Potential for Golden Cheese Blend as a Protein Source for Nursery Diets

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Story in Brief

An experiment involving 315 weanling pigs was conducted to evaluate the feeding value of Golden Cheese relative to dried skim milk in early-weaned pig diets. Golden Cheese, manufactured by Keys Manufacturing Co., Inc., is an alternative to dried skim milk in nursery diets. During Phase 1, pigs fed the negative control diet devoid of dried skim milk tended to grow more rapidly and efficiently than those fed the positive control 10% dried skim milk diet. Increasing the replacement of dried skim milk with Golden Cheese, however, further improved performance over that observed in pigs fed the negative control diet, particularly at the 50 and 100 lb replacement rates. During phases 2 and 3, pigs fed 2.5% and 1.25% Golden Cheese, respectively had improved performance when compared to pigs fed a diet devoid of Golden Cheese. Results of this study suggests that replacement of dried skim milk with either 50 or 100 lb/ton of Golden Cheese in phase 1 improved feed intake and gain over that observed for pigs fed the negative or positive control diets and the replacement of 150 lb of dried skim milk with Golden Cheese resulted in similar performance. In addition, inclusion of Golden Cheese at 50 lb/ton in phase 2 diets, and 25 lb/ton in phase 3 diets also improved growth performance when compared to pigs fed a diet devoid of cheese.

Introduction

Pigs reared in conventional intensively managed swine production systems are routinely weaned at 17 to 21 d of age. At this age, pigs are very sensitive to the source of dietary protein. Many dietary proteins produce allergic reactions, in which diarrhea, reduced growth, and increased mortality can occur (Bimbo and Crowther, 1992). Various protein sources have been tested in early-weaned pig diets in an attempt to overcome these problems and to decrease diet cost. Milk proteins have historically been considered excellent protein sources for early-weaned pigs since Speer et al. (1954) and Diaz et al. (1959) demonstrated that pigs weaned at 1 to 2 wk of age could be successfully reared on dry diets containing 40% dried skim milk plus other highly digestible ingredients. Early-weaned pigs fed milk-based diets have generally outperformed those fed other protein sources (Fitzpatrick and Bayley, 1977; Wilson and Leibholz, 1981a,b,c; Walker et al., 1986). Recent research has been directed at attempts to identify other protein sources that can be substituted for the more expensive milk proteins which can be fed in combination with milk proteins to improve performance. Therefore this study was conducted to determine the potential of a cheese by-product (Golden Cheese Blend manufactured by Keys Manufacturing Co., Inc.) as an alternative to dried skim milk in nursery diets. Specific objectives of this study were to: 1) determine the efficacy of Golden Cheese as a replacement for milk protein in Phase 1 diets of early-weaned pigs; 2) determine the response to dried skim milk in Phase 1 nursery diets; 3) determine the effect of Golden Cheese as a replacement for milk protein in Phase 1 diets of early-weaned pigs on subsequent performance in Phases 2 and 3; and 4) determine the efficacy of Golden Cheese on performance during Phases 2 and 3.

Experimental Procedures

Animals and diet. A total of 315 weanling pigs (Dekalb line 348 sired by Dekalb EB boars) were sorted by weight, and divided into nine weight groups (blocks). Pigs within each weight group were allotted into equal subgroups (seven pigs per pen) with stratification based on sex and litter. Then treatments were randomly assigned to pens (subgroups) within each of the weight groups (nine pens/treatment). The study was designed as a randomized complete block design. Five dietary treatment regimens were imposed during the Phase 1 (0 to 10 d; Table 1) period, and six dietary treatment regimes were imposed in the Phase 2 (10 to 24 d) and Phase 3 (24 to 38 d) periods.

Diets during the first 10 d postweaning (Phase 1), consisted of the following:

1) A positive control diet containing 2.5% plasma protein, 2.0% blood meal, 6.00% fish meal, and 10% dried skim milk (34% protein, 67% lactose; Table 1).
2) A negative control diet formulated as the positive control diet, but dried skim milk was replaced on an equal weight basis with 48% soybean.
3) The positive control diet with Golden Cheese replacing 50 lb/ton of dried skim milk on an equal weight basis (2.5% Golden Cheese, and 7.5% dried skim milk).
4) The positive control diet with Golden Cheese replacing 100 lb/ton of dried skim milk on an equal weight basis (5.0% Golden Cheese,and 5% dried skim milk).
5) The positive control diet with Golden Cheese replacing 150 lb/ton of the dried skim milk on an equal weight basis (7.50% Golden Cheese, and 2.5% dried skim milk).

