

# Liquid Feeding of Ethanol Industry Co-Products on Growth Performance of Wean-to-Finish Pigs

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Liquid feeding systems for swine have been widely used in Western Europe and are gaining popularity in North America. For example, in Ontario, Canada, about 20% of growing-finishing pigs are raised on liquid feeding systems. Liquid feeding has many potential benefits over conventional dry feeding of pigs, such as use of inexpensive co-products from the alcohol industry, and benefits of growth performance, health and environment. The objective of this study was to determine the effects of liquid feeding using byproducts from ethanol production with corn as fermentation substrate, including distillers dried grains with solubles (DDGS), wet distillers grains with solubles (WDGS), wet distillers grains (WDG), thin stillage (wet distillers solubles, WDS), and dry thin stillage (freeze-dried distillers solubles, DDS) on the performance of wean-finish pigs in comparison to feeding conventional dry corn soybean meal.

A total of 480 pigs (average initial body weight  $11.3 \pm 1.5$  kg) were blocked by body weight and gender and randomly allocated to 1 of 6 dietary treatments: 1) corn-soybean meal (Control), 2) 30% DDGS (DDGS), 3) 30% DDS in the first 2 weeks (phase 1) and 30% DDGS for the remaining phases (DDS), 4) 30% WDS (WDS), 5) 30% WDG (WDG), 6) 30% WDGS (25.5 % WDG + 4.5 % WDS, WDGS), in a phase feeding program (day 0-14, 14-42, 42-70, 70-98, and 98-112). All dietary treatments had the same levels of crude protein and true ileal digestible lysine, methionine, threonine and tryptophan, and similar concentration of metabolizable energy, which met or exceeded NRC (1998) nutrient requirements. Conventional dry feeding was applied for treatments 1, 2, and 3, whereas pigs from treatments 4, 5, and 6 were fed using a Big Dutchman liquid feeding system. Each treatment had 4 pens of barrows and 4 pens of gilts with 10 pigs per pen. Average body gain (ADG), average daily feed intake on a dry matter basis (ADFI), feed efficiency (ADG:ADFI ratio), and water consumption, were recorded for each phase. Data were analyzed by analysis of covariance with the initial body weight as a covariate. Preplanned contrast was used for comparison of liquid feeding (WDS, WDG, and WDGS) with dry feeding (Control, DDGS, and DDS) and Tukey test was employed for multiple comparisons. Least squares means were reported. Level of significance level was set at 0.05.

The results are shown in Table 1. Pigs on liquid feeding had better feed efficiency, lower ADFI, and higher water intake ( $P < 0.05$ ) when compared with those on dry feeding. However, no difference ( $P > 0.05$ ) was observed for ADG between the liquid feeding and dry feeding for all phases except that dry feeding resulted in higher ADG ( $P < 0.05$ ) during day 42 to 70 in comparison with liquid feeding.

During day 14 to 42, the WDS group had lower ADG compared with the WDG group ( $P < 0.05$ ). During day 42 to 70, the corn-soybean diet had greater ADG than the WDS and WDG treatments, and WDS decreased ADG in comparison with the two dry feeding groups DDGS and DDS ( $P < 0.05$ ). For the overall period and other feeding phases, ADG did not differ among the 6 dietary treatment groups ( $P > 0.05$ ).



No differences in terms of ADFI, feed efficiency, and water intake were found among the 3 groups within the same feeding type, i.e. liquid feeding (WDS, WDG, and WDGS) or dry feeding (Control, DDGS, and DDS), for all phases ( $P > 0.05$ ). Among the 6 treatments, the 3 liquid feeding groups all had improved feed efficiency, lower ADFI, and higher water intake when compared with the 3 dry feeding treatments for the overall period and majority of the feeding phases ( $P < 0.05$ ).

In conclusion, our results suggest that liquid feeding of ethanol industry co-products to wean to finish pigs does not compromise growth performance in comparison to dry feeding of corn soybean meal or DDGS when diets are formulated on basis of available nutrients, although water intake may increase.

*Acknowledgement:* Funding for this project was provided by Minnesota Pork Board, Minnesota Corn Growers Association, and Agricultural Utilization Research Institute. Supply of wet distillers grain, wet distillers solubles, distillers dried grains with solubles from Guardian Energy, Janesville, MN is much appreciated.

