# COMPARISON OF CARBOHYDRATE SOURCES FOR THE EARLY-WEANED PIG[1]

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## Summary

A total of 180 weanling pigs (initially 11.7 lb and 21 d of age) was used in a 35 d growth assay to compare various carbohydrate sources from d 0 to 14 postweaning in phase I. Pigs were allotted by weight and ancestry to one of five experimental diets with six pigs per pen and six replications per treatment. Pigs were fed one of five experimental diets from d 0 to 14 postweaning. The experimental carbohydrate sources compared were corn, oat flour, two modified potato starches, and lactose. All pigs were then fed a common phase II diet from d 14 to 35 postweaning. For the phase I period, pigs consuming the modified potato starch 1 diet had higher average daily gain (ADG) and average daily feed intake (ADFI) than pigs consuming the corn or oat flour diets. Pigs consuming the modified potato starch 1 diet had numerically higher ADG and ADFI than pigs fed the other four diets. The performance of pigs consuming the modified potato starch 1 diets warrants further investigation. Currently, the hygroscopic nature of modified potato starches prohibits regular application in starter pig diets, because it causes problems in feed manufacturing and ingredient handling. Pigs consuming the lactose diets had higher ADG than the pigs consuming the corn diet. During the phase II (d 14 to 35 postweaning) and cumulative (d 0 to 35 postweaning) periods, no differences occurred in growth performance. Thus, economics indicate no additional inclusion of lactose in the phase I diet above 18% (25% dried edible grade whey). No differences occurred in performance for any phase of the experiment between the pigs consuming the corn or oat flour diets. In conclusion, oat flour does not appear to be a better carbohydrate source than corn in the phase I nursery diet.

(Key Words: Starter, Carbohydrate.)

## Introduction

Recent research at Kansas State University indicates that increasing the level of lactose from 7% to 23% in a spray-dried porcine plasma-based diet resulted in a linear improvement in growth performance. Several other carbohydrate sources have been used by the feed industry to decrease the amount of corn in the phase I diet. The main purpose of the alternative carbohydrate sources is to provide the young pig with a more digestible carbohydrate source than corn. Carbohydrate sources compared in this experiment included corn, oat flour, two modified potato starches, and lactose. Oat flour is used as a food ingredient in the human food industry. Modified potato starch 1 was treated to break the carbohydrate molecules into individual glucose molecules and then spray-dried. Modified potato starch 2 was treated to break the starch molecules into glucose chains of

[1]Appreciation is expressed to AVEBE America Inc. for the donation of modified potato starches.

intermediate length and spray-dried. These intermediate glucose chains are composed of primarily malto dextran. Lactose is a very simple and highly digestible sugar made up of one glucose and one galactose molecule bonded together. This experiment was designed to compare corn, oat flour, potato starch 1, modified potato starch 2, and lactose as carbohydrate sources in the phase I diet for the early weaned pig.

## Procedures

A total of 180 weanling pigs (initially 11.7 lb and 21 d of age) was used in a 35 d growth assay. Pigs were allotted by weight and ancestry to one of five experimental treatments with six pigs per pen and six replications per treatment. Pigs were fed the five experimental diets from d 0 to 14 postweaning. The phase I diets contained 7.5% spray-dried porcine plasma, 1.75% spray-dried blood meal, and 25% edible grade dried whey (Table 1.). These diets were formulated to contain 1.6% lysine, .44% methionine, .9% calcium, and .8% phosphorus. Soybean meal level was held constant in all phase I diets. The various carbohydrate sources were substituted on an equal lysine basis using a combination of casein and L-lysine HCl. The five diet carbohydrate inclusion levels were as follows: 1) 36.5% ground corn (corn), 2) 36.5% oat flour (oat flour), 3) 12% modified potato starch 1 and 23.9% ground corn (potato starch 1), 4) 12% modified potato starch 2 and 23.9% ground corn (potato starch 2), and 5) 12% lactose and 23.9% ground corn (lactose). All pigs were fed a common phase II diet from d 14 to 35 postweaning. This diet contained 10% edible grade dried whey and 2.5% spray-dried blood meal. The phase II diet was formulated to contain 1.25% lysine, .36% methionine, .9% calcium, and .8% phosphorus. All diets were fed in meal form. Pigs were housed in an environmentally controlled nursery with metal flooring and were allowed ad libitum access to feed and water. Pigs were weighed and feed disappearance was measured on d 7, 14, 21, 28, and 35 postweaning to determined ADG, ADFI, and feed efficiency (F/G).

## Results and Discussion

For the phase I period (0 to 14 d postweaning), pigs consuming modified potato starch 1 diet had higher ADG ($P<.05$) and ADFI ($P<.05$) than pigs consuming the corn or oat-flour based diets. Pigs consuming the modified potato starch 1 diet had numerically higher ADG and ADFI than pigs fed the other four diets. As a result, pigs fed the modified potato starch 1 diet were heavier ($P<.05$) on d 14 postweaning than pigs consuming the corn or oat flour diets. Pigs consuming the lactose diet had higher ADG ($P<.05$) than pigs consuming the corn diet. During phase II, no differences occurred in growth performance when pigs were fed a common diet. Also, no difference was seen in pig weights on d 35 postweaning. This is the result of a decrease in ADG for the 14 to 21 d postweaning period with the two modified potato starches and lactose diets compared to the corn and oat flour diets.

