid concentration on serum folic acid concentrations in pigs at body weights (BW) of 19, 34, and 51 pounds.**

Serum folic acid concentrations were low (35 to 45 ng/ml) in pigs at the initiation of the study, which indicates that body reserves and dietary intakes likely were marginal. As the pigs grew to 34 and 54 lb of body weight, serum folic acid concentrations increased, particularly in animals consuming the higher folic acid concentration. These data indicate that dietary intakes of 300 to 500% of the NRC (2) requirement met or exceeded the pigs folic acid needs.

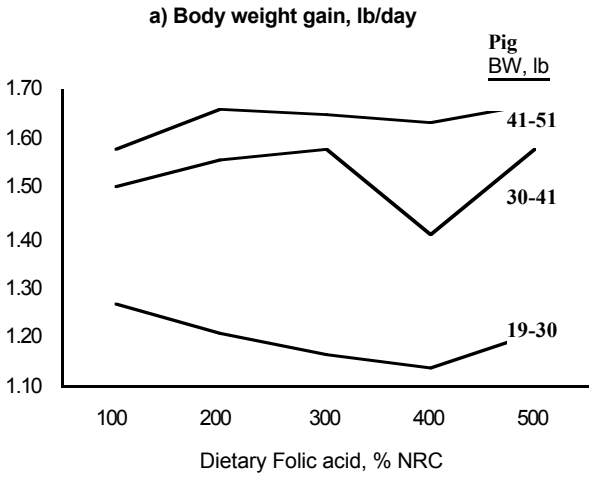
Daily body weight gain, daily feed intake, feed:gain ratio were not altered by dietary folic acid concentration (Table 2). Daily body protein and fat accretion also were not altered by dietary folic acid concentration (Table 2). This would suggest that genetically lean pigs of a high health status have a dietary requirement for folic acid of no more than 0.14 mg per pound of feed when fed a corn-soybean meal diet from 19 to 51 lb.

**Table 2. Pig growth and feed utilization, body nutrient accretion, and serum AGP concentrations.**

| | Folic acid concentration, % NRC | | | | |
|---|---|---|---|---|---|
| Item | 100 | 200 | 300 | 400 | 500 |
| No. of pens | 12 | 12 | 12 | 12 | 11 |
| Pig weight, lb | | | | | |
| Initial | 18.8 | 18.7 | 19.0 | 18.5 | 18.6 |
| Final | 51.3 | 51.1 | 52.1 | 50.2 | 51.8 |
| Growth and feed utilization, lb/day[a] | | | | | |
| Feed | 1.80 | 1.76 | 1.85 | 1.71 | 1.81 |
| Gain | 1.45 | 1.44 | 1.47 | 1.39 | 1.47 |
| Feed/gain | 1.25 | 1.22 | 1.26 | 1.23 | 1.23 |
| Body nutrient accretion, lb/day[a] | | | | | |
| Protein | .251 | .249 | .257 | .246 | .260 |
| Fat | .145 | .150 | .128 | .130 | .128 |
| Serum AGP μg/ml[b] | | | | | |
| Initial | 660 | 630 | 600 | 670 | 725 |
| Final | 556 | 524 | 524 | 584 | 574 |

[a]Nonsignificant differences among dietary treatment groups, P>0.1
[b]Serum alpha-1-acid glycoprotein (AGP) concentration

Pig weights and feed intake were monitored every 4 days to determine the dietary folic acid needs of pigs at various stages of growth. Daily body weight gain, daily feed intake, or feed:gain ratio were not altered by dietary folic acid concentration in the three stages of growth (19 to 30, 30 to 41, and 41 to 51 pounds) evaluated (Figure 2).



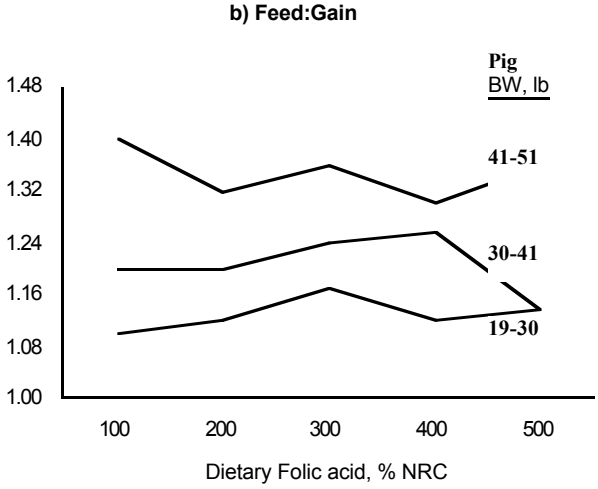




**Figure 2. Effect of dietary folic acid concentration on (a) daily body weight gain and (b) feed:gain ratio of pigs fed from body weights (BW) of 19 to 30, 30 to 41, and 41 to 51 pounds. Dietary folic acid concentration expressed as a percentage of estimated NRC (2) requirement for 11 to 22 pound pigs.**

## References

1. Allen, R., et al. 1979. J. Anim. Sci. 49:115.
2. NRC. 1988. Nutrient Requirements of Swine. National Academy of Sciences, Washington, D.C.
3. Stahly et. al. 1994. ISU Swine Research Report, ASL-R1165
4. Stahly et al. 1995. ISU Swine Research Report, ASL-R1263.
5. Williams et. al. 1997. J. Anim. Sci. 75:2463.