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An evaluation of dextrose, lactose, and whey sources in phase 2 starter diets for weanling pigs

Abstract

Two experiments were conducted to evaluate the effects of various dextrose, lactose, and whey sources on weanling pig performance. In Exp. 1, a total of 228 pigs (initially 17.1 lb) were used in a 14-d experiment. There were six treatments consisting of a control (corn-soybean meal diet) or the control diet with 7.2% lactose, 7.2% dextrose anhydrous, 7.2% dextrose monohydrate, 10% feed-grade whey, or 10% food-grade whey. Pigs were blocked by weight and randomly allotted to treatment after being fed SEW and Transition diets for the first seven days post-weaning. Overall, ADG and d 14 weight were improved (P<0.05) for pigs fed lactose or food-grade whey when compared to pigs fed feed-grade whey. There were no other differences in ADG or d 14 weights among the treatments. Average daily feed intake was improved (P<0.05) for pigs fed lactose, dextrose monohydrate, or food-grade whey when compared to those fed feed-grade whey. Feed efficiency was improved (P<0.05) for pigs fed food-grade whey rather than dextrose monohydrate. For the economic analysis, pigs fed the control diet had the lowest (P<0.01) cost per pound of gain, followed by pigs fed dextrose monohydrate, dextrose anhydrous, feed-grade whey, lactose, and food-grade whey. Margin-over-feed cost was improved (P<0.05) for pigs fed the control diet rather than the diets containing lactose, dextrose anhydrous, or either whey source. In Exp. 2, a total of 352 pigs (initially 17.1 lb) were used in a 14-d experiment to evaluate seven commercial whey sources. There were eight treatments consisting of a corn-soybean meal-based control diet and seven diets containing 10% whey, each of a different whey source. Pigs were blocked by weight and randomly allotted to treatment after being fed SEW and Transition diets for the first five days post-weaning. Overall, ADG and d 14 weight were improved (P<0.05) for pigs fed whey sources A and E when compared to the control and sources B and D. Pigs fed whey sources C, F, and G had intermediate ADG. Average daily feed intake was greater (P<0.05) for pigs fed whey source E rather than the control or whey sources B, C, D, and G. Feed efficiency was improved (P<0.05) for pigs fed whey source A rather than the control. Pigs fed the remaining whey sources had intermediate F/G. For the economic analysis, pigs fed the control diet had the lowest cost per pound of gain (P<0.01). Margin-over-feed cost was improved (P<0.05) for pigs fed the control diet rather than the diets containing whey sources B, D, and G. Pigs fed whey source A had intermediate MOF that was also greater (P<0.05) than that of pigs fed whey sources B and D. In conclusion, differences in the growth performance of pigs fed various whey (or lactose) and dextrose sources exist. The quality, cost, and relative feeding value of lactose sources should be considered when formulating diets for nursery pigs. In some cases, especially with the current high price of dried whey, feeding a Phase 2 diet containing no added source of lactose may be a more economical option despite the slight reduction in growth performance.; Swine Day, 2007, Kansas State University, Manhattan, KS, 2007

Keywords

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AN EVALUATION OF DEXTROSE, LACTOSE, AND WHEY SOURCES IN PHASE 2 STARTER DIETS FOR WEANLING PIGS[1]

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Summary

Two experiments were conducted to evaluate the effects of various dextrose, lactose, and whey sources on weanling pig performance. In Exp. 1, a total of 228 pigs (initially 17.1 lb) were used in a 14-d experiment. There were six treatments consisting of a control (corn-soybean meal diet) or the control diet with 7.2% lactose, 7.2% dextrose anhydrous, 7.2% dextrose monohydrate, 10% feed-grade whey, or 10% food-grade whey. Pigs were blocked by weight and randomly allotted to treatment after being fed SEW and Transition diets for the first seven days post-weaning. Overall, ADG and d 14 weight were improved ($P<0.05$) for pigs fed lactose or food-grade whey when compared to pigs fed feed-grade whey. There were no other differences in ADG or d 14 weights among the treatments. Average daily feed intake was improved ($P<0.05$) for pigs fed lactose, dextrose monohydrate, or food-grade whey when compared to those fed feed-grade whey. Feed efficiency was improved ($P<0.05$) for pigs fed food-grade whey rather than dextrose monohydrate. For the economic analysis, pigs fed the control diet had the lowest ($P<0.01$) cost per pound of gain, followed by pigs fed dextrose monohydrate, dextrose anhydrous, feed-grade whey, lactose, and food-grade whey. Margin-over-feed cost was improved ($P<0.05$) for pigs fed the control diet rather than the diets containing lactose, dextrose anhydrous, or either whey source.

