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## Lysine Supplementation of Low-Protein Diets for Finishing Pigs

Gary L. Allee

### Summary

Four experiments involving 311 finishing pigs (112 to 220 pounds) were conducted to determine the minimum level of soybean meal necessary to supply all essential amino acids except lysine that are deficient in milo or corn and to determine the influence of lysine supplementation of low-protein diets for finishing pigs. The results of three trials using milo as the grain source demonstrated that pigs fed milo supplemented with 7.5% soybean meal and lysine gained at the same rate and were just as efficient in feed utilization as pigs fed milo supplemented with 15% soybean meal. Carcass composition as measured by backfat thickness, loin-eye area, and percentage of the carcass in ham and loin did not differ between pigs fed milo supplemented with 7.5% soybean meal and lysine and pigs fed the control diet containing 15% soybean meal. In the fourth trial with corn as the grain source, weight gain and feed efficiency of pigs fed corn supplemented with 7.5% soybean and lysine were equivalent to that of pigs fed the control diet containing 15% soybean meal. These results demonstrate that the amount of soybean meal in the diet of finishing pigs can be reduced approximately 50% by adding crystalline lysine with no detrimental effects on weight gain, feed efficiency, or carcass composition.

### Introduction

Previous research (Swine Industry Day, 1971) indicated that milo alone or milo supplemented with lysine was inadequate as the sole source of amino acids for finishing pigs. The present study was designed to determine the minimum level of soybean meal necessary to supply all essential amino acids except lysine for finishing pigs fed milo or corn, and to determine the influence of lysine supplementation of these diets.

### Procedures

General. All trials were conducted in a modified open-front building with concrete, slatted floor. Each pen (6' x 15') contained a two-hole self-feeder and an automatic watering cup.

Pigs were randomly allotted to treatments by breed, sex, and initial weight. Pig performance was summarized on an equal-time basis; that is, when the fastest gaining pen of pigs averaged 220 pounds.

Diets. Protein content and amino acid analyses of the milo used are shown in table 3.1. The control diet contained 15% soybean meal with lysine content of 0.60-0.65%. Lysine as L-lysine·HCl, feed grade 98% (78% L-lysine) was added so that all diets contained approximately the same level of lysine as the control diet. All diets were fed in pellet form.

Table 3.1. Protein and Essential Amino Acid Analyses of Milo

| Amino acid       | Percent of the sample |           |
|------------------|-----------------------|-----------|
|                  | Trial I and II        | Trial III |
| Arginine         | 0.540                 | 0.399     |
| Histidine        | 0.245                 | 0.244     |
| Isoleucine       | 0.316                 | 0.346     |
| Leucine          | 0.997                 | 1.201     |
| Lysine           | 0.301                 | 0.265     |
| Methionine       | 0.118                 | 0.094     |
| Phenylalanine    | 0.419                 | 0.495     |
| Threonine        | 0.315                 | 0.324     |
| Tryptophan       | -----                 | -----     |
| Valine           | 0.444                 | 0.438     |
| Crude protein, % | 9.85                  | 9.01      |

Trial I. Seventy-five pigs averaging 110 pounds were used to evaluate these diets: (1) milo + lysine, (2) milo + lysine + methionine, (3) milo + 5% SBM + lysine, (4) milo + 10% SBM + lysine, (5) milo + 15% SBM (control diet). Composition of the diets is shown in table 3.2.

Trial II. Fifty-four pigs averaging 112 pounds were used to evaluate these diets: (1) milo + 5% SBM + lysine, (2) milo + 7.5% SBM + lysine, (3) milo + 15% SBM (control diet).

Trial III. Seventy-seven Duroc pigs averaging 119 pounds were randomly assigned to one of these diets: (1) milo + 5% SBM, (2) milo + 5% SBM + lysine, (3) milo + 7.5% SBM, (4) milo + 7.5% SBM + lysine, (5) milo + 10% SBM, (6) milo + 10% SBM + lysine, (7) milo + 15% SBM.

Composition of the diets used is shown in table 3.3. Pigs were individually removed for slaughter at approximately 220 pounds.

Table 3.2. Composition of Diets (Trial I)