Dietary fat level was maintained constant by adjusting soy oil,

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and lactose levels were kept constant by adjusting the amount of dietary lactose. Diets were formulated to contain at least 1.50% lysine, 0.86% methionine plus cystine, 0.90% Ca, 0.80% P, and 15.05% lactose. Substitutions in all diets were made at the expense of corn and soybean meal.

Upon completion of the Phase 1 diet, half the pens fed the positive control diet received the negative control Phase 2 and Phase 3 diets devoid of Golden Cheese, whereas the other half of pens continued to receive the Phase 2 and Phase 3 diets containing Golden Cheese (2.50 and 1.25% Golden Cheese and 1.35 and 1.20% lysine, respectively; Table 2). Pigs fed the negative control diet continued to receive a negative control diet devoid of milk products in Phase 2 and Phase 3 (1.35% and 1.20% lysine, respectively; Table 2). Pigs fed increasing levels of Golden Cheese in Phase 1 received a Phase 2 diet with 2.5% Golden Cheese (1.35% lysine; Table 2) and a Phase 3 diet with 1.25% Golden Cheese (1.2% lysine Table 2). The Phase 2 diet was fed from day 10 to 24 and the Phase 3 diet was fed from day 24 to 38 postweaning.

Pigs were housed in a conventional nursery facility in elevated pens with one nipple waterer, a three-hole feeder, and wire flooring. Pigs had ad libitum access to feed and water. For the first week of the trial, the nursery was maintained at 82°F and decreased 1°F per week. Pig BW and feed intake were determined at initiation, at the end of each week in Phase 1, as well as at the end of Phase 2 and Phase 3 to evaluate ADG, ADFI, and gain:feed.

Statistical Analysis. Data were analyzed as a randomized complete block design with pen as the experimental unit and blocks based on initial BW. Analysis of variance was performed using the GLM procedures of SAS (SAS Inst., Inc., Cary, N.C.). Orthogonal polynomials were used to test for linear, quadratic, and cubic effects of increasing levels of Golden Cheese Blend and dried Skim milk in the diet. In addition, contrast statements were included to compare the negative control (Treatment 2, 0% dried skim milk) vs. the positive control (Treatment 1, 10% dried skim milk) and the negative control (Treatment 2) vs. the average of Treatments 3, 4, and 5. Additional contrasts statements evaluated the effect of Phase 2 and 3 diets with and without cheese in pigs fed the positive control diet. Lastly, the negative control was compared with the positive control with and without Golden Cheese in Phases 2 and 3.

Results and Discussion

During Phase 1 (Table 3), pigs fed the negative control diet devoid of dried skim milk (Treatment 2) grew more rapidly (20%, $P < 0.06$), and were 16% more efficient ($P < 0.10$) than those fed the positive control 10% dried skim milk diet (Treatment 1). Increasing the replacement of dried skim milk with Golden Cheese, however, further improved performance over that observed in pigs fed the negative control diet, particularly at the 50 and 100 lb replacement rates. This resulted in a quadratic increase in ADG ($P < 0.02$) and ADFI ($P < 0.09$) with increasing replacement of dried skim milk from 0 in the negative control diet (Treatment 2) to 150 lb/ton in the highest replacement level (Treatments 2 through 5). As might be expected based on the gain data, pigs fed the negative control diet (Treatment 2) were heaver at the end of Phase 1 ($P < 0.06$) when compared to those fed the positive control diet (Treatment 1). Similarly, there was a quadratic increase ($P < 0.02$) in pig weight at the end of phase 1 with increasing replacement of dried skim milk from 0 (Treatment 2), to 150 lb/ton (Treatments 2 through 5). Results of this study suggests that replacement of dried skim milk with either 50 or 100 lb/ton of Golden Cheese in Phase 1 nursery diets improved feed intake and gain over that observed for pigs fed the negative or positive control diets, and the replacement of 150 lb of dried skim milk with Golden Cheese resulted in similar performance.

