Effect of Diet Complexity and Physical Form on Performance of Starter Pigs and on Efficiency of Feed Processing

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Summary

In two trials 330 crossbred pigs averaging 12 pounds were used to evaluate the effect of starter diet complexity and physical form on average daily gain, feed efficiency, and cost of gain. In a processing-efficiency trial, pellet durability, amount fines returned, and power consumption were determined. A diet with milo-soybean meal as a basis (simple) was compared with one containing 3% tallow and 5% dried whey in milo-soybean meal (complex). Each was processed into three physical forms: meal, pellet, and crumble.

Adding 3% tallow and 5% whey to milo-soybean meal diet did not improve performance of the starter pigs but did increase cost of gain. In Trial I, average daily gain of pigs consuming pellets or crumbles was improved over that of meal-fed pigs ($P<.05$). In both trials, cost of gain was the greatest for crumble-fed pigs. Starter pig diet complexity and physical form did not affect the number of days to market or weight per day of age.

In the processing efficiency trial, pellet durability and fines returned for reprocessing were adversely affected by adding of whey and tallow, but rate and power efficiency were improved by including whey and tallow.

These results suggest that starter pigs will perform similarly and that cost of gain will be less for pigs on a simple diet in meal form than on a more complex diet in pellets or crumbles.

Introduction

There has been a great interest in diet composition and physical form for starter pigs. Dried whey and fat have been shown to improve average daily gain and feed efficiency of starter pigs (3 to 5 weeks old). The form of the diets -- such as meal, pellet, and crumble -- has also been studied. Therefore, the objective was to evaluate the influence of diet composition and diet physical form on performance of starter pigs.

The price of feed formula includes the cost of the ingredients, transportation, packaging, and processing diet. Processing can be as complex as pelleting and crumbling. Therefore, it was also determined how the efficiency of processing and diet composition affect pellet quality.

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Procedure

In Trial I, 150 crossbred starter pigs averaging about 13.5 pounds were allotted to pens by initial weight. Using five pigs per pen (3.5 square feet per pig) and five pens per treatment in a four-week trial, a diet of milo-soybean meal (simple) was compared with one containing 3% tallow and 5% dried whey in the milo-soybean meal (complex). The diets were formulated to have similar levels of lysine, minerals, and vitamins (Table 11). Each diet was processed into three physical forms: meal, pellet, and crumble. At the termination of the starter trail, pig performance was monitored through the growing-finishing phase. Number of days to market, slaughter weight, and weight per day of age (slaughter weight divided by days of age) were recorded to determine the effect of the starter treatments on later performance of the pigs.

Table 11. Diet Compositions and Calculated Analyses

Ingredient	Diet: Simple	Diet: Complex
	(%)	(%)
Milo	66.7	61.3
Soybean meal, 44%	29.3	27.1
Dried whey	--	5.0
Tallow	--	3.0
Dicalcium phosphate	1.8	1.9
Limestone	.9	.4
Salt	.3	.3
Premix[a]	1.0	1.0
Calculated analyses:		
Crude protein (%)	18.9	18.7
Lysine (%)	1.2	1.2
Calcium (%)	.8	.8
Phosphorus (%)	.7	.7
ME (kcal/lb.)	1350	1422

[a]Contained vitamins, trace minerals, L-Lysine HCL, and ASP-250.

The coarse grain ingredients were ground through a 1/8-inch hammermill screen prior to blending, which was in a 1,000-lb capacity horizontal ribbon mixer. After blending, the meal was either sacked-off or transferred to a holding bin above the pelleting system. All pelleting was done using 1,000 lb batches in a California Pellet Mill Company "Master" model pellet mill. Conditioned mash temperature was held near 70^{o} C. After the run was completed, the 3/16-inch pellets were cooled for 20 minutes in a vertical pellet cooler, prior to crumbling the diets. To process into crumbles, pellets were rolled through a crumble roll with a LePage cut set at 1/8-inch opening.

In the processing-efficiency trial, these data were collected: temperature rise from conditioning and pelleting, Pellet Durability Index (PDI), production rate, percentage of fines returned, and power required per unit of final product. The pellets or crumbles were scalped across a 1/16-inch screen; the fines and finished product were sacked and weighed separately. The fines were reported as "fines return" as this product would normally be returned for repelleting. Pellet Durability Index was determined by accepted procedures (ASAE Standard S-269.1). Hot pellets were cooled to ambient temperature prior to testing. Four samples of hot pellets were randomly taken during each production run; average value were reported for the run.

In Trial II, a repeat of Trial I, 180 crossbred pigs were used averaging 10.5 pounds. With six pigs (3.0 square feet per pig) per pen and five pens per treatment, a five week growth trial was conducted. In both trials, the pigs were weighed after two weeks on the treatments.

Results and Discussion

Growth. In Table 12, the effect of diet complexity is shown. In both trials, the pigs consuming the simple diet had the same average daily gain (ADG) as those on the complex diet. Because of no differences in feed efficiency of the diets, the cost of gain was greater for the complex diet due to cost of whey and tallow. Other researchers have demonstrated that feed efficiency (F/G) and ADG are improved when whey and tallow are added at higher levels than 5% and 3%, respectively, to starter pig diets. In these trials, however, adding 5% whey and 3% tallow to diets did not improve performance.