In Exp. 2, a total of 352 pigs (initially 17.1 lb) were used in a 14-d experiment to evaluate seven commercial whey sources. There were eight treatments consisting of a corn-soybean meal-based control diet and seven diets containing 10% whey, each of a different whey source. Pigs were blocked by weight and randomly allotted to treatment after being fed SEW and Transition diets for the first five days post-weaning. Overall, ADG and d 14 weight were improved ($P<0.05$) for pigs fed whey sources A and E when compared to the control and sources B and D. Pigs fed whey sources C, F, and G had intermediate ADG. Average daily feed intake was greater ($P<0.05$) for pigs fed whey source E rather than the control or whey sources B, C, D, and G. Feed efficiency was improved ($P<0.05$) for pigs fed whey source A rather than the control. Pigs fed the remaining whey sources had intermediate F/G. For the economic analysis, pigs fed the control diet had the lowest cost per pound of gain ($P<0.01$). Margin-over-feed cost was improved ($P<0.05$) for pigs fed the control diet rather than the diets containing whey sources B, D, and G. Pigs fed whey

[1]Appreciation is expressed to Denny McKilligan of TechMix, Inc., for providing the lactose, dextrose monohydrate, and dextrose anhydrous for a portion of this research.

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source A had intermediate MOF that was also greater ($P<0.05$) than that of pigs fed whey sources B and D.

In conclusion, differences in the growth performance of pigs fed various whey (or lactose) and dextrose sources exist. The quality, cost, and relative feeding value of lactose sources should be considered when formulating diets for nursery pigs. In some cases, especially with the current high price of dried whey, feeding a Phase 2 diet containing no added source of lactose may be a more economical option despite the slight reduction in growth performance.

(Key words: feed ingredients, lactose, dextrose, whey.)

Introduction

Lactose and/or whey are important dietary components in many commercial pig starter diets because they provide an easily digestible source of energy for pigs immediately post-weaning. Spray-dried whey also provides a highly digestible source of essential amino acids. Both have also been demonstrated to stimulate feed intake in the weanling pig, making the adaptation to a dry, cereal-based diet easier.

Recent increases in the market price of whey and lactose have stimulated interest in determining the feeding value of alternative feedstuffs that may stimulate feed intake and provide digestible energy and/or amino acids for young pigs. Research from Ohio State University has reported that pigs fed diets containing dextrose performed equally to those fed diets containing lactose. More research is needed, however, to evaluate the suitability of dextrose replacement for lactose in commercial-type, pig-starter diets.

The increased demand for lactose and food-grade whey is responsible for much of the recent increase in cost of these ingredients. As a consequence, whey sources not previously utilized by feed manufacturers are finding a place in the market because they are available and may be less expensive. However, differences in quality among the various whey sources currently being used in piglet diets may exist. Previous research has demonstrated such differences.

The objective of these experiments was to compare various commercially available lactose, whey, or "replacement" products in pig starter diets and determine the economic impact of including these ingredients in Phase 2 diets.

Procedures

General. Procedures used in these experiments were approved by the Kansas State University Animal Care and Use Committee. Both projects were conducted at the KSU Segregated Early-Weaning Research Facility. Pens had steel "tri-bar" flooring, and provided approximately 3 ft^2 per pig. Each pen was equipped with a four-hole, dry, self-feeder and one cup waterer to provide *ad libitum* access to feed and water. The facility was a mechanically ventilated room with a pull-plug manure storage pit.