The effect of Golden Cheese on performance in Phase 2 and Phase 1 and 2 is summarized in Table 4. During Phase 2, one-half of the pens fed the positive control diet in Phase 1 were fed a negative control diet devoid of Golden Cheese (Treatment 1) and one-half of the pens were fed a diet containing 2.5% Golden Cheese (Treatment 1A). Pigs fed the positive control diet in Phase 1 and Golden Cheese in Phase 2 (Treatment 1A) had greater ADG and ADFI in Phase 2 ($P < 0.01$) than those fed the positive control diet in Phase 1 followed by the negative control diet in Phase 2 (Treatment 1). The improved gain and feed intake in pigs continued on the Golden Cheese diet in Phase 2 (Treatment 1A) resulted in improved ADG ($P < 0.05$) and ADFI ($P < 0.01$) during the combined Phase 1 and 2 periods, and produced heavier pigs at the completion of Phase 2 ($P < 0.01$) than those fed the positive control diet in Phase 1 and the negative control diet in Phase 2 (Treatment 1). In addition, pigs fed the positive control diet in Phase 1 and were fed the positive control diet containing 2.5% Golden Cheese in Phase 2 (Treatment 1A) had improved gain in Phase 2 ($P < 0.01$) and for the combined Phase 1 and 2 periods ($P < 0.10$) as well as improved feed:gain ($P < 0.05$) in Phase 2, when compared to those fed the negative control diet in Phases 1 and 2 (Treatment 2). This represents a dramatic improvement in performance of pigs fed 2.5% Golden Cheese in Phase 2 over pigs receiving a diet devoid of Golden Cheese. Pigs fed the negative control diet in Phase 1 and 2 (Treatment 2), however, continued to have improved ADG in the combined Phase 1 and 2 periods ($P < 0.05$), improved ADFI in Phase 2 ($P < 0.01$), and improved feed:gain when compared to those fed the positive control dried skim milk diet in Phase 1 and the negative control diet in Phase 2 (Treatment 1). It should be noted, however, that feed intake and gain were improved (Quadratic effect; $P < 0.05$) in pigs previously fed Golden Cheese in Phase 1 and continued on 2.5% Golden Cheese in Phase 2 over that observed in pigs fed the negative control diet in both phase 1 and 2. Pigs fed the negative control diet in Phase 1 and 2 (Treatment 2) had reduced ADG in Phase 2 when compared the average performance of pigs fed all levels of Golden Cheese in Phase 1 and 2 (Treatments 3, 4, and 5; $P < 0.02$). Lastly, pigs fed diets with increasing replacement of dried skim milk with Golden Cheese in Phase 1 and fed a positive control diet in Phase 2 continued to have improved performance over that observed in pigs fed the negative control diet, particularly at the 50 and 100 lb replacement rates. This carry over effect of dietary level of Golden Cheese in Phase 1 resulted in a quadratic increase in ADG ($P < 0.01$), ADFI ($P < 0.05$), and pig weight ($P < 0.01$) in Phase 2 with increasing replacement of dried skim milk from 0 (Treatment 2) to 150 lb/ton in Phase 1 (Treatments 2 through 5). This suggests that not only did pigs perform better in Phase 1 when Golden Cheese replaced dried skim milk, but performance continued to be improved in Phase 2 in pigs previously fed Golden Cheese and continued on diets with reduced Golden Cheese in Phase 2.

The effect of Golden Cheese on performance in Phase 3 and Phase 1 through 3 is summarized in Table 5. During Phase 3, pigs fed the positive control diet in Phase 1 and Golden Cheese in Phase 2 and 3 (Treatment 1) had improved ADG and ADFI in Phase 3 ($P < 0.05$) and for the overall study (Phase 1 through 3; $P < 0.01$) compared to those fed the positive control diet in Phase 1, followed by the negative control diet in Phase 2 and 3 (Treatment 1A). This continues the improvement in performance observed in Phase 2 in pigs fed Golden Cheese even though the inclusion level was reduced to 1.25%. This improved performance in pigs fed Golden Cheese in Phase 2 and 3 resulted in a 6.49 lb heavier pig at the completion of the study ($P < 0.01$) than pigs fed the positive control diet in Phase 1 followed by the negative control devoid of Golden cheese in Phase