Table 12. Effect of Starter Diet Complexity on Performance

	Trial I[a]		Trial II[b]	
	Simple	Complex[c]	Simple	Complex[c]
ADG (lb)	.73	.73	.58	.58
F/G	1.62	1.65	1.82	1.69
Cost of gain (¢/lb)	16.8	20.7	18.9	21.2

[a]15 pens/treatment (5 pigs/pen); average initial wt., 13.8 lbs.; 4-week trial

[b]15 pens/treatment (6 pigs/pen); average initial wt., 10.5 lbs.; 5-week trial

[c]Contained 5% dried whey + 3% tallow.

Physical form of the starter diet appeared to affect performance, but results were not consistent between the trials (Table 13). In Trial I, pelleting or crumbling the diet resulted in improved ($P<.05$) average daily gain, but in Trial II no difference was observed. Although no physical-form differences were observed for feed efficiency in Trial I, in Trial II feed efficiency was improved, pigs consuming the meal form ($P<.05$) than those consuming the crumble form. The cost of gain was the greatest for the crumble form. Other researchers have demonstrated that pelleting increases feed efficiency, thereby, making additional processing costs economically feasible. In these trials, the additional cost of pelleting or crumbling the starter diet did not improve performance consistently.

Table 13. Effect of Physical Form of Starter Diet on Pig Performance

	Trial I[a]			Trial II[b]		
	Meal	Pellet	Crumble	Meal	Pellet	Crumble
ADG (lb)	.68[c]	.75[d]	.75[d]	.58	.59	.57
F/G	1.65	1.61	1.65	1.61[c]	1.79[cd]	1.86[d]
Cost of gain (¢/lb)	18.6	18.5	19.3	18.2	20.5	21.7

[a]10 pens/treatment (5 pigs/pen); average initial wt., 13.8 lbs.

[b]10 pens/treatment (6 pigs/pen); average initial wt., 10.5 lbs.

[c,d]Means in row with different superscripts differ significantly (P<.05).

In many trials evaluating various starter pig diets the influence on the performance during growing-finishing phase have not been evaluated. Although in Trial I of this study pelleting and crumbling increased (P<.05) average daily gains of pigs during the starter phase by 10%, the number of days to market was not significantly affected by physical form or diet complexity (Table 14). Since average slaughter weight was consistent among the treatments, weight per day of age was not affected by dietary treatment during the starter phase.

Table 14. Effect of Starter Diet Complexity and Physical Form on Overall Performance of Pigs.

Diet complexity	Simple			Complex		
Physical form	Meal	Pellet	Crumble	Meal	Pellet	Crumble
Slaughter wt. (lbs)	220	221	217	219	217	222
Days to market	173	172	172	172	172	172
Wt/day of age (lbs)	1.27	1.29	1.26	1.27	1.27	1.29

The heaviest pigs at the beginning of Trial I -- those with an average initial weight of 17.5 lb -- reached market weight faster (P<.05) than did the lighter pigs averaging 9.7 lb (169.4 compared with 173.7 days). Weight per day of age was .09 lb greater (P<.05) for the heavier than the lighter pigs in that trial. Although the pigs were approximately the same age, the heavier pigs at the beginning of the trial performed better than the lighter littermates.

Processing. Results of the processing-efficiency trial are shown in Table 15. The pellet durability of the simple and complex diets differed. Whey is often thought of as a pellet-quality enhancer; tallow as a reducer of pellet quality. Here with the complex diet, the magnitude of quality reduction caused by the tallow seemed to outweigh any improvement caused by the whey. In all cases, the PDI test was run on whole, cooled pellets prior to crumbling; therefore, the only treatment difference was in the formulation.

Tallow in the complex diet appeared to affect production rate for both pellets and crumbles over similar processes for the simple diet, a difference also reflected in the energy-efficiency (power) data (Table 15). Assuming an energy cost of 5¢ per kilowatt hour, the cost to manufacture the meal form of the diet was assumed to be constant, with no effect on further processing.

Table 15. Processing Efficiency of Simple and Complex Swine Diets.

Diet	Form	PDI (%)	Production rate (lbs/hr)	Fines return (%)	Power consumption (kwh/ton)	Cost ($/ton)
Simple	Pellet	95.4	2250	2.9	13.45	.67
Simple	Crumble	94.7	1650	25.3	18.54	.93
Complex	Pellet	92.2	3040	7.1	10.00	.50
Complex	Crumble	91.9	2100	26.9	15.82	.79

Although the cost of pelleting is the sum of many costs beyond those for energy, the energy input can be very significant if the mill size is large. Industrial estimates of total pelleting costs range from $4 to $12 per ton, but they will vary greatly depending on such factors as capacity, formula, and equipment.

The data for the amount of fines returned to the pellet mill indicated that the production rate was severely restricted by the crumbling operation. If the amount of fines returned to the pellet mix were 25% greater for a crumbled product than for a pelleted produce, the effective production rate would be reduced by 25%.