Experiment 1. A total of 228 pigs were weaned at 14.2 lb and 21 d of age and fed SEW and Transition diets for the first seven days post-weaning. Afterwards, pigs were blocked by weight and randomly allotted to one of the six dietary treatments with 8 pens per treatment. Each pen within 6 replications contained 5 pigs, and each pen within the remaining 2 replications contained 4 pigs. Experimental Phase 2 diets were fed for 14 d in meal form (Table 1). The control diet was a corn-soybean meal-based diet. Lactose, dextrose anhydrous, or dextrose monohydrate (7.2%) were added to the control diet at the expense of corn; or 10% feed-grade whey or food-grade whey were added at the expense of corn, select menhaden fish meal, spray-dried

blood cells, and salt to create the five additional treatments. Pigs and feeders were weighed on d 0, 7, and 14 to determine the response criteria of ADG, ADFI, and F/G.

Experiment 2. A total of 352 pigs were weaned at 15.2 lb and 21 d of age and fed SEW and Transition diets for the first five days post-weaning. Afterwards, pigs were blocked by weight and randomly allotted to one of the eight dietary treatments with 8 pens per treatment. Each pen within 4 replications contained 6 pigs, and each pen within the remaining 4 replications contained 5 pigs. Experimental Phase 2 diets were fed for 14 d in meal form (Table 1). The control diet was a corn-soybean meal-based diet. Seven different sources of commercial whey were each added to the control diet at 10% at the expense of corn, select menhaden fish meal, spray-dried blood cells, and salt to achieve the dietary treatments. Samples of each whey source were collected and analyzed for chemical composition (Table 2). Pigs and feeders were weighed on d 0, 7, and 14 to determine the response criteria of ADG, ADFI, and F/G.

Statistical Analysis. Data were analyzed as a randomized complete block design using the PROC MIXED procedure of SAS with pen as the experimental unit. Least squares means were used to determine differences among treatments.

Results

Experiment 1. For the overall 14-d trial, ADG and d 14 weight were improved ($P<0.05$) for pigs fed lactose or food-grade whey when compared to pigs fed feed-grade whey (Table 3). There were no other differences in ADG or d 14 weights among the treatments. Average daily feed intake was improved ($P<0.05$) for pigs fed lactose, dextrose monohydrate, or food-grade whey when compared to those fed feed-grade whey. Feed efficiency was improved ($P<0.05$) for pigs fed food-grade whey rather than dextrose monohydrate.

For the economic analysis, pigs fed the control diet had the lowest ($P<0.01$) cost per pound of gain, followed by pigs fed dextrose monohydrate, dextrose anhydrous, feed-grade whey, lactose, and food-grade whey. Margin-over-feed (MOF) cost was improved ($P<0.05$) for pigs fed the control diet rather than the diets containing lactose, dextrose anhydrous, or either whey source. Pigs fed dextrose monohydrate had intermediate MOF that was also higher ($P<0.05$) than that of pigs fed feed-grade whey.

Experiment 2. Throughout the entire 14-d trial, ADG and d 14 weight were improved ($P<0.05$) for pigs fed whey sources A and E when compared to the control and sources B and D (Table 4). Pigs fed whey sources C, F, and G had intermediate ADG. Average daily feed intake was greater ($P<0.05$) for pigs fed whey source E rather than the control or whey sources B, C, D, and G. Feed efficiency was improved ($P<0.05$) for pigs fed whey source A rather than the control. Pigs fed the remaining whey sources had intermediate F/G.

For the economic analysis, pigs fed the control diet had the lowest ($P<0.01$) cost per pound of gain. Margin-over-feed cost was improved ($P<0.05$) for pigs fed the control diet rather than the diets containing whey sources B, D, and G. Pigs fed whey source A had intermediate MOF that was also greater ($P<0.05$) than that of pigs fed whey sources B and D.

Discussion

These experiments demonstrate that not all sources of dextrose, lactose, and/or whey protein are created equal; it is important to use sources of known, high-quality whey in nursery diets. The performance of pigs fed feed-grade whey in Exp. 1 was similar to that of pigs fed the control diet, but was poorer than

that observed for pigs fed pure lactose or food-grade whey. In Exp. 2, there were only two sources of whey that resulted in growth performance superior to that of the controls. None of the criteria from the chemical analysis of the whey sources appear to explain the differences in pig performance.