| Ingredients                                     | Milo<br>+<br>Lysine | Milo<br>+<br>Lysine<br>+<br>Methionine | Milo<br>+<br>5% SBM<br>+<br>Lysine | Milo<br>+<br>10% SBM<br>+<br>Lysine | Milo<br>+<br>15% SBM |
|-------------------------------------------------|---------------------|----------------------------------------|------------------------------------|-------------------------------------|----------------------|
| Milo                                            | 95.95               | 95.85                                  | 91.31                              | 86.55                               | 81.70                |
| Soybean meal (44%)                              | -----               | -----                                  | 5.00                               | 10.00                               | 15.00                |
| Dicalcium phosphate                             | 1.7                 | 1.7                                    | 1.10                               | 1.00                                | 1.00                 |
| Limestone                                       | 0.4                 | 0.4                                    | 0.80                               | 0.80                                | 0.80                 |
| Salt                                            | 0.5                 | 0.5                                    | 0.50                               | 0.50                                | 0.50                 |
| Vitamin, trace mineral<br>and antibiotic premix | 1.0                 | 1.0                                    | 1.00                               | 1.00                                | 1.00                 |
| L-lysine·HCl (feed grade 98%)                   | 0.45                | 0.45                                   | 0.29                               | 0.15                                | -----                |
| DL-methionine                                   | <u>-----</u>        | <u>0.10</u>                            | <u>-----</u>                       | <u>-----</u>                        | <u>-----</u>         |
|                                                 | 100.0               | 100.0                                  | 100.0                              | 100.0                               | 100.0                |
| Crude protein, %                                | 9.45                | 9.45                                   | 11.19                              | 12.92                               | 14.65                |
| Lysine, %                                       | 0.65                | 0.65                                   | 0.65                               | 0.65                                | 0.65                 |

Table 3.3. Composition of Diets (Trial III)

| Ingredients                                     | Milo<br>+<br>5% SBM   | Milo<br>+<br>5% SBM<br>+<br>Lysine | Milo<br>+<br>7.5% SBM | Milo<br>+<br>7.5% SBM<br>+<br>Lysine | Milo<br>+<br>10% SBM  | Milo<br>+<br>10% SBM<br>+<br>Lysine | Milo<br>+<br>15% SBM  |
|-------------------------------------------------|-----------------------|------------------------------------|-----------------------|--------------------------------------|-----------------------|-------------------------------------|-----------------------|
| Milo                                            | 91.60                 | 91.32                              | 89.20                 | 88.99                                | 86.70                 | 86.57                               | 81.70                 |
| Soybean meal (44%)                              | 5.00                  | 5.00                               | 7.50                  | 7.50                                 | 10.00                 | 10.00                               | 15.00                 |
| Dicalcium phosphate                             | 1.10                  | 1.10                               | 1.00                  | 1.00                                 | 1.00                  | 1.00                                | 1.00                  |
| Limestone                                       | 0.80                  | 0.80                               | 0.80                  | 0.80                                 | 0.80                  | 0.80                                | 0.80                  |
| Salt                                            | 0.50                  | 0.50                               | 0.50                  | 0.50                                 | 0.50                  | 0.50                                | 0.50                  |
| Vitamin, trace mineral<br>and antibiotic premix | 1.00                  | 1.00                               | 1.00                  | 1.00                                 | 1.00                  | 1.00                                | 1.00                  |
| L-Lysine·HCl (feed grade 98%)                   | <u>-----</u><br>100.0 | <u>0.28</u><br>100.0               | <u>-----</u><br>100.0 | <u>0.21</u><br>100.0                 | <u>-----</u><br>100.0 | <u>0.13</u><br>100.0                | <u>-----</u><br>100.0 |
| Crude protein, %                                | 10.44                 | 10.44                              | 11.34                 | 11.34                                | 12.21                 | 12.21                               | 13.96                 |
| Lysine, %                                       | 0.38                  | 0.60                               | 0.44                  | 0.60                                 | 0.50                  | 0.60                                | 0.63                  |

Trial IV. Treatments employed in trial IV were identical with those in trial III with the exception that corn was used as the grain source replacing milo. One hundred five pigs averaging 118 pounds were randomly assigned to 14 pens representing two replications of the seven dietary treatments.

### Results and Discussion

The results of trial I are shown in table 3.4. Pigs fed milo supplemented with lysine or lysine and methionine gained significantly ( $P < .05$ ) slower and required more feed per pounds of gain than pigs fed any of the other diets. Pigs fed milo supplemented with 5% SBM and lysine gained 0.1 pound a day less than pigs on the control (15% SBM) diet. Gains of pigs fed milo supplemented with 10% SBM and lysine exceeded ( $P < .05$ ) gains of pigs fed milo and 15% SBM.

Table 3.4. Performance of Pigs Fed Low-Protein Diets Supplemented with Lysine and Methionine (Trial 1)<sup>a</sup>

| Indicated<br>item | Milo<br>+<br>Lysine | Milo<br>+<br>Lysine<br>+<br>Methionine | Milo<br>+<br>5% SBM<br>+<br>Lysine | Milo<br>+<br>10% SBM<br>+<br>Lysine | Milo<br>+<br>15% SBM |
|-------------------|---------------------|----------------------------------------|------------------------------------|-------------------------------------|----------------------|
| No. of pigs       | 15                  | 15                                     | 15                                 | 15                                  | 15                   |
| Initial wt., lbs. | 109                 | 114                                    | 106                                | 114                                 | 108                  |
| Daily gain, lbs.  | 1.21 <sup>b</sup>   | 1.18 <sup>b</sup>                      | 1.50 <sup>c</sup>                  | 1.70 <sup>d</sup>                   | 1.60 <sup>e</sup>    |
| Feed intake, lbs. | 5.49 <sup>b</sup>   | 5.58 <sup>b</sup>                      | 5.34 <sup>b</sup>                  | 5.86 <sup>b</sup>                   | 5.67 <sup>b</sup>    |
| Feed/gain         | 4.54 <sup>b</sup>   | 4.70 <sup>b</sup>                      | 3.57 <sup>c</sup>                  | 3.44 <sup>c</sup>                   | 3.55 <sup>c</sup>    |

