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C A. Maloney

Robert H. Hines

H Cao

See next page for additional authors

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Abstract

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Keywords

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Authors

C A. Maloney, Robert H. Hines, H Cao, J S. Park, Joe D. Hancock, and Carla S. Nemecek

EFFECTS OF A HEAT-STABLE YEAST PRODUCT IN PELLETED DIETS FOR WEANLING PIGS[1]

C. A. Maloney, J. D. Hancock, R. H. Hines, H. Cao, C. S. Nemecek, and J. S. Park

Summary

The results from two experiments showed that a heat-stable yeast product survived well in diets that were steam conditioned at 158 to 176°F and pelletized. Also, inclusion of .2% yeast product resulted in a greater rate of gain and a trend for improved feed efficiency in weanling pigs.

(Key Words: Weanling Pigs, Nursery, Yeast.)

Introduction

The effects of direct-fed microbials on animal growth and health have been of interest for many years, especially with the ever-increasing pressure to reduce (or eliminate) use of antibiotics as nonspecific growth promoters. However, growth and (or) health benefits from such products have not been demonstrated consistently in pigs. Also, the thermal processing (e.g., pelletizing) that has become part of modern feed preparation for swine and poultry is known to inactivate or kill the organisms in most direct-fed microbial products. The data in this report result from experiments designed to evaluate new yeast products for their ability to withstand the rigors of pelletizing and to determine if they affect growth performance in weanling pigs.

Procedures

Experiment 1. A heat-stable (BIOSAF) or conventional (Procreatin-7) active yeast product was added as .2% of a corn-soybean meal-based diet (Phase III nursery). The diet (Table 1) was steam conditioned at atmospheric pressure with temperatures of 140, 158, 176, and 194°F. Retention time in the conditioner was approximately 10 sec for all temperature treatments. Pelleting was in a CPM Master Model HD1000 pellet mill equipped with a 1.5 in.-thick die having 5/32 in.- diameter holes. The pelletized diets were cooled with ambient temperature air in a horizontal pellet cooler. A mash conditioned at 158°F (near our normal conditioning temperature for this type of diet) without added yeast was used as the control for the experiment. Samples were taken before conditioning, after conditioning, and after cooling for determination of colony forming units (CFU) of yeast. Two independent laboratories conducted the yeast CFU analyses.

The data for CFU of yeast were transformed ($\log_{10}$) before analyses as a 2 × 4 factorial plus control. Orthogonal contrasts were used to separate treatment means with comparisons of control vs all other treatments; yeast source (heat-stable vs conventional); conditioning temperature (linear, quadratic, and cubic effects); and interactions among yeast source and conditioning temperature.

Experiment 2. A total of 144 pigs (average initial BW of 10.2 lb and 21 d of age) was used in a 31-d growth assay to determine the effects of the heat-stable yeast product (BIOSAF) on growth performance of wean-

[1]Appreciation is expressed to Tom Meloche and Francisco Garcia, SAF Products, Minneapolis, MN, for supplying the BIOSAF and Procreatin-7 and for financial support.

ling pigs. The pigs were blocked by weight and allotted to pens based on gender and ancestry. There were six pigs per pen and eight pens per treatment. The diets (Table 1) were formulated to 1.7% lysine, .9% Ca, and .8% P in Phase I (d 0 to 14) and 1.5% lysine, .8% Ca, and .7% P in Phase II (d 14 to 31). Treatments were control and .2% and .4% of the heat-stable yeast fed in both phases of the growth assay. Feed processing was the same as in Exp. 1 (i.e., the same conditioner, pellet mill, and cooler), but low conditioning temperatures were used (140°F for Phase I and 149°F for Phase II) to avoid heat damage to the milk and specialty protein products in those diets.

The pigs were housed in an environmentally controlled nursery room in 4-ft × 5-ft pens with wire mesh flooring. Room temperature initially was 90°F and was decreased by 3°F each week thereafter. The pens had a self-feeder and nipple waterer to allow ad libitum consumption of feed and water. Pig and feeder weights were collected on d 0, 14, and 31 to allow calculation of ADG, ADFI, and F/G. Fecal samples were collected on d 13 of the assay to determine CFU of yeast, total coliforms, and *E. coli*.

Results and Discussion

Experiment 1. In the conditioned mash, the control had fewer (P<.05) CFU/g than the average of the yeast treatments. As conditioning temperature was increased from 140 to 194°F, CFU of yeast (Tables 2 and 3) in the conditioned mash and cooled pellets decreased (linear effect, P<.006). However, the heat-stable product was better able to survive conditioning (P<.02) and pelleting (P<.001) than the conventional yeast product. Indeed, the heat-stable yeast generally was not affected by pelletizing with steam conditioning temperatures of at least 158°F, whereas the conventional suffered markedly with pelleting at conditioning temperatures of even 140. Thus, the technology used to manufacture the heat-stable yeast did yield a product that survived typical U.S. feed manufacturing practices (e.g., steam-conditioning temperatures of 158 to 176°F) prior to pelletizing.

Experiment 2. As addition of the heat-stable yeast was increased from 0 to .4% of the diet (Table 4), CFU of yeast in the pelleted diet increased (quadratic effects, P<.02). Also, CFU of yeast in the feces of pigs fed those diets increased (quadratic effect, P<.04), with a corresponding trend (linear effect, P<.08) for decreased CFU of total coliforms (Table 5). For d 0 to 14 of the growth assay (Table 6), ADG was increased by 16% with addition of .2% of the heat-stable yeast and then plateaued as the heat-stable yeast addition was increased to .4% (quadratic effect, P<.01). Also, the addition of heat-stable yeast at .2% to the Phase I diet resulted in a trend (quadratic effect, P<.06) for improved F/G compared to the control diet without added yeast. During Phase II (d 14 to 31), no differences in ADG or F/G were observed (P>.42), but overall (d 0 to 31), pigs fed diets with the heat-stable yeast still had 5% greater ADG (linear effect, P<.03) and a trend (quadratic effect, P<.09) for improved F/G.

