

Triticale in Swine Diets: Effects on Nutrient Management and Pig Performance

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For the past 70 years, swine nutritionists have been trying to develop diets that meet animal needs while minimizing waste. Pig growth, feed conversion and cost per unit of growth have been the primary criteria for evaluation of diets. As facilities, animals and management changed, diets were adjusted to better meet the animal needs. Animal agriculture, especially swine production, has reached a point where efficient use of diet nutrients may be as important as animal performance in determining the economic viability of a farm. Emphasis on farm nutrient management, and accounting for all nutrients entering a farm, requires careful evaluation of quality and nutrient availability of all diet ingredients.

In the early 1980s, scientists in Florida and Georgia released a variety of triticale specifically designed for use in the Southeast United States. "Beagle 82" soon became the subject of a widespread research effort to determine its use in swine diets. Despite the advantages in amino acid levels, production problems kept Beagle 82 and subsequent varieties from becoming more than a novelty grain with limited use.

With the increased emphasis on nutrient management and reducing nitrogen and phosphorus excretion, nutritionists are looking for ways to reduce nutrient output while maintaining "normal" growth and feed conversion. The use of synthetic amino acids and phytase has proven effective in reducing nutrient output when included in traditional corn-soybean meal diets. Small grains, specifically triticale, provide another option for consideration in the formulation of environmentally friendly swine diets.

Triticale in swine diets: a review

Triticale is a cereal grain produced by crossing wheat and rye (Coffey and Gerrits, 1988). The use of triticale in livestock diets promotes the absorption of phytate bound phosphorus due to its high phytase activity (Reddy *et al.*, 1982; Meyer *et al.*, 1989; Pointillart *et al.*, 1987; Pointillart, 1993). The phytase activity in triticale is typically found in the bran (Kornegay, 2001).

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The feeding value of early varieties of triticale (i.e., Beagle 82), on average, was estimated as 94% that of corn and approximately equal to that of rye (Myer *et al.*, 1987). Shimada *et al.*, (1974) reported that the nutritive values of corn and wheat were higher than that of triticale.

Triticale has been shown to have a high concentration of amino acids and has been found to be a good choice for replacing corn in swine diets due to its high lysine content (Erickson *et al.*, 1979; Hale and Utley, 1985; Myer *et al.*, 1987; Coffey and Gerrits, 1988; Bruckner *et al.*, 1998; Meyer and Mullinax, 1999). On average, triticale will contain 35% more crude protein than corn and 52% more lysine (Myer *et al.*, 1996). According to Myer *et al.*, (1989) Beagle 82 triticale was found to have 68% more lysine and 53% more crude protein than corn, and the feeding value of Beagle 82 was found to be 95-100% of that of corn. Several studies have been performed to investigate the possibility of triticale as a replacement for corn. Shimada *et al.*, (1974) concluded that in the diets of growing pigs, triticale could replace corn on an equal weight basis. According to Myer *et al.*, (1987) the crude protein digestibility of triticale in grower diets was not affected by replacing a portion of the soybean meal and all of the corn by Florida 201 triticale. This was concurred by another study performed in 1990 investigating the nutritive value of Florida 201, Florico Triticale, where it was found that the dietary protein value of the triticale was comparable to that of corn. The Florico Triticale, due to its high lysine content, also replaced 75-85 pounds of soybean meal per ton of diet (Myer *et al.*, 1990).

Erickson *et al.*, (1979) found that 60% of the corn in a typical corn-soybean meal diet for swine could be replaced by triticale. Several subsequent investigations have shown that replacing corn with triticale and amino acids does not adversely affect either carcass quality or pig performance (Brand *et al.*, 1995; Myer *et al.*, 1996). Hale *et al.* (1985) reported that the carcasses of pigs fed triticale are comparable to the carcasses of pigs fed a corn-soybean meal diet. According to Pointillart *et al.* (1987) pigs fed the triticale diet exhibited a higher feed efficiency and better growth than pigs fed the corn diet. The pigs on triticale appeared to have better bone mineralization and did not differ in slaughter weight from the corn soybean meal fed pigs. Pointillart *et al.*, (1987) also observed that the phosphorus absorbed and subsequently retained by the pig was greater in the pigs fed triticale than the pigs fed corn. Pigs fed the corn based diet; on average, absorbed 2 grams less phosphorus than the pigs fed the triticale based diet. As a result it was determined that the phosphorus retention was increased in the triticale diets.

Triticale offers several benefits as a feedstuff. Unlike rye, modern triticale varieties are generally free of ergot. This cereal grain also offers increased phytase activity as well as low trypsin inhibitor activity, a problem in raw soybeans, and in studies, most animals

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have found triticale to be palatable (Shimada and Cline, 1974; Hale *et al.*, 1985; Coffey and Gerrits, 1998).

Environmental implications of feeding triticale

In a series of studies conducted at the Swine Research and Education Complex at Auburn University, an attempt was made to determine what effects, if any, including triticale in swine diets would have on environmental concerns.