2 and 3. During Phase 3, pigs fed the negative control diet in Phase 1, 2 and 3 (Treatment 2) continued to have improved ADG in Phase 3 ($P < 0.05$), improved gain in the overall study (Phases 1 through 3; $P < 0.01$), improved ADFI in Phase 3 ($P < 0.05$) and for the overall study (Phases 1 through 3; $P < 0.01$), and greater pig weights at study termination when compared to pigs fed the positive control dried skim milk diet in Phase 1 and the negative control diet in Phases 2 and 3 (Treatment 1). Lastly, pigs fed diets with increasing replacement of dried skim milk with Golden Cheese in Phase 1 and fed a positive control diet in Phases 2 and 3 continued to have improved performance for the overall nursery study. This carry over effect of dietary level of Golden Cheese in Phase 1 resulted in a quadratic increase in ADG ($P < 0.01$), ADFI ($P < 0.05$), and pig weight ($P < 0.01$) in the overall nursery study with increasing replacement of dried skim milk from 0 (Treatment 2) to 150 lb/ton in Phase 1 (Treatments 2 through 5). Feeding Golden Cheese at the 50 lb replacement level in Phase 1, followed by inclusion of Golden Cheese in Phase 2 and 3 diets (Treatment 3), resulted in the heaviest pigs at weaning, which were 8.73 lb heavier than those fed the positive control in Phase 1 followed by the negative control in Phase 2 and 3 (Treatment 2) and 4.14 lb heavier than those fed the negative control for the entire study (Treatment 2).

Implications

Replacement of dried skim milk with Golden Cheese on an equal weight basis in Phase 1 diets up to 100 lb/ton of Golden Cheese improved performance in Phase 1 when compared to the performance of pigs fed the negative control diet devoid of dried skim milk or the positive control diet containing 10% dried skim milk. Golden Cheese inclusion in Phase 1 diets at the 50 lb. inclusion level had a positive impact on subsequent performance in Phase 2 and 3, suggesting that Golden Cheese in Phase 1 had a carry over effect in Phases 2 and 3. Feeding Golden Cheese in Phases 2 and 3 (50 and 25 lb/ton, respectively) to pigs previously fed the positive control diet with 10% dried skim milk diet in Phase 1 improved feed intake gain and final pig weight. This study suggest that Golden Cheese is an effective replacement for dried skim milk in Phase 1 diets and improves performance in Phases 2 and 3 at inclusion levels of 50 and 25 lb/ton, respectively.

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Table 1. Composition of experimental Phase 1 diets.

	1	2	3	4	5
	DSM		Dietary level of Golden Cheese		
Item, %	Positive Control	Negative Control	50 lb/ton	100 lb/ton	150 lb/ton
Corn, ground	45.20	37.98	43.97	42.74	41.51
Lactose, 99%	8.43	15.20	10.13	11.82	13.51
Soybean Meal, 48%	6.00	16.00	6.00	6.00	6.00
Proc. Soy Protein (Optipro)	8.00	8.00	8.00	8.00	8.00
Steamed rolled oats	5.00	5.00	5.00	5.00	5.00
Dried skim milk, 34%	**10.00**	**0.00**	**7.50**	**5.00**	**2.50**
Golden Cheese blend, 46	**0.00**	**0.00**	**2.50**	**5.00**	**7.50**
Cells, Spray Dried—AP-301	2.00	2.00	2.00	2.00	2.00
Plasma protein	2.50	2.50	2.50	2.50	2.50
Fish meal	6.00	6.00	6.00	6.00	6.00
Soy oil	3.82	3.89	3.24	2.66	2.08
Threonine	0.06	0.06	0.07	0.08	0.09
Lysine	0.00	0.00	0.02	0.05	0.07
Methionine	0.11	0.12	0.12	0.13	0.14
Isoleucine	0.00	0.00	0.00	0.01	0.02
Vitamin premix (NB-6157B)	0.25	0.25	0.25	0.25	0.25
Ethoxiquin	0.03	0.03	0.03	0.03	0.03
Neoterramysin	0.10	0.10	0.10	0.10	0.10
Zinc Oxide	0.25	0.25	0.25	0.25	0.25
Copper sulfate ($CuSO_4$)	0.07	0.07	0.07	0.07	0.07
Mineral premix (NB-8534)	0.15	0.15	0.15	0.15	0.15
Dicalcium phosphate	1.20	1.45	1.25	1.30	1.35
Calcium carbonate	0.33	0.45	0.35	0.36	0.38
Salt	0.50	0.50	0.50	0.50	0.50
Calculated composition, %					
Crude protein	22.10	23.32	22.55	22.79	23.03
Lysine	1.50	1.50	1.50	1.50	1.50
Threonine	0.98	0.98	0.98	0.98	0.98
Tryptophan	0.28	0.29	0.28	0.28	0.28
Methionine + Cysteine	0.86	0.87	0.86	0.86	0.86
Isoleucine	0.87	0.88	0.86	0.86	0.86
Calcium	0.90	0.90	0.90	0.90	0.90
Phosphorus	0.80	0.80	0.80	0.80	0.80
Lactose	15.05	15.05	15.05	15.05	15.05
Fat	6.78	6.78	6.78	6.78	6.78

