

# RESPONSE OF 60 TO 110 KG PIGS TO DIETARY BETAINES SUPPLEMENTATION

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## Introduction

Betaine, a byproduct of molasses production from the sugar beet, has recently received a great deal of attention as a livestock feed additive. Little is currently known about the exact action of betaine on body metabolism, however, betaine is an intermediate in the metabolism of choline and has shown possibility as a replacement for choline and methionine in poultry diets. Betaine has also been suggested and promoted for swine to reduce carcass backfat, increase lean composition, as well as improve feed efficiency. Subsequently, it was suggested that the betaine feeding should be initiated at lighter weight and fed for longer intervals. Thus, the objective of this experiment was to evaluate the effectiveness of betaine in altering pig performance and composition from 60 to 110 kg live weight. A recent study by Schinckel and Cera investigated responses to betaine in barrows and gilts of two different lean genetic potentials, when fed from either 83 kg or 104 kg to about 116 kg body weight. Results showed no influence of feeding betaine on either fat depth, loin eye area or lean percentage for pigs in either genotype and either sex. An impersoned feed-per-gain ratio resulted for gilts, but not barrows, when betaine was fed beginning at either 83 kg or 104 kg.

## Materials and Methods

A total of 400 pigs (barrows:gilts, 1:1) were obtained from a commercial source at an average age of 12-d and an average weight of 3.8 kg. Upon arrival, pigs were injected with 1 cc. penicillin, weighed, and randomly assigned to pens (6 - 7 pigs per pen) in medicated early weaning (MEW) facilities located at Purdue University based upon initial weight. All pigs were fed a common corn-soybean meal pelleted diet until an average weight of 11.3 kg was achieved. Pigs were subsequently trucked approximately 2.3 km to an open-fronted confinement facility. Pigs were weighed and assigned to one of 96 pens (1.88 m X 3.66 m) on the basis of initial weight and assigned to either a high or low dietary lysine diet (4 - 5 pigs per pen). When an average pen weight of 61.6 kg was attained, dietary betaine was added to both the high and low lysine diets at either 0 or 1 g/kg. Pigs were slaughtered and an average weight of 113.6 kg. Pig weights and feed intakes were recorded weekly from arrival to 15.4 kg, and every 28 d thereafter. Real-time ultrasound measurement were taken on 64 pigs (16 pigs per treatment) at average weights of  $61.6 \pm .50$ ,  $90.3 \pm .66$ , and on all pigs at  $113.6 \pm .83$  kg. Typical corn-soybean meal pelleted diets, obtained from a commercial source, were fed during the entire experiment. A common diet was fed from the pigs arrival to an average weight of 11.3 kg. The high or low lysine diets contained the following dietary lysine levels for each weight interval: 1.25 or 1.15 % lysine from 11.3 to 34.0 kg, 1.00 or .85 % lysine from 34.0 to 61.7 kg, and .85 or .70 % lysine from 61.7 to 113.6 kg live weight. From 61.7 to 113.6 kg, the .85 or .70 % lysine diets were supplemented with either 0 or 1 g/kg betaine (Table 1). Diets met or exceeded current nutrient recommendations (NRC, 1988) for the 50 to 110 kg pig. Each diet

was supplemented with 300 mg/kg choline, as choline chloride, with a total calculated choline level of 1200 mg/kg.

## Results and Discussion

*Growth performance* Data presented within this paper are for the weight ranges from 61.6 to 113.6 kg live weight. Barrows and gilts receiving the high lysine diets grew fastest ( $P < .05$ ) from 11.3 to 61.7 kg and thus initial weight served as a covariate in analyzing pig performance from 61.6 kg to 113.6 kg (Table 2). During the first 28 d and the entire 56 d during which betaine was included in the diet, no effect of betaine ( $P > .10$ ) on growth performance was observed.

However, from d 28 to 56, a lysine X betaine interaction ( $P < .05$ ) was observed with pigs growing faster either when fed .70% lysine and 0 g/kg betaine but with 1 g/kg betaine when fed .85% lysine (Table 3). Also, pigs fed .70% lysine without betaine gained the fastest of all groups during this period. Barrows and gilts receiving the low (.70% lysine) diets grew fastest ( $P < .05$ ) for the entire 56-day diets. Gilts had lower feed intakes ( $P < .05$ ) and converted feed into body weight gain more efficiently ( $P < .05$ ) than barrows from 61.7 to 113.6 kg. A lysine X betaine interaction was also observed for feed intake and gain:feed ratio from d 28 to 56 with feed intake being lowest and gain:feed ratio highest when pigs were fed diets containing either .70% lysine and 0 g/kg betaine or .85% lysine and 1 g/kg betaine. However, no effect of betaine on gain per feed ratio for the overall 56 d resulted. Differences in growth rate from 11.3 kg resulted in barrows being heavier than gilts ( $P < .05$ ) at slaughter, and pigs receiving .70% lysine, 0 g/kg betaine being heavier than pigs on the same lysine level but receiving 1 g/kg betaine, while pigs receiving .85 % lysine were heaviest at slaughter when supplemented with 1 g/kg betaine ( $P < .05$ ).