In the first study, six pigs weighing 40kg were used in a metabolism trial to determine the effects of diet on nutrient output. Pigs were housed in stainless steel metabolism stalls designed to allow for total fecal and urine output. Pigs were meal fed twice daily to approximately 90% of *ad libitum* intake. Dietary treatments were corn+soybean meal (A), triticale+soybean meal (B) and triticale+soybean meal+L-lysine+L-threonine+DL-methionine+L-tryptophan(C). The triticale used throughout the experiment was Tricale-498 provided by Resource Seeds. Experimental diets (table 1) were formulated to contain comparable levels of lysine and available phosphorus, and to meet the daily requirement of each based on 90% of *ad libitum* intake. All other nutrients levels either met or exceeded NRC recommendations (NRC, 1998).

TABLE 1. Nutrient composition of diets

Nutrient ²	Dietary treatment ¹		
	A	B	C
Crude protein	16.27	17.77	13.53
Lysine	0.95	0.95	0.95
Calcium	0.60	0.60	0.60
Total phosphorus	0.50	0.45	0.41
Available phosphorus	0.23	0.23	0.23

¹A: corn+soybean meal; B: triticale+soybean meal; C: triticale+soybean meal+synthetic amino acids

²Values calculated from chemical analyses of ingredients (available P calculated using availability values from NRC (1998))

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Table 2 contains the nitrogen excretion data. Fecal nitrogen excretion was lower and nitrogen retention higher for pigs fed the corn-based diet. However, replacing soybean meal with synthetic amino acids decreased urinary nitrogen excretion and increased nitrogen retention.

TABLE 2. Effects of dietary treatment on nitrogen excretion.

Response	Dietary treatment ¹			Contrasts		
	A	B	C	Pr>F	AvsB	BvsC
Fecal excretion, g/d	15.94	18.82	20.51	0.15	*	
Urinary excretion, g/d	13.28	16.45	10.35	0.08	*	*
Total excretion, g/d	29.22	35.26	30.86	0.12	*	*
Retention, %	41.57	28.53	35.86	0.05		*

¹A: corn+soybean meal; B: triticale+soybean meal; C: triticale+soybean meal+synthetic amino acids

Table 3 contains the phosphorus excretion data from Experiment 1. Replacing soybean meal with synthetic amino acids had no effect on phosphorus excretion ($P>0.20$.) Fecal and total phosphorus excretion were greater for the corn-based diet than for the triticale-based diet. Further analysis of the data using phosphorus intake as a covariable produced the same results, indicating the estimates used for phosphorus availability were probably low.

TABLE 3. Effects of dietary treatment on phosphorus excretion.

Response	Dietary treatment ¹			Contrasts		
	A	B	C	Pr>F	AvsB	BvsC
Fecal excretion, g/d	1.05	0.74	0.77	0.08	*	
Urinary excretion, g/d	0.03	0.03	0.02			
Total excretion, g/d	1.08	0.77	0.79	0.07	*	

¹A: corn+soybean meal; B: triticale+soybean meal; C: triticale+soybean meal+synthetic amino acids

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A second metabolism trial was conducted using only corn-soybean meal and triticale-soybean meal diets. Table 4 contains the phosphorus excretion data, adjusted for phosphorus intake, from this trial. As in the first trial, phosphorus digestibility was improved when triticale was used as the sole grain.

TABLE 4. Effects of corn and triticale based diets on phosphorus apparent digestibility and availability when adjusted for phosphorus intake.

	Corn	Triticale	SE ^b	P-value
Apparent digestibility, % ^c	15.6	23.3	2.33	0.041
Apparent availability, % ^c	8.29	21.1	2.35	0.001

^aLeast square means.

^bPooled standard error.

^cPhosphorus intake was a covariate.

These two studies clearly show that using triticale in grow/finish diets will reduce phosphorus excretion when formulated using available phosphorus.

Another possible implication of feeding triticale is changes in the odor associated with grow/finish pigs. While no formal studies are complete, everyone involved with the triticale studies at Auburn University noticed a pronounced change in the odor associated with grow/finish feces when pigs were fed triticale compared to corn. Triticale produces what was described as a “fermented odor comparable to silage”. Another experiment is underway to determine the effects of diet on the concentration of select volatile organic compounds in swine feces.

Performance implications of feeding triticale

While the emphasis of the experiments at Auburn University was on environmental issues, grow/finish performance was also evaluated. A grow/finish feeding experiment using the corn-soybean meal(A) and triticale-soybean meal(B) diets from the first metabolism trial was conducted. In this experiment, growth rate and feed conversion were monitored for 98 days for 144 pigs starting at 60 pounds. There was no difference in growth rate (1.80 vs 1.85 lb/d) or conversion (gain/feed) (.288 vs .309) for pigs fed diets A or B, respectively (P>0.20) for any period or for the 98 day trial.

To evaluate additional varieties of triticale, two more experiments were conducted. Approximately 40 head were used in each experiment to see if there was justification for expanded trials. Since Trical®498 was the only variety tested in earlier studies, a small feeding trial was conducted to compare it with Trical®2115. Pigs were placed on test at

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65-70 pounds and fed for 56 days. A second trial was conducted to compare Trical®314 and wheat (Pioneer 26R61). Pigs were placed on test at 147-155 pounds and fed for 23 days. The results of both trials are in table 5.

