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# The effects of particle size and dried whey level in barley diets for starter-pigs

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### Abstract

Three hundred and thirty-six weanling pigs were utilized in two, 3 X 2 factorial design experiments to determine the effects of whey level (0, 10 or 20%) and particle size (1/8 or 3/16-in screen size) in barley diets on starter-pig performance. Grinding barley through a 1/8-in screen decreased the mean particle size of the diet compared to diets made up of barley ground through a 3/16-in screen. Average daily gain (ADG) and average daily feed intake (ADFI) increased linearly (P<.01) as whey level increased. Pigs fed diets containing 1/8-in ground barley were more efficient (P<.02) than those fed diets containing 3/16-in ground barley. However, pigs fed a 20% dried whey-milo-soybean meal control diet grew faster (P<.05) than those fed any of the barley starter diets. In these experiments, the relative feeding value of 20% dried whey-barley starter diet was 94-97% that of the 20'% dried whey-milo diet. Also, these results indicate that increasing levels of dried whey improves ADG and ADFI of pigs fed barley-based starter diets, and decreasing particle size of the diet improves feed efficiency.; Swine Day, Manhattan, KS, November 20, 1986



### Keywords

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# THE EFFECTS OF PARTICLE SIZE AND DRIED WHEY LEVEL IN BARLEY DIETS FOR STARTER-PIGS

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## Summary

Three hundred and thirty-six weanling pigs were utilized in two, 3 X 2 factorial design experiments to determine the effects of whey level (0, 10 or 20%) and particle size (1/8 or 3/16-in screen size) in barley diets on starter-pig performance. Grinding barley through a 1/8-in screen decreased the mean particle size of the diet compared to diets made up of barley ground through a 3/16-in screen. Average daily gain (ADG) and average daily feed intake (ADFI) increased linearly ($P<.01$) as whey level increased. Pigs fed diets containing 1/8-in ground barley were more efficient ($P<.02$) than those fed diets containing 3/16-in ground barley. However, pigs fed a 20% dried whey-milo-soybean meal control diet grew faster ($P<.05$) than those fed any of the barley starter diets.

In these experiments, the relative feeding value of 20% dried whey-barley starter diet was 94-97% that of the 20% dried whey-milo diet. Also, these results indicate that increasing levels of dried whey improves ADG and ADFI of pigs fed barley-based starter diets, and decreasing particle size of the diet improves feed efficiency.


## Introduction

Numerous studies have demonstrated the beneficial effects of dried whey in starter-pig diets. However, because of the high cost of whey, recent research has focused on finding its optimal inclusion level in the starter diet. The particle size of the diet may have an effect on starter-pig feed intake and has also been shown to effect pig feed efficiency. Therefore, this study was designed to evaluate the effects of increasing dried whey levels and particle size on pigs fed barley starter diets.

## Experimental Procedures

A total of 336 weanling pigs averaging 28  3 days old and 12.7 lbs (experiment 1) or 21  3 days old and 10.0 lbs (experiment 2) were allotted to one of six dietary treatments in a 3 x 2 factorial design. In addition, pigs were allotted to a 20% dried whey-milo-soybean meal (3/16-in screen) control diet. There were either 7 or 5 pigs/pen (experiments 1 and 2, respectively) for a total of 8 pens/treatment. Dietary treatments included barley ground through a hammermill equipped with either a 1/8 or 3/16-in screen, and additions of either 0, 10 or 20% dried whey. All diets were formulated to contain 1.25% lysine, .8% calcium, and .7% phosphorus. Pigs were housed in 4 X 5 ft pens with woven wire floors over a

Y-flush gutter. Each pen was equipped with one four-hole feeder and a nipple waterer. Feed and water were provided ad libitum. Pigs were weighed and feed intake and feed efficiency were determined weekly. Each trial lasted 35 days. Two ground grain and feed samples were obtained during each trial for particle size analysis according to the procedures of American Society of Agricultural Engineers Handbook. There were no trial x treatment interactions; therefore, results of both trials have been pooled.

## Results and Discussion

Particle size analysis of the ground grain and diets is presented in Tables 2 and 3, respectively. Processing barley through a hammermill with a 1/8-in screen resulted in finer particle size and greater particle surface area for both ground grain and complete diets compared to 3/16-in ground barley. The 20% dried whey-milo control diet was similar in mean particle size and particle surface area to the 3/16-in, 20% dried whey-barley diet.