*Body composition* Body composition (Table 4) was adjusted for differences in live weight when real-time ultrasound measurements were obtained. Regardless of live weight, gilts had larger ( $P < .05$ ) loin-eye measurements, although live weight was lower than for barrows. Loin-eye measurements were unaffected by dietary lysine or betaine. First and last rib fat measurements at 61.6 kg were lower ( $P < .05$ ) for gilts than for barrows, and last rib and last lumbar vertebrae fat measurements were lower ( $P < .05$ ) for pigs fed the higher dietary lysine regime from 11.3 to 61.7 kg. Although pigs were randomized to betaine treatment within lysine level, last rib fat measurements at 61.6 kg were higher ( $P < .05$ ) for pigs assigned to the 1 g/kg betaine diets. Little effect of betaine on fat deposition was detected by 90.3 kg after 28 d of betaine supplementation. After 56 d of betaine supplementation and an average weight of 113.6 kg, a betaine X sex ( $P < .05$ ) interaction resulted in positive response of barrows to betaine ( $P < .05$ ) resulting in a net reduction in fat deposition (Table 5) at the first, last, and last lumbar vertebrae (Table 4). Betaine was not effective in reducing fat deposition in gilts. Rate of lean deposition (Table 4), which was higher for the pigs fed the .70% lysine diets from 61.7 kg to slaughter, was similar for both sexes and was not affected by betaine supplementation. The efficiency with which feed was converted into lean deposition, however, was higher for gilts and for pigs fed the .70% lysine diets. Although betaine supplementation was effective in reducing fat measurements only when fed to barrows, an overall reduction in the rate of fat accretion was detected regardless of sex or dietary lysine level.

## Summary

The results of this experiment indicate that growth performance and gain:feed ratio may be enhanced in finishing pigs when betaine is included in the diet at 1 g/kg, if dietary lysine is in excess of the level needed for maximal growth performance. Thus, betaine supplementation may not be effective in enhancing growth performance when diets are formulated to closely match the animals nutrient requirements. Betain had no overall effect on daily gain, lean gain, gain-feed ratio for combined sexes or lean gain to feed ratio. The .70% lysine diet fed from 61.6 to 113.6 kg was effective not only in maximizing growth performance within this study, but also resulted in a small reduction in carcass backfat. In this study, the 85% lysine diets were higher than optimal to essential amino acids. Although betaine supplementation did not result in improvements in growth performance, 1 g/kg betaine was effective in inducing a slight reduction (.17 cm, or .06 in) in fat depth in barrows, regardless of dietary lysine level. Although this reduction in backfat was statistically significant, its economic importance is certainly questionable. Betaine had no effect on carcass composition in gilts. The effects of betaine supplementation may only be observed in finishing pigs which are split-sex fed. Also, a response to betaine may only occur in diets which are not optimal in lysine level or not well-balanced for amino acids relative to lysine. Therefore, most profitable feeding program must utilize diets that are close to optimal for amino acid requirements.

Table 1. Composition of dietary treatments

| Lysine, %                       | .70   |       | .85   |       |
|---------------------------------|-------|-------|-------|-------|
| Betaine, g/kg                   | 0     | 1     | 0     | 1     |
| Ingredient, %                   |       |       |       |       |
| Corn                            | 72.41 | 72.30 | 67.04 | 66.94 |
| Soybean meal                    | 12.92 | 12.93 | 18.43 | 18.44 |
| Wheat middlings                 | 10.00 | 10.00 | 10.00 | 10.00 |
| Dicalcium phosphate             | .84   | .84   | .70   | .70   |
| Limestone                       | .59   | .59   | .59   | .59   |
| Salt                            | .35   | .35   | .35   | .35   |
| Vitamin premix <sup>a</sup>     | .05   | .05   | .05   | .05   |
| Trace mineral mix <sup>b</sup>  | .11   | .11   | .11   | .11   |
| Choline chloride <sup>c</sup>   | .05   | .05   | .05   | .05   |
| Vitamin E                       | .05   | .05   | .05   | .05   |
| Lysine-HCl                      | .08   | .08   | .07   | .07   |
| Betaine                         | ---   | .10   | ---   | .10   |
| Tylan <sup>d</sup>              | .05   | .05   | .05   | .05   |
| Wood sugar binde                | 2.5   | 2.5   | 2.5   | 2.5   |
| Total                           | 100   | 100   | 100   | 100   |
| Calculated nutrient composition |       |       |       |       |
| ME, kcal/kg                     | 3,112 | 3,109 | 3,117 | 3,114 |
| CP, %                           | 12.7  | 12.7  | 15.0  | 15.0  |
| Lysine, %                       | .71   | .71   | .85   | .85   |
| Ca, %                           | .70   | .70   | .70   | .70   |
| P, %                            | .50   | .50   | .50   | .50   |