Economic analysis using recent market prices indicates that none of the dextrose or lactose and/or whey protein sources evaluated may be justifiable in Phase 2 diets. While the inclusion of these ingredients may be necessary in diets fed immediately post-weaning, their use in later diets should be minimized to reduce the cost per pound of gain. The quality, cost, and relative feeding value of dietary lactose sources should be considered when formulating nursery pig diets for improved MOF. Also, guaranteed analysis is not necessarily a good indicator of whey quality for weanling pigs. Verification of the quality of a lactose source, and its impact on palatability and performance, is best determined through feeding trials.

Table 1. Composition of Experimental Diets (Experiments 1 and 2)

Ingredient	Negative control (Exp. 1 and 2)	7.2% Lactose or Dextrose (Exp. 1)	10% Dried Whey (Exp. 1 and 2)
Corn	64.10	56.65	55.50
Soybean meal (46.5% CP)	25.70	25.70	25.70
Select menhaden fish meal	3.29	3.49	2.50
Spray-dried blood cells	1.32	1.40	1.00
Lactose or dextrose	-	7.20	-
Spray-dried edible whey	-	-	10.00
Soybean oil	2.00	2.00	2.00
Monocalcium P (21% P)	1.20	1.20	1.00
Limestone	0.80	0.75	0.75
Salt	0.33	0.33	0.30
L-lysine HCl	0.30	0.30	0.30
DL-methionine	0.16	0.18	0.17
L-threonine	0.14	0.15	0.13
Vitamin premix	0.25	0.25	0.25
Trace mineral premix	0.15	0.15	0.15
Zinc oxide	0.25	0.25	0.25
Total	100.00	100.00	100.00
Calculated analysis			
Total lysine, %	1.45	1.45	1.45
True digestible amino acids			
Lysine, %	1.32	1.32	1.32
Isoleucine:lysine ratio, %	56	55	57
Leucine:lysine ratio, %	130	126	126
Methionine:lysine ratio, %	36	37	36
Met & Cys:lysine ratio, %	58	58	58
Threonine:lysine ratio, %	62	62	62
Tryptophan:lysine ratio, %	17	17	17
Valine:lysine ratio, %	70	69	68
Protein, %	21.2	20.7	20.9
ME, kcal/lb	1,545	1,546	1,540
TID lysine:ME ratio, g/Mcal	3.88	3.87	3.89
Ca, %	0.80	0.79	0.78
P, %	0.71	0.70	0.69
Available P, %	0.42	0.42	0.42

Table 2. Analyzed Composition of Various Whey Sources (Exp. 2)[a]

Item	Whey Source						
	A	B	C	D	E	F	G
Dry matter, %	96.38	95.21	94.46	94.14	93.27	n/a	95.66
Crude protein, %	12.50	12.70	12.20	12.80	13.60	n/a	12.10
Ca, %	0.35	0.45	0.56	0.57	0.51	n/a	0.39
P, %	0.62	0.67	0.66	0.67	0.67	n/a	0.60
Na, %	0.60	0.66	1.02	0.68	0.65	n/a	0.65
Salt, %	2.37	2.66	2.45	2.60	2.57	n/a	2.63
Cl, %	1.44	1.61	1.49	1.58	1.56	n/a	1.60
Ash, %	6.30	5.90	6.30	5.90	5.30	n/a	6.10
pH	7.19	8.02	8.80	8.11	7.94	n/a	7.56

[a]The chemical composition of whey source F was unavailable.