Results of 14-day pig performance are presented in Table 4, and overall results (d 0-35) in Table 5. During the first 14 days on trial, increasing levels of whey resulted in a linear increase (P<.01) in ADG and ADFI. Pigs fed 1/8-in ground barley diets tended (P<.06) to be more efficient than those fed 3/16-in ground barley diets. Pigs fed the 20% dried whey-milo-soybean meal control diet were not different in ADG or ADFI from those pigs fed either 20% dried whey-barley diet.

Results for the overall trial (d 0-35) also indicate linear increases in ADG and ADFI (P<.01) as whey level increased. Pigs fed 1/8-in ground barley diets were more efficient (P<.02) than those fed 3/16-in ground barley. In addition, an improvement in ADG (P<.02) was noted for pigs fed 1/8-in barley diets.

When compared to the performance of pigs fed the 20% dried whey-milo-soybean meal control diet, pigs fed all barley-based diets had lower ADG (P<.05). Pigs fed the milo control diet had the highest ADFI; however it was not different from that of pigs fed either 20% dried whey-barley diet. Feed efficiency was numerically similar for pigs fed the 1/8-in ground barley diets and pigs fed the milo control diet. However, pigs fed the milo control diet were more efficient than those fed 3/16-in ground barley diets with 0 or 20% added whey (P<.05).

These results suggest that dried whey plays an important role in stimulating the appetite of starter-pigs fed barley diets. The increase in ADFI as whey level of the diet was increased resulted in a linear improvement in ADG at both 14 and 35 days. However, during the first 14 days on trial, only pigs fed 20% dried whey-barley diets performed similarly to those fed a 20% dried whey-milo diet. At the conclusion of the trial, pigs fed the 20% dried whey-milo diet had greater ADG than pigs fed any of barley-based diets. The increased ADFI of pigs fed the 20% dried whey-milo diet and the lower dietary fiber level of that diet may have been responsible for the improved pig performance.

These results indicate that pigs fed barley processed through a hammermill equipped with a 1/8-in screen were more efficient than those fed 3/16-in ground barley. In addition, if barley is to be the sole energy source of the starter diet, at least 20% dried whey should be included in the diet to improve pig performance. However, pigs fed a 20% dried whey-milo starter diet grew more rapidly than those fed a 20% dried whey-barley diet. Therefore, in these experiments, the relative feeding value of the 20% dried whey-barley diets was 94-97% that of the 20% dried whey-milo starter diet.

Table 1. Composition of Starter Diets.[a]

| | | Treatments | | | |
|---|---|---|---|---|---|
| | Grain: | Milo | Barley | Barley | Barley |
| Ingredient, % | Whey: | 20% | 0% | 10% | 20% |
| Milo | | 42.8 | — | — | — |
| Barley | | — | 65.0 | 55.6 | 46.1 |
| Whey | | 20.0 | — | 10.0 | 20.0 |
| Soybean meal (44%) | | 30.3 | 27.4 | 27.2 | 27.1 |
| Soy oil | | 4.0 | 4.0 | 4.0 | 4.0 |
| Dicalcium phosphate (21%) | | 1.13 | 1.21 | 1.10 | .95 |
| Limestone | | .65 | 1.00 | .85 | .70 |
| Salt | | .15 | .25 | .15 | .15 |
| L-Lysine HCL | | .12 | .29 | .22 | .15 |
| Trace mineral premix[b] | | .25 | .10 | .10 | .25 |
| Vitamin premix[c] | | .10 | .25 | .25 | .10 |
| Selenium premix | | .15 | .15 | .15 | .15 |
| $CuSO_4$ | | .10 | .10 | .10 | .10 |
| Antibiotic[d] | | .25 | .25 | .25 | .25 |
| | | 100.0 | 100.0 | 100.0 | 100.00 |

[a]Barley was processed through a hammermill with either a 1/8 or 3/16-in screen. Milo was processed through a hammermill with a 3/16-in screen.
[b]Containing 5.5% Mn, 10% Fe, 1.1% Cu, 20% Zn, 0.15% I, and 0.1% Co.
[c]Each lb of premix contains the following: vitamin A 400,000 IU, vitamin D 30,000 IU, vitamin E 2,000 IU, riboflavin 450 mg d-pantothenic acid 1,200 mg, choline 40 g, niacin 2,500 mg $B_{12}$ 2.2 mg, menadione dymethylpyrimidinol bisulfite 250 mg.
[d]Antibiotic contained 44 g chlortetracycline, 44 g sulfamethazine and 22 g penicillin per kg.