<sup>a</sup>Provides per kilogram of diet: vitamin A, 5,000 IU; vitamin D<sub>3</sub>, 1,450 IU; vitamin E, 46 IU; vitamin B<sub>12</sub>, 35 mg; riboflavin, 5.82 mg; d-pantothenic acid, 23.3 mg; niacin, 29 mg.

<sup>b</sup>Provides per kilogram of diet: Zn, 126 mg; Cu, 12.6 mg; Fe, 100 mg; Mn, 50 mg; I, .50 mg; Se, 250 µg.

<sup>c</sup>Provides per kilogram of diet: Choline, 300 mg.

<sup>d</sup>Provides 10.4 mg tylosin phosphate per kilogram of diet

Table 2. Growth performance of pigs fed at two lysine and betaine levels.

| Item                  | Sex    |       | Lysine, % |       | Betaine, g/kg |       | SEM  | ANOVA               |
|-----------------------|--------|-------|-----------|-------|---------------|-------|------|---------------------|
|                       | Barrow | Gilt  | .70       | .85   | 0             | 1     |      |                     |
| Live weight, kg       |        |       |           |       |               |       |      |                     |
| Day 0                 | 62.5   | 60.8  | 60.7      | 62.6  | 61.6          | 61.8  | .50  | Lys, Sex            |
| Day 28                | 92.2   | 88.7  | 89.7      | 91.2  | 90.2          | 90.7  | .67  | Lys, Sex            |
| Day 56                | 115.6  | 111.5 | 113.3     | 113.8 | 113.0         | 114.1 | .83  | Lys X Bet, Sex      |
| Live weight gain, g/d |        |       |           |       |               |       |      |                     |
| Day 0 - 28            | 1053   | 1003  | 1044      | 1012  | 1026          | 1030  | 9.99 | Lys, Sex            |
| Day 28 - 56           | 885    | 890   | 917       | 858   | 876           | 894   | 17.2 | Lys, Lys X Bet      |
| Day 0 - 56            | 976    | 944   | 980       | 935   | 953           | 962   | 10.4 | Lys, Sex            |
| Feed intake, kg/d     |        |       |           |       |               |       |      |                     |
| Day 0 - 28            | 3.55   | 3.20  | 3.40      | 3.35  | 3.37          | 3.39  | .02  | Lys, Sex            |
| Day 28 - 56           | 3.92   | 3.64  | 3.80      | 3.76  | 3.79          | 3.76  | .04  | Lys X Bet, Lys, Sex |
| Day 0 - 56            | 3.75   | 3.41  | 3.62      | 3.55  | 3.57          | 3.59  | .03  | Lys, Sex            |
| Gain:feed, g:g        |        |       |           |       |               |       |      |                     |
| Day 0 - 28            | .29    | .32   | .31       | .30   | .30           | .30   | .003 | Lys, Sex            |
| Day 28 - 56           | .22    | .25   | .24       | .23   | .23           | .24   | .005 | Lys, Lys X Bet, Sex |
| Day 0 - 56            | .26    | .28   | .27       | .26   | .26           | .27   | .003 | Lys, Sex            |

Table 3. Lysine X Betaine interaction for growth performance of pigs fed at two lysine and betaine levels from day 28 - 56, adjusted for final weight.

| Lysine, %                      | .70           |       | .85   |       | SEM  |
|--------------------------------|---------------|-------|-------|-------|------|
|                                | Betaine, g/kg | 0     | 1     | 0     |      |
| Gain, g/d <sup>a</sup>         | 931           | 899   | 822   | 899   | 24.9 |
| Intake, kg/d <sup>a</sup>      | 3.74          | 3.77  | 3.77  | 3.81  | .54  |
| Gain:feed, g:g <sup>a</sup>    | .25           | .24   | .22   | .24   | .006 |
| Day 56 weight, kg <sup>a</sup> | 113.7         | 112.9 | 112.2 | 115.5 | 1.18 |

<sup>a</sup>Lysine X betaine interaction, P<.05.