The performance of pigs consuming the modified potato starch 1 warrants further investigation. Currently, the hygroscopic nature of modified potato starches prohibits regular application in starter pig diets because it causes major problems in feed manufacturing and ingredient handling. Although added lactose resulted in higher ADG than the corn diet for pigs in phase I, no difference in performance occurred for the overall period. Thus, economics indicate no additional inclusion of lactose in the phase I diet above 18% (25% dried edible grade whey).

No differences in performance were seen for any phase of the experiment between the pigs consuming the corn or oat flour diets. Many companies in the commercial feed industry advocate no inclusion of corn in the phase I diet. The alternative ingredients substituted for corn usually increase the cost of the diet. The results of this trial support the inclusion

of corn in the phase I diet on the basis of economics and performance. In conclusion, oat flour does not appear to be a better carbohydrate source than corn in the phase I nursery diet.

**Table 1. Diet Composition[a]**

| | Carbohydrate Source - Phase I | | | | | |
|---|---|---|---|---|---|---|
| Ingredient | Corn | Oat | Potato Starch 1 | Potato Starch 2 | Lactose | Phase II |
| Corn | 36.51 | -- | 23.92 | 23.92 | 23.92 | 58.76 |
| Oat flour | -- | 36.56 | -- | -- | -- | -- |
| Potato starch 1 | -- | -- | 12.00 | -- | -- | -- |
| Potato starch 2 | -- | -- | -- | 12.00 | -- | -- |
| Lactose | -- | -- | -- | -- | 12.00 | -- |
| Dried whey | 25.00 | 25.00 | 25.00 | 25.00 | 25.00 | 10.00 |
| Soybean meal (48.5% CP) | 19.18 | 19.18 | 19.18 | 19.18 | 19.18 | 21.26 |
| Spray-dried porcine plasma | 7.50 | 7.50 | 7.50 | 7.50 | 7.50 | -- |
| Soybean oil | 6.00 | 6.00 | 6.00 | 6.00 | 6.00 | 3.00 |
| Spray-dried blood meal | 1.75 | 1.75 | 1.75 | 1.75 | 1.75 | 2.50 |
| Monocalcium phosphate (21% P) | 1.75 | 1.89 | 1.90 | 1.90 | 1.90 | 1.97 |
| Antibiotic[b] | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 | 1.00 |
| Casein | -- | -- | .51 | .51 | .51 | -- |
| Limestone | .62 | .54 | .55 | .55 | .55 | .83 |
| Vitamin premix | .25 | .25 | .25 | .25 | .25 | .25 |
| Trace mineral premix | .15 | .15 | .15 | .15 | .15 | .15 |
| DL-methionine | .136 | .106 | .145 | .145 | .145 | .05 |
| Copper sulfate | .075 | .075 | .075 | .075 | .075 | .075 |
| L-lysine HCl | .074 | -- | .072 | .072 | .072 | .150 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

[a]All carbohydrate source diets were formulated to contain 1.6% lysine and .46% methionine. The phase II diet was formulated to contain 1.25% lysine and .36% methionine. All diets were formulated to contain .9% calcium and .8% phosphorus.
[b]To provide 150 g/ton of apramycin in Phase I and 50 g/ton carbadox in Phase II.

**Table 2. Influence of Carbohydrate Source in Phase I on Growth Performance[a]**

| Item | Corn | Oat | Pot 1 | Pot 2 | Lactose | CV |
|---|---|---|---|---|---|---|
| d 0 to 14 | | | | | | |
| ADG, lb[b] | .69[x] | .72[xy] | .82[z] | .75[xyz] | .77[yz] | 8.3 |
| ADFI, lb[b] | .89[x] | .88[x] | 1.00[y] | .91[xy] | .97[xy] | 8.7 |
| F/G | 1.34 | 1.21 | 1.24 | 1.21 | 1.31 | 7.6 |
| d 14 to 35 | | | | | | |
| ADG, lb | 1.08 | 1.11 | 1.14 | 1.11 | 1.06 | 8.1 |
| ADFI, lb | 2.26 | 2.31 | 2.28 | 2.19 | 2.15 | 4.9 |
| F/G | 2.13 | 2.05 | 1.99 | 1.98 | 2.10 | 7.1 |
| d 0 to 35 | | | | | | |
| ADG, lb | .92 | .95 | 1.01 | .96 | .94 | 6.8 |
| ADFI, lb | 1.73 | 1.74 | 1.76 | 1.68 | 1.68 | 4.7 |
| F/G | 1.88 | 1.83 | 1.74 | 1.74 | 1.84 | 6.2 |

[a]One hundred sixty weanling pigs were used (initially 11.7 lb and 21 d of age), six pigs per pen, six pens per treatment. Experimental diets were fed from d 0 to 14 postweaning, and all pigs were fed a common phase II diet from d 14 to 35 postweaning.
[b]Means lacking a common superscript differ (P<.05).

**Table 3. Influence of Carbohydrate Source in Phase I on Pig Weights[a]**

| Item, lb | Corn | Oat | Pot 1 | Pot 2 | Lactose | CV |
|---|---|---|---|---|---|---|
| d 0 | 11.7 | 11.7 | 11.7 | 11.7 | 11.7 | -- |
| d 14[b] | 21.4[x] | 21.8[xy] | 23.2[z] | 22.2[xyz] | 22.6[yz] | 3.9 |
| d 35 | 44.1 | 45.0 | 47.1 | 45.5 | 44.8 | 5.0 |

[a]One hundred sixty weanling pigs were used (initially 11.7 lb and 21 d of age), six pigs per pen, six pens per treatment. Experimental diets were fed from d 0 to 14 postweaning, and all pigs were fed a common phase II diet from d 14 to 35 postweaning.
[b]Means lacking a common superscript differ (P<.05).