TABLE 5. Effects of triticale variety on performance of grow/finish pigs

	Trial 1		Trial 2	
Criteria	Trical®498	Trical®2115	Trical®314	Wheat
Daily gain, lb	1.73	1.74	1.76	1.70
Gain/feed	.358	.369	.318	.324

Based on the results of these two small trials, there does not appear to be a difference in performance of grow/finish pigs fed either variety of triticale. There was no apparent difference in performance of pigs fed triticale or wheat.

Samples of various triticale varieties and the Pioneer 26R61 wheat were chemically analyzed to estimate their feeding value. Tables 6-8 contain the results of those analyses.

Initial estimates of the energy content showed the triticale varieties to be comparable to wheat. Based on values from the Nutrient Requirements for Swine, the M.E. values for corn and wheat are comparable. Based on our data to date on grow-finish swine, the energy values for Trical®498 and corn are comparable. Among these samples, the Trical®498 was consistently lower in test weight and estimated M.E. than the other triticale varieties. Based solely on these estimates, Trical®2115, 308 and 314 are comparable to wheat and superior to Trical®498.

With the exception of Trical®2115, the triticale varieties contained 93 to 95 percent of the crude protein found in the wheat variety. Using the formulas in the 1998 "Nutrient Requirements of Swine", the levels of selected amino acids are in table 8. Lysine values for all triticale varieties were greater than the values for the wheat variety. Based on estimates of lysine content, all triticale varieties tested were superior to the wheat variety.

The NDF values from table 6 do not support the estimates of M.E. based on test weight. While the 1998 "Nutrient Requirements of Swine" does not list a value for soft red winter wheat, other "types" are comparable to triticale (12-13%.) The NDF of the triticale varieties we tested were 20 to 30 percent higher than for the wheat variety, indicating lower M.E. for swine.

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TABLE 6. Nutrient content of various triticale varieties and wheat, means by replication, 90% dry matter

Site	Variety	CP	Test wt.	M.E.	G.E.	NDF	ADF	Ca	K	Mg	P
		%	lb/bu	kcal/lb	kcal/lb	%	%	%	%	%	%
NC	P26R61	12.83	56.0	1424		14.4	3	0.03	0.38	0.13	0.35
	T2115	12.77	50.0	1496		18	3.6	0.04	0.52	0.14	0.39
	T498	12.15	46.3	1384		17.1	3.9	0.03	0.45	0.12	0.32
SC	P26R61	12.15	58.5	1485	1756	12.6	2.7	0.03	0.35	0.11	0.32
	T314	11.25	52.7	1576	1763	16.5	3.6	0.03	0.43	0.14	0.37
	T498	11.57	50.3	1506	1750	15.6	3.3	0.04	0.45	0.12	0.36

TABLE 7. Nutrient content of triticale varieties as compared to wheat

Site	Variety	CP	Test wt.	M.E.	G.E.	NDF	ADF	Ca	K	Mg	P
NC	T2115	1.00	0.89	1.05		1.25	1.20	1.13	1.35	1.03	1.10
	T498	0.95	0.83	0.97		1.19	1.30	1.04	1.18	0.87	0.91
SC	T314	0.93	0.90	1.06	1.00	1.31	1.33	1.01	1.23	1.26	1.16
	T498	0.95	0.86	1.01	1.00	1.24	1.22	1.33	1.30	1.07	1.13

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TABLE 8. Estimated amino acid content of triticale and comparison to wheat.

Site	Variety	CP	Lys	Try	Thr	Met	Lys	Try	Thr	Met
						%		% of wheat		
NC	P26R61	12.83	0.37	0.15	0.37	0.20				
	T2115	12.77	0.44	0.13	0.41	0.22	1.20	0.88	1.11	1.09
	T498	12.15	0.43	0.12	0.40	0.21	1.17	0.84	1.07	1.05
SC	P26R61	12.15	0.34	0.14	0.35	0.19				
	T314	11.25	0.41	0.12	0.38	0.20	1.19	0.83	1.08	1.04
	T498	11.57	0.42	0.12	0.39	0.21	1.21	0.85	1.10	1.07

Conclusions

Trical®498 triticale does have promise in the formulation of swine diets considering nutrient management and the environment. The experiments conducted at Auburn University show reduced phosphorus output when pigs were fed diets containing triticale. There was also an apparent affect on the perception of odor resulting from feeding diets containing triticale.

Performance of grow/finish pigs fed diets containing Trical®498 was comparable to those fed corn. Both the Trical®314 and Trical®2115 varieties appear to be comparable to Trical®498 as far as their feeding value is concerned. Based on the chemical analyses, however, Trical®498 does not look as good.

There is no doubt that triticale can and is a replacement for either corn or wheat based on the amino acid content and profile, and the phosphorus level. Feeding grow/finish diets using Trical®498 should improve the nutrient management issues faced by many producers, and may help with the perceptions of odor. The value of triticale must be based on the nutrient content, as well as the price of other grains, soybean meal and other amino acid sources.

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