Table 1. Growth performance and water intake of pigs fed dry and liquid diets based on ethanol industry co-products from wean to finish<sup>#</sup>

| Feeding type                                 | Liquid feeding      |                      |                      | Dry feeding           |                     |                     | P Values |          |          |               |                |
|--|---------------------|----------------------|----------------------|-----------------------|---------------------|---------------------|----------|----------|----------|---------------|----------------|
|  | WDS                 | WDG                  | WDGS                 | Control<br>(Corn-SBM) | DDGS                | DDS                 | SEM      | Diet     | Gender   | Diet x gender | Dry vs. liquid |
| <b>Average daily gain, kg/d</b>              |                     |                      |                      |                       |                     |                     |          |          |          |               |                |
| Day 0-14                                     | 0.669               | 0.682                | 0.687                | 0.637                 | 0.644               | 0.673               | 0.016    | 0.2826   | 0.0515   | 0.9980        | 0.0650         |
| Day 14-42                                    | 0.662 <sup>b</sup>  | 0.752 <sup>a</sup>   | 0.724 <sup>ab</sup>  | 0.739 <sup>ab</sup>   | 0.737 <sup>ab</sup> | 0.720 <sup>ab</sup> | 0.019    | 0.0343   | 0.4570   | 0.0219        | 0.2898         |
| Day 42-70                                    | 0.819 <sup>c</sup>  | 0.828 <sup>bc</sup>  | 0.923 <sup>abc</sup> | 0.961 <sup>a</sup>    | 0.942 <sup>ab</sup> | 0.940 <sup>ab</sup> | 0.027    | 0.0020   | 0.1124   | 0.2483        | 0.0008         |
| Day 70-98                                    | 0.917               | 0.933                | 0.870                | 1.001                 | 0.955               | 0.975               | 0.058    | 0.7486   | 0.8705   | 0.5255        | 0.2051         |
| Day 98-112                                   | 1.359               | 1.123                | 1.387                | 1.104                 | 1.248               | 1.298               | 0.121    | 0.4696   | 0.1085   | 0.7758        | 0.5286         |
| Day 0-112                                    | 0.853               | 0.855                | 0.889                | 0.892                 | 0.894               | 0.905               | 0.024    | 0.6004   | 0.1715   | 0.1659        | 0.1706         |
| <b>Average daily dry matter intake, kg/d</b> |                     |                      |                      |                       |                     |                     |          |          |          |               |                |
| Day 0-14                                     | 0.766 <sup>b</sup>  | 0.735 <sup>b</sup>   | 0.728 <sup>b</sup>   | 0.900 <sup>a</sup>    | 0.912 <sup>a</sup>  | 0.956 <sup>a</sup>  | 0.020    | < 0.0001 | 0.1042   | 0.4241        | < 0.0001       |
| Day 14-42                                    | 1.104 <sup>b</sup>  | 1.220 <sup>b</sup>   | 1.182 <sup>b</sup>   | 1.366 <sup>a</sup>    | 1.450 <sup>a</sup>  | 1.427 <sup>a</sup>  | 0.031    | < 0.0001 | 0.9491   | 0.0917        | < 0.0001       |
| Day 42-70                                    | 1.610 <sup>b</sup>  | 1.727 <sup>b</sup>   | 1.748 <sup>b</sup>   | 2.090 <sup>a</sup>    | 2.133 <sup>a</sup>  | 2.121 <sup>a</sup>  | 0.067    | < 0.0001 | 0.3100   | 0.1966        | < 0.0001       |
| Day 70-98                                    | 2.082 <sup>b</sup>  | 2.051 <sup>b</sup>   | 2.027 <sup>b</sup>   | 2.625 <sup>a</sup>    | 2.778 <sup>a</sup>  | 2.655 <sup>a</sup>  | 0.044    | < 0.0001 | < 0.0001 | 0.0003        | < 0.0001       |
| Day 98-112                                   | 2.486 <sup>bc</sup> | 2.264 <sup>c</sup>   | 2.141 <sup>c</sup>   | 2.723 <sup>ab</sup>   | 3.003 <sup>a</sup>  | 2.799 <sup>ab</sup> | 0.092    | < 0.0001 | 0.0733   | 0.1205        | < 0.0001       |