Table 2. Particle Size Analysis of Ground Milo and Barley Grain.

| Item | Grain: Screen Size, in: | Treatments: Milo 3/16 | Barley 1/8 | Barley 3/16 |
|---|---|---|---|---|
| Partice size diameter (microns) | | 753.2 | 676.3 | 789.3 |
| Surface area ($cm^2/g$) | | 81.9 | 77.7 | 75.2 |

Table 3. Particle Size Analysis of Milo and Barley Starter Diets.

| Item | Screen Size, in | % Whey 0 | % Whey 10 | % Whey 20 | Milo Control |
|---|---|---|---|---|---|
| Particle size diameter (microns) | | | | | |
| | 3/16 | 886.1 | 792.1 | 623.1 | 623.8 |
| | 1/8 | 710.8 | 655.6 | 539.2 | |
| Surface are ($cm^2/g$) | | | | | |
| | 3/16 | 60.1 | 73.2 | 99.7 | 93.8 |
| | 1/8 | 76.0 | 83.4 | 114.5 | |

Table 4. The Effect of Whey Level and Barley Particle Size on Starter-Pig Performance (d 0-14).[a]

| Item | Screen Size, in | % Whey 0 | % Whey 10 | % Whey 20 | Mean | Milo Control |
|---|---|---|---|---|---|---|
| Average daily gain, lbs | | | | | | |
| | 3/16 | .41 | .46 | .48 | .45 | .55[d] |
| | 1/8 | .42 | .43 | .53 | .46 | |
| | Mean[b] | .42 | .45 | .50 | | |
| Average daily feed intake, lbs | | | | | | |
| | 3/16 | .63 | .70 | .74 | .69 | .75[d] |
| | 1/8 | .60 | .64 | .74 | .66 | |
| | Mean[b] | .62 | .67 | .74 | | |
| Feed efficiency | | | | | | |
| | 3/16 | 1.54 | 1.56 | 1.55 | 1.55[c] | 1.39 |
| | 1/8 | 1.47 | 1.49 | 1.42 | 1.46[c] | |
| | Mean | 1.50 | 1.52 | 1.48 | | |

[a]A total of 336 pigs, 7 or 5 pigs/pen and 8 pens/treatment, average initial wt 11.4 lbs, average final wt 40.0 lbs.
[b]Linear whey effect (P<.01).
[c]Particle size effect (P<.06).
[d]Control different from 0 and 10% whey-barley diets (P<.01).

Table 5. The Effect of Whey Level and Barley Particle Size on Starter-Pig Performance (d 0-35).[a]

| Item | Screen Size, in | % Whey 0 | % Whey 10 | % Whey 20 | Mean | Milo Control |
|---|---|---|---|---|---|---|
| Average daily gain, lbs | | | | | | |
| | 3/16 | .74 | .83 | .87 | .81[c] | .97[d] |
| | 1/8 | .80 | .84 | .91 | .85[c] | |
| | Mean[b] | .77 | .83 | .89 | | |
| Average daily feed intake, lbs | | | | | | |
| | 3/16 | 1.33 | 1.44 | 1.55 | 1.44 | 1.62[e] |
| | 1/8 | 1.33 | 1.42 | 1.56 | 1.44 | |
| | Mean[b] | 1.33 | 1.43 | 1.56 | | |
| Feed efficiency | | | | | | |
| | 3/16 | 1.80 | 1.76 | 1.79 | 1.79[c] | 1.69[f] |
| | 1/8 | 1.69 | 1.71 | 1.72 | 1.70[c] | |
| | Mean | 1.74 | 1.74 | 1.76 | | |

[a]A total of 336 pigs, 7 or 5 pigs/pen with 8 pens/treatment, average intial wt 11.4 lbs. Average final wt 40.0 lbs, trial duration 35 days.
[b]Linear whey effect (P<.01).
[c]Particle size effect (P<.02).
[d]Control different from all barley diets (P<.05).
[e]Control different from 0 and 10% whey, barley diets (P<.05).
[f]Control different from 3/16-in 0 and 20% whey, barley diets (P<.05).