<sup>a</sup>Performance data were summarized after 60 days.

<sup>bcd</sup>Means with different superscripts differ significantly ( $P < .05$ ).

The result of trial I confirms earlier studies conducted at this station in demonstrating that milo supplemented with lysine or lysine and methionine are inadequate for finishing pigs.

Poor performance of pigs fed milo supplemented with lysine probably results from a threonine deficiency, as threonine is the second-limiting amino acid in milo.

Trial II was conducted to confirm the results of trial I and determine if an intermediate level (7.5%) of soybean meal would be adequate to supply all essential amino acids except lysine that are deficient in milo for finishing pigs. The results of trial II are shown in table 3.5. Pigs fed milo supplemented with 5% SBM and lysine gained significantly ( $P<.05$ ) slower and required more feed per pound of gain than pigs fed the control diet containing 15% SBM. Weight gain and feed efficiency of pigs fed the milo supplemented with 7.5% SBM and lysine was equivalent to that of pigs fed the 15% SBM control diet.

Table 3.5. Performance of Pigs Fed Low-Protein Diets Supplemented with Lysine (Trial II)<sup>a</sup>

| Indicated item    | Milo<br>+<br>5% SBM<br>+<br>Lysine | Milo<br>+<br>7.5% SBM<br>+<br>Lysine | Milo<br>+<br>15% SBM |
|-------------------|------------------------------------|--------------------------------------|----------------------|
| No. of pigs       | 18                                 | 18                                   | 18                   |
| Initial wt., lbs. | 112                                | 113                                  | 110                  |
| Daily gain, lbs.  | 1.53 <sup>b</sup>                  | 1.73 <sup>c</sup>                    | 1.71 <sup>c</sup>    |
| Feed intake, lbs. | 5.49 <sup>b</sup>                  | 5.83 <sup>b</sup>                    | 5.61 <sup>b</sup>    |
| Feed/gain         | 3.59 <sup>b</sup>                  | 3.37 <sup>c</sup>                    | 3.28 <sup>c</sup>    |

<sup>a</sup>Performance data were summarized after an experimental period of 60 days.

<sup>bc</sup>Means with different superscripts differ significantly ( $P<.05$ ).

Trial III compared various levels of SBM (5, 7.5 and 10%) and the effect of lysine supplementation on the performance of finishing pigs (table 3.6). As expected, daily gains and feed efficiency increased as the level of SBM in the diet increased. Lysine addition to the milo supplemented with 5% SBM resulted in a marked improvement in daily gain and feed efficiency. Similarly, daily gains and feed efficiency were improved when lysine was added to the milo supplemented with 7.5% SBM. Milo supplemented with 5% SBM + lysine resulted in identical performance to that observed on the control diet containing 15% SBM.

All pigs in trial III were slaughtered to determine the effects of low-protein diets and lysine supplementation on carcass characteristics. Backfat thickness, loin-eye area and percentage of the carcass in ham and loin did not differ among pigs fed milo supplemented with 5, 7.5, or 10% SBM and lysine, and pigs fed the control diet containing 15% SBM.

Results of trial IV using corn as the grain source are shown in table 3.7. Adding lysine significantly ( $P < .05$ ) improved daily gain and feed efficiency at each level of SBM studied.

Pigs fed corn supplemented with 5% SBM and lysine gained significantly ( $P < .05$ ) slower than pigs fed the control diet. Daily gain and feed efficiency of pigs fed corn supplemented with 7.5% SBM and lysine was equivalent to that of pigs fed the control diet containing 15% SBM.