| Day 0-112                                    | 1.605 <sup>b</sup>  | 1.622 <sup>b</sup>   | 1.596 <sup>b</sup>   | 1.975 <sup>a</sup>    | 2.082 <sup>a</sup>  | 2.021 <sup>a</sup>  | 0.032    | < 0.0001 | 0.0050   | 0.0038        | < 0.0001       |
| <b>Gain to dry matter intake ratio</b>       |                     |                      |                      |                       |                     |                     |          |          |          |               |                |
| Day 0-14                                     | 0.878 <sup>a</sup>  | 0.936 <sup>a</sup>   | 0.949 <sup>a</sup>   | 0.720 <sup>b</sup>    | 0.719 <sup>b</sup>  | 0.708 <sup>b</sup>  | 0.020    | < 0.0001 | 0.6657   | 0.6609        | < 0.0001       |
| Day 14-42                                    | 0.598 <sup>a</sup>  | 0.624 <sup>a</sup>   | 0.619 <sup>a</sup>   | 0.541 <sup>b</sup>    | 0.510 <sup>b</sup>  | 0.505 <sup>b</sup>  | 0.012    | < 0.0001 | 0.3413   | 0.0732        | < 0.0001       |
| Day 42-70                                    | 0.514 <sup>ab</sup> | 0.485 <sup>abc</sup> | 0.531 <sup>a</sup>   | 0.466 <sup>bc</sup>   | 0.449 <sup>c</sup>  | 0.445 <sup>c</sup>  | 0.012    | 0.0001   | 0.2467   | 0.6122        | < 0.0001       |
| Day 70-98                                    | 0.437 <sup>ab</sup> | 0.452 <sup>a</sup>   | 0.426 <sup>ab</sup>  | 0.378 <sup>ab</sup>   | 0.340 <sup>b</sup>  | 0.366 <sup>ab</sup> | 0.023    | 0.0319   | 0.0507   | 0.9306        | 0.0013         |
| Day 98-112                                   | 0.554 <sup>ab</sup> | 0.511 <sup>ab</sup>  | 0.731 <sup>a</sup>   | 0.395 <sup>b</sup>    | 0.397 <sup>ab</sup> | 0.463 <sup>ab</sup> | 0.073    | 0.0488   | 0.3173   | 0.7177        | 0.0124         |
| Day 0-112                                    | 0.532 <sup>a</sup>  | 0.526 <sup>a</sup>   | 0.556 <sup>a</sup>   | 0.455 <sup>b</sup>    | 0.433 <sup>b</sup>  | 0.449 <sup>b</sup>  | 0.011    | < 0.0001 | 0.6440   | 0.8944        | < 0.0001       |
| <b>Average daily water intake, L/d</b>       |                     |                      |                      |                       |                     |                     |          |          |          |               |                |
| Day 0-14                                     | 3.333               | 3.529                | 3.284                | 2.644                 | 2.317               | 2.878               | 0.292    | 0.1293   | 0.7076   | 0.2457        | 0.0083         |
| Day 14-42                                    | 5.064               | 5.721                | 5.153                | 4.624                 | 4.622               | 4.668               | 0.426    | 0.5631   | 0.8821   | 0.3064        | 0.1027         |
| Day 42-70                                    | 6.865 <sup>a</sup>  | 7.273 <sup>a</sup>   | 7.075 <sup>a</sup>   | 4.642 <sup>b</sup>    | 4.725 <sup>b</sup>  | 4.207 <sup>b</sup>  | 0.379    | < 0.0001 | 0.6254   | 0.1353        | < 0.0001       |
| Day 70-98                                    | 7.800 <sup>a</sup>  | 8.032 <sup>a</sup>   | 7.571 <sup>a</sup>   | 3.804 <sup>b</sup>    | 4.138 <sup>b</sup>  | 3.742 <sup>b</sup>  | 0.270    | < 0.0001 | 0.3862   | 0.5183        | < 0.0001       |
| Day 98-112                                   | 8.789 <sup>a</sup>  | 8.390 <sup>a</sup>   | 7.830 <sup>a</sup>   | 3.803 <sup>b</sup>    | 4.236 <sup>b</sup>  | 4.053 <sup>b</sup>  | 0.374    | < 0.0001 | 0.6114   | 0.4350        | < 0.0001       |
| Day 0-112                                    | 6.448 <sup>a</sup>  | 6.746 <sup>a</sup>   | 6.339 <sup>a</sup>   | 4.073 <sup>b</sup>    | 4.190 <sup>b</sup>  | 4.021 <sup>b</sup>  | 0.296    | < 0.0001 | 0.7779   | 0.2791        | < 0.0001       |

<sup>#</sup> Day = days on trial





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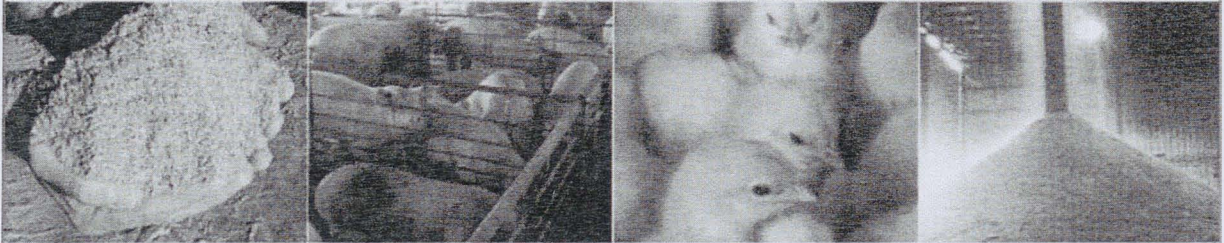
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