Table 2. Composition of experimental Phase 2 and Phase 3 diets.

	Phase 2		Phase 3	
Item, %	Negative Control	Cheese	Negative Control	Cheese
Yellow corn	48.22	47.81	61.55	61.11
Soy meal, 48%	28.30	26.50	30.50	29.70
Golden cheese, 46%	**0.00**	**2.50**	**0.00**	**1.25**
AP-301	2.00	2.00	0.00	0.00
Fish meal	4.00	4.00	0.00	0.00
Ethoxiquin	0.03	0.03	0.03	0.03
Lysine	0.01	0.01	0.15	0.15
Zinc Oxide	0.30	0.30	0.00	0.00
Carbadox	0.25	0.25	0.25	0.25
Lactose	10.00	10.00	0.00	0.00
Methionine	0.08	0.07	0.03	0.03
Copper sulfate ($CuSO_4$)	0.07	0.07	0.07	0.07
Mineral premix (NB-8534)	0.15	0.15	0.15	0.15
Vitamin premix (NB-6157B)	0.25	0.25	0.25	0.25
Dicalcium phosphate	1.30	1.25	1.70	1.70
Fat	4.00	3.75	4.00	4.00
Calcium carbonate	0.50	0.52	0.78	0.78
Threonine	0.04	0.04	0.04	0.03
Salt	0.50	0.50	0.50	0.50
Calculated composition, %				
Lysine	1.35	1.35	1.20	1.20
Threonine	.88	.88	.78	.78
Trytophan	.27	.27	.24	.24
Methionine + Cystein	.78	.78	.68	.68
Calcium	.80	.80	.80	.80
Phosophorus	.70	.70	.70	.70
Lactose	9.90	9.90	0.00	0.00
Fat, Total	7.11	6.47	7.32	7.65
Metabolizable energy	1569.25	1566.90	1564.50	1565.22

Table 3. Effect of Golden Cheese Blend as a protein source for nursery pigs, Phase 1.

	Treatment					
Item	1 DSM Positive Control	2 Negative Control 0 lb	3 Golden Cheese 50 lb	4 Golden Cheese 100 lb	5 Golden Cheese 150 lb	SE
ADG, lb [a b]	0.40	0.47	0.55	0.52	0.47	0.03
ADFI, lb [c]	0.46	0.50	0.58	0.52	0.51	0.02
Feed:gain [d]	1.27	1.07	1.06	1.00	1.10	0.08
Initial weight, lb	16.96	16.96	16.96	16.96	16.96	0.01
Phase 1 weight, lb [e f]	20.99	21.74	22.44	22.20	21.67	0.26

[a] Pigs fed the negative control diet had increased ADG when compared to those fed the positive control, $P < 0.06$.
[b] Quadratic increase in ADG with increasing Golden Cheese
[c] Quadratic increase in ADFI with increasing Golden Cheese
[d] Pigs fed the negative control diet had improved Feed/Gain when compared to those fed the positive control
[e] Pigs fed the negative control diet were heavier at the end of phase 1 when compared to those fed the positive control
[f] Quadratic increase in pig weight at the end of phase 1 with increasing Golden Cheese.