Table 3.6. Effect of Lysine Supplementation on Performance and Carcass Traits of Pigs Fed Various Levels of Soybean Meal (Trial III)<sup>a</sup>

| Indicated item         | Milo<br>+<br>5% SBM | Milo<br>+<br>5% SBM<br>+<br>Lysine | Milo<br>+<br>7.5% SBM | Milo<br>+<br>7.5% SBM<br>+<br>Lysine | Milo<br>+<br>10% SBM | Milo<br>+<br>10% SBM<br>+<br>Lysine | Milo<br>+<br>15% SBM |
|------------------------|---------------------|------------------------------------|-----------------------|--------------------------------------|----------------------|-------------------------------------|----------------------|
| No. of pigs            | 11                  | 11                                 | 11                    | 11                                   | 11                   | 11                                  | 11                   |
| Initial wt., lbs.      | 115                 | 119                                | 117                   | 121                                  | 120                  | 121                                 | 117                  |
| Daily gain, lbs.       | 1.67 <sup>b</sup>   | 2.06 <sup>cd</sup>                 | 1.92 <sup>c</sup>     | 2.00 <sup>cd</sup>                   | 1.98 <sup>cd</sup>   | 2.11 <sup>d</sup>                   | 2.05 <sup>cd</sup>   |
| Feed intake, lbs.      | 5.98                | 6.34                               | 6.59                  | 6.20                                 | 6.36                 | 6.39                                | 6.29                 |
| Feed/gain              | 3.58 <sup>b</sup>   | 3.08 <sup>d</sup>                  | 3.43 <sup>bc</sup>    | 3.10 <sup>d</sup>                    | 3.21 <sup>cd</sup>   | 3.03 <sup>d</sup>                   | 3.07 <sup>d</sup>    |
| Slaughter wt., lbs.    | 216                 | 218                                | 223                   | 220                                  | 215                  | 224                                 | 217                  |
| Carcass length, in.    | 29.60 <sup>b</sup>  | 29.60 <sup>b</sup>                 | 29.82 <sup>b</sup>    | 29.90 <sup>b</sup>                   | 29.86 <sup>b</sup>   | 30.05 <sup>b</sup>                  | 29.89 <sup>b</sup>   |
| Backfat thickness, in. | 1.27 <sup>bc</sup>  | 1.35 <sup>b</sup>                  | 1.31 <sup>bc</sup>    | 1.28 <sup>bc</sup>                   | 1.25 <sup>bc</sup>   | 1.19 <sup>c</sup>                   | 1.27 <sup>bc</sup>   |
| Loin-eye area, sq. in. | 4.66 <sup>b</sup>   | 5.08 <sup>bc</sup>                 | 4.98 <sup>bc</sup>    | 5.09 <sup>bc</sup>                   | 5.13 <sup>bc</sup>   | 5.44 <sup>c</sup>                   | 5.31 <sup>bc</sup>   |
| Ham and Loin, %        | 38.79 <sup>b</sup>  | 40.44 <sup>bc</sup>                | 40.18 <sup>bc</sup>   | 40.50 <sup>bc</sup>                  | 40.82 <sup>bc</sup>  | 41.57 <sup>bc</sup>                 | 42.11 <sup>c</sup>   |

<sup>a</sup>Performance data summarized after 45 days.

<sup>bcd</sup>Means with different superscripts differ significantly ( $P < .05$ ).

Table 3.7. Effect of Lysine Supplementation on Performance of Pigs Fed Various Levels of Soybean Meal (Trial IV)<sup>a</sup>

| Diet description  | Corn<br>+<br>5% SBM | Corn<br>+<br>5% SBM<br>+<br>Lysine | Corn<br>+<br>7.5% SBM | Corn<br>+<br>7.5% SBM<br>+<br>Lysine | Corn<br>+<br>10% SBM | Corn<br>+<br>10% SBM<br>+<br>Lysine | Corn<br>+<br>15% SBM |
|-------------------|---------------------|------------------------------------|-----------------------|--------------------------------------|----------------------|-------------------------------------|----------------------|
| Crude protein, %  | 10.43               | 10.43                              | 11.31                 | 11.31                                | 12.18                | 12.18                               | 13.94                |
| Lysine, %         | 0.36                | 0.60                               | 0.42                  | 0.60                                 | 0.49                 | 0.60                                | 0.62                 |
| No. of pigs       | 15                  | 15                                 | 15                    | 15                                   | 15                   | 15                                  | 15                   |
| Initial wt., lbs. | 119                 | 122                                | 117                   | 114                                  | 120                  | 117                                 | 120                  |
| Daily gain, lbs.  | 1.38 <sup>b</sup>   | 1.46 <sup>bc</sup>                 | 1.44 <sup>bc</sup>    | 1.65 <sup>e</sup>                    | 1.50 <sup>cd</sup>   | 1.66 <sup>e</sup>                   | 1.57 <sup>de</sup>   |
| Feed/gain         | 3.76 <sup>b</sup>   | 3.31 <sup>c</sup>                  | 3.65 <sup>b</sup>     | 2.99 <sup>d</sup>                    | 3.31 <sup>c</sup>    | 3.07 <sup>d</sup>                   | 3.15 <sup>cd</sup>   |

<sup>a</sup>Corn contained 9.0% protein, 0.22% lysine.

<sup>bcd</sup>Mean with different superscripts differ significantly (P<.05).