Results from the two experiments showed that the heat-stable yeast product survived well in diets that were steam conditioned at 158 to 176°F and pelletized. Also, inclusion of .2% yeast product resulted in a greater rate of gain and a trend for improved feed efficiency in weanling pigs.

Table 1. Diet Composition

Ingredient, %	Phase I[a] (d 0 to 14)	Phase II[b] (d 14 to 31)	Diet for Pelleting Experiment
Corn	32.28	49.15	62.17
Soybean meal (46.5% CP)	20.53	21.25	30.43
Spray-dried whey	20.00	20.00	----
Lactose	10.00	----	----
Spray-dried wheat gluten	5.00	----	----
Spray-dried plasma protein	4.00	----	----
Spray-dried blood meal	1.00	2.00	----
Soybean oil	2.00	3.00	3.00
Monocalcium phosphate	1.68	1.27	1.55
Limestone	.77	.70	.90
L-Lysine HCl	.35	.41	.10
DL-Methionine	.20	.18	.05
Threonine	.03	.04	----
Tryptophan	.01	----	----
Salt	.20	.30	.30
KSU vitamin premix	.25	.25	.25
KSU mineral premix	.15	.15	.15
Antibiotic	1.00[c]	1.00[d]	1.00[d]
Zinc oxide	.35	----	----
$CuSO_4$	----	.10	.10
Chromic oxide	.20	.20	----
Total	100.00	100.00	100.00

[a]Formulated to 1.7% lysine, .9 % Ca, and .8% P.
[b]Formulated to 1.5% lysine, .8% Ca, and .7% P.
[c]Provided 150 g of apramycin / ton of feed.
[d]Provided 50 g of carbadox / ton of feed.

Table 2. Effects of Conditioning Temperature on Live Yeast Cell Counts (*Saccharomyces cerevisiae*, Sc. 47) in Processed Feed[a]

Item[b]	Control (no yeast 158°F)	Conventional (cond temp., °F)				Heat-Stable (cond temp., °F)				SE
		140	158	176	194	140	158	176	194	
Conditioned mash, log_{10}	3.0	7.1	5.6	2.2	1.2	7.3	6.5	5.9	2.2	.7
Cooled pellets, log_{10}	3.1	3.5	1.4	2.6	1.3	6.3	6.4	5.1	3.2	.7

[a]The same corn-soybean meal-based diet was used for all treatments.
[b] Yeast counts before the conditioner were: control 4.5 log_{10}; heat-stable 6.8 log_{10}; conventional 7.3 log_{10}.

Table 3. Probability Values for the Conditioning Experiment (log_{10} data)

Item	Probability (P <) Values[a]							
	Control vs others	Conventional vs Heat-stable	Temp. linear	Yeast × linear	Temp. quadratic	Yeast × quadratic	Temp. cubic	Yeast × cubic
Conditioned mash	.05	.02	.001	.28	.27	.14	.78	.14
Cooled pellets	.44	.001	.006	.27	.57	.19	.27	.18

Table 4. CFU of a Heat-Stable Yeast Product in Diets for the Growth Assay[a]

	Heat-Stable, %				P Values	
Item	0	.2	.4	SE	Lin	Quad
Phase I CFU/g, log_{10}	1.7	6.6	6.9	.3	.002	.008
Phase II CFU/g, log_{10}	1.6	6.8	7.5	.4	.003	.02

[a]Samples cooled pellets collected before sacking.

Table 5. Yeast, Total Coliform, and *E. coli* Concentrations in Pig Feces[a]

	Heat-Stable, %				P Values	
Item	0	.2	.4	SE	Lin	Quad
Yeast CFU/g, log_{10}	2.9	4.6	4.7	.3	.001	.04
Coliform CFU/g, log_{10}	3.3	2.3	2.0	.5	.08	.56
E. coli CFU/g, log_{10}	3.2	2.1	1.7	.6	.11	.66

[a]Samples were taken from 4 pigs/pen on d 13 of the growth assay and pooled within pen.

Table 6. Effects of a Heat-Stable Yeast Product on Growth Performance of Weaned Pigs[a]

	Heat-Stable, %				P Values	
Item	0	.2	.4	SE	Lin	Quad
Phase I (d 0 to 14)						
ADG, lb	.69	.80	.77	.02	.02	.01
ADFI, lb	1.09	1.04	1.07	.02	.63	.28
F/G	1.58	1.30	1.39	.07	.08	.06
Phase II (d 14 to 31)						
ADG, lb	1.11	1.11	1.14	.02	.43	.66
ADFI, lb	1.94	1.89	1.94	.02	.93	.08
F/G	1.75	1.70	1.70	.05	.69	.69
Overall (d 0 to 31)						
ADG, lb	.92	.97	.97	.01	.03	.18
ADFI, lb	1.54	1.49	1.54	.02	.81	.09
F/G	1.67	1.54	1.59	.04	.15	.09

[a]A total of 144 weanling pigs (six pigs per pen and eight pens per treatment) with an average initial BW of 10.2 lb and 21 d of age.