Table 4. Carcass composition at various weights for pigs fed two lysine and betaine levels as measured by real-time ultrasound and accretion rates from 60 to 110 kg.

| Item                          | Sex    |       | Lysine, % |       | Betaine, g/kg |       | SEM  | ANOVA               |
|-------------------------------|--------|-------|-----------|-------|---------------|-------|------|---------------------|
|                               | Barrow | Gilt  | .70       | .85   | 0             | 1     |      |                     |
| Weight, kg                    |        |       |           |       |               |       |      |                     |
| Day 0                         | 62.5   | 60.8  | 60.6      | 62.6  | 61.8          | 61.3  | .50  | Lys, Sex            |
| Day 28                        | 92.1   | 88.6  | 89.6      | 91.2  | 90.1          | 90.6  | .67  | Lys, Sex            |
| Day 56                        | 115.7  | 111.5 | 113.3     | 113.9 | 113.0         | 114.2 | .83  | Lys X Bet, Sex      |
| Loineye area, cm <sup>2</sup> |        |       |           |       |               |       |      |                     |
| Day 0                         | 19.7   | 20.8  | 20.1      | 20.5  | 21.2          | 22.4  | .27  | Sex                 |
| Day 28                        | 24.6   | 26.1  | 25.2      | 25.6  | 25.5          | 25.2  | .39  | Sex                 |
| Day 56                        | 26.7   | 28.2  | 27.6      | 27.3  | 27.5          | 27.4  | .26  | Sex                 |
| First rib fat, cm             |        |       |           |       |               |       |      |                     |
| Day 0                         | 2.77   | 2.67  | 2.74      | 2.69  | 2.69          | 2.74  | .03  | Sex                 |
| Day 28                        | 3.81   | 3.63  | 3.73      | 3.71  | 3.73          | 3.71  | .05  | Sex                 |
| Day 56                        | 4.42   | 3.94  | 4.14      | 4.22  | 4.24          | 4.11  | .04  | Bet, Sex, Bet X Sex |
| Last rib fat, cm              |        |       |           |       |               |       |      |                     |
| Day 0                         | 1.50   | 1.42  | 1.50      | 1.42  | 1.39          | 1.49  | .03  | Sex, Lys, Bet       |
| Day 28                        | 2.34   | 1.93  | 2.16      | 2.13  | 2.16          | 2.13  | .04  | Sex                 |
| Day 56                        | 2.72   | 2.16  | 2.41      | 2.49  | 2.49          | 2.41  | .03  | Sex, Bet, Bet X Sex |
| Last lumbar vertebrae fat, cm |        |       |           |       |               |       |      |                     |
| Day 0                         | 1.78   | 1.78  | 1.80      | 1.78  | 1.75          | 1.80  | .03  | Sex X Lys           |
| Day 28                        | 2.36   | 2.18  | 2.24      | 2.31  | 2.26          | 2.29  | .04  | Sex                 |
| Day 56                        | 2.74   | 2.49  | 2.59      | 2.67  | 2.67          | 2.57  | .02  | Bet, Bet X Sex      |
| Fat Free Lean                 |        |       |           |       |               |       |      |                     |
| Gain, g/d                     | 325    | 331   | 345       | 311   | 326           | 331   | 5.0  | Lys                 |
| Gain:feed, g/d                | .086   | .097  | .095      | .087  | .091          | .092  | .001 | Sex, Lys            |
| Fat gain, g/d                 | 221    | 185   | 208       | 198   | 209           | 197   | 5.0  | Sex, Bet            |

Table 5. Betaine and betaine X sex interactions for real-time ultrasound fat measurements on d 56.

| Sex                                    | 0       |       | 1       |       | SEM  |
|--|---------|-------|---------|-------|------|
|  | Barrows | Gilts | Barrows | Gilts |      |
| First rib fat, cm <sup>ab</sup>        | 4.55    | 3.96  | 4.32    | 3.94  | .053 |
| Last rib fat, cm <sup>ab</sup>         | 2.82    | 2.16  | 2.64    | 2.18  | .041 |
| Last lumbar vertebra, cm <sup>ab</sup> | 2.84    | 2.46  | 2.67    | 2.49  | .036 |

<sup>a</sup>Betaine (P<.05)<sup>b</sup>Betaine x sex interaction (P<.05)