Table 3. Comparison of Dextrose and Lactose Sources in Phase 2 Nursery Diets (Exp. 1)[a]

Item	Control	Lactose	Dextrose Anhydrous	Dextrose Monohydrate	Feed-Grade Whey	Food-Grade Whey	SE Mean
D 0 to 14							
ADG, lb	0.79^{de}	0.84^{d}	0.79^{de}	0.80^{de}	0.73^{e}	0.83^{d}	0.05
ADFI, lb	0.99^{de}	1.02^{d}	1.00^{de}	1.02^{d}	0.92^{e}	1.02^{d}	0.07
F/G	1.26^{de}	1.22^{de}	1.26^{de}	1.27^{d}	1.26^{de}	1.22^{e}	0.02
Cost/lb gain, $[b]	0.15^{d}	0.21^{e}	0.19^{f}	0.18^{g}	0.20^{e}	0.22^{h}	0.003
Margin over feed, $[c]	3.85^{de}	3.43^{fg}	3.45^{fg}	3.62^{ef}	3.06^{g}	3.27^{fg}	0.24
Pig weight, lb							
D 0	17.0	17.1	17.0	17.1	17.0	17.1	1.11
D 14	28.0^{de}	28.9^{d}	28.1^{de}	28.3^{de}	27.3^{e}	28.7^{d}	1.80

[a]A total of 228 pigs were used in a 14-day, Phase 2 experiment with eight replications of 4 or 5 pigs per pen. Diets were fed from d 7 to 21 after weaning.
[b]Ingredient pricing used in this analysis included: corn, $118/ton; soybean meal, $207/ton; select menhaden fish meal and spray-dried blood cells, $1100/ton; lactose, $1680/ton; dextrose anhydrous, $1040/ton; dextrose monohydrate, $640/ton; feed-grade whey, $1100/ton; food-grade whey, $1400/ton; soy oil, $660/ton; mono-calcium phosphate, $332/ton; limestone, $30/ton; salt, $53/ton; and $15/ton processing and delivery fee.
[c]Based on market price of $0.50/lb. Calculated as gain × $0.50/lb, minus feed cost per pig.
[defgh]Means in the same row with different superscripts differ (P<0.05).

Table 4. Comparison of Whey Sources in Phase 2 Nursery Diets (Exp. 2)[a]

Item	Control	Whey Source							SE Mean
		A	B	C	D	E	F	G	
D 0 to 14									
ADG, lb	0.65^{d}	0.77^{e}	0.68^{d}	0.72^{de}	0.68^{d}	0.77^{e}	0.72^{de}	0.70^{de}	0.03
ADFI, lb	0.86^{de}	0.92^{def}	0.85^{e}	0.89^{de}	0.87^{de}	0.97^{f}	0.92^{def}	0.87^{de}	0.03
F/G	1.31^{d}	1.20^{e}	1.27^{de}	1.25^{de}	1.29^{de}	1.26^{de}	1.28^{de}	1.26^{de}	0.04
Cost/lb gain, $[b]	0.16^{d}	0.22^{e}	0.23^{e}	0.23^{e}	0.23^{e}	0.23^{e}	0.23^{e}	0.23^{e}	0.006
Margin over feed, $[c]	3.14^{d}	3.06^{de}	2.58^{f}	2.77^{def}	2.56^{f}	2.95^{def}	2.72^{def}	2.66^{ef}	0.16
Pig weight, lb									
D 0	17.1	17.2	17.1	17.1	17.1	17.2	17.1	17.1	0.81
D 14	26.3^{d}	27.9^{e}	26.7^{d}	27.2^{de}	26.6^{d}	27.9^{e}	27.2^{de}	26.9^{de}	0.43

[a]A total of 352 pigs were used in a 14-day, Phase 2 experiment with eight replications of 5 or 6 pigs per pen. Diets were fed from d 5 to 19 after weaning.
[b]Ingredient pricing used in this analysis included: corn, $118/ton; soybean meal, $207/ton; select menhaden fish meal and spray-dried blood cells, $1100/ton; lactose, $1680/ton; dextrose anhydrous, $1040/ton; dextrose monohydrate, $640/ton; feed-grade whey, $1100/ton; food-grade whey, $1400/ton; soy oil, $660/ton; mono-calcium phosphate, $332/ton; limestone, $30/ton; salt, $53/ton; and $15/ton processing and delivery fee.
[c]Based on market price of $0.50/lb. Calculated as gain × $0.50/lb, minus feed cost per pig.
[def]Means in the same row with different superscripts differ ($P<0.05$).