Table 4. Effect of Golden Cheese blend as a protein source for nursery pigs (Phase 2).

	Treatment						
Phase 1	Pos. Control	Pos. Control	Neg. Control 0 lb	Golden Cheese 50 lb	Golden Cheese 100 lb	Golden Cheese 150 lb	
Phase 2	Neg. Control	Pos. Control	Neg. Control	Golden Cheese 50 lb	Golden Cheese 50 lb	Golden Cheese 50 lb	
Item Phase 1/2	1	1A	2	3	4	5	SE
ADG, phase 2, lb[b c d e]	1.08	1.30	1.15	1.34	1.18	1.19	0.03-0.05
ADG, phase 1-2, lb[d f g]	0.78	0.94	0.87	1.00	0.90	0.89	0.02-0.04
ADFI, phase 2, lb[h i]	1.29	1.61	1.53	1.74	1.50	1.54	0.04-0.07
ADFI, phase 1-2, lb[i j]	0.94	1.13	1.10	1.26	1.09	1.11	0.03-0.05
Feed:gain, phase 2[f k]	1.23	1.23	1.33	1.30	1.27	1.29	0.02-0.04
Feed:gain, phase 1-2	1.24	1.20	1.27	1.25	1.20	1.25	0.03-0.04
Weight, phase 2, lb[b d e f g]	35.77	39.49	37.82	41.12	38.68	38.37	0.25-0.39

[b] Treatment 1 vs. Treatment 1A, P < 0.01.
[c] Treatment 1A vs. Treatment 2, P < 0.01.
[d] Quadratic increase in ADG with increasing Golden Cheese, P < 0 .01 (Treatments 2 through 5).
[e] Treatment 2 vs. average of Treatment 3, 4, and 5, P < 0.05.
[f] Treatment 1 vs. Treatment 2, P < 0.05.
[g] Treatment 1A vs. Treatment 2, P < 0.10.
[h] Treatment 1 vs. Treatment 2, P < 0.01.
[i] Quadratic increase in ADFI with increasing Golden Cheese, P < 0 .05 (Treatments 2 through 5).
[j] Treatment 1 vs. Treatment 1A, P < 0.05.
[k] Treatment 1A vs. Treatment 2, P < 0.05.

Table 5. Effect of Golden Cheese blend as a protein source for nursery pigs (Phase 3).

	Treatment						
Phase 1	Pos. Control	Pos. Control	Neg. Control 0 lb	Golden Cheese 50 lb	Golden Cheese 100 lb	Golden Cheese 150 lb	
Phase2/3	1	1A	2	3	4	5	
	Neg. Control	Pos. Control	Neg. Control	Golden Cheese 50/25 lb	Golden Cheese 50/25 lb	Golden Cheese 50/25 lb	SE
ADG, phase 3, lb[b c]	1.24	1.44	1.43	1.48	1.35	1.33	0.04-0.06
ADG, phase 1-3, lb[d e f h]	0.95	1.12	1.07	1.18	1.07	1.06	0.02-0.03
ADFI, phase 3, lb[b c]	2.07	2.38	2.29	2.41	2.23	2.20	0.05-0.09
ADFI, phase 1-3, lb[f g]	1.34	1.59	1.54	1.68	1.51	1.52	0.04-0.06
Feed:gain, phase 3	1.67	1.65	1.61	1.62	1.65	1.66	0.04-0.06
Feed:gain, phase 1-3	1.44	1.41	1.43	1.42	1.42	1.44	0.02-0.04
Weight, phase 3, lb[d e f h]	53.13	59.62	57.72	61.86	57.62	57.02	0.68-1.10

[b] Treatment 1 vs. Treatment 1A, P < 0.05.
[c] Treatment 1 vs. Treatment 2, P < 0.05.
[d] Treatment 1 vs. Treatment 2, P < 0.01.
[e] Quadratic increase in ADG with increasing Golden Cheese, P < 0 .01 (Treatments 2 through 5).
[f] Treatment 1 vs. Treatment 1A, P < 0.01.
[g] Quadratic increase in ADG with increasing Golden Cheese, P < 0 .06 (Treatments 2 through 5).
[h] Treatment 1A vs. Treatment 2, P < 0.12.