Rice bran in swine rations

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Too much in growing-finishing rations can retard growth

Rice bran has received increased attention as a feedstuff for swine and as a source of oil for human consumption. Depending on milling conditions and hull contamination, bran from California rice contains 15 to 20 percent oil, 30 to 40 percent digestible carbohydrate, and 12 to 14 percent protein, although levels of up to 18 percent protein have been reported. Rice bran is also an excellent source of vitamins and minerals. Two problems may be encountered, however, when feeding rice bran to swine: (1) It contains high levels of phytic acid; levels of 5 percent or more have been reported. (2) Milling activates an enzyme system that rapidly degrades the oil to free fatty acids and glycerol.

The adverse effects of dietary phytic acid have long been recognized. Although cereal grains are high in phosphorus, 60 to 80 percent of that is present as phytic acid phosphorus, only 25 percent of which, on average, is available to the pig. A larger problem associated with feeding diets containing high levels of phytic acid is its capacity to irreversibly bind trace elements such as zinc and iron. Previous research from this laboratory demonstrated that when wheat-soybean oil meal diets containing 40 percent raw rice bran were fed to growing pigs, some animals developed parakeratosis, a typical zinc deficiency symptom, characterized by a scaly type of dermatitis.

Enzymatic degradation of rice bran oil begins immediately, when activated by milling. Although the rate of hydrolysis varies with temperature and other factors, approximately 30 percent of the oil is degraded to free fatty acids during a week of storage under tropical conditions. The increased concentration of free fatty acids has two disadvantages: (1) It dramatically lowers the yield of edible oil, if the oil is to be extracted for human consumption. (2) It is likely to decrease palatability if the bran is fed to livestock, and ultimately may lower feed intake.

Research has shown that the enzymes responsible for degrading rice bran oil can be destroyed by heat, allowing the bran to be stored for several months. A bran stabilization process has recently been developed by the Western Regional Research Center, U.S. Department of Agriculture, in which rice bran is heated for about 3 seconds to 130°C in an extrusion cooker then held at about 100°C for 3 minutes before cooling. This treatment permanently inactivates the lipolytic enzyme system in the milled bran and prevents any increase in free fatty acid content of the oil.

Although rice bran is widely used as a livestock feed in tropical regions, its full feeding value is often not realized because of deterioration during storage and incorrect ration formulation. Raw rice bran is used to replace a portion of the dietary grain, although the degree of replacement possible has not been well defined owing to inconsistent results. In some cases, 30 percent raw rice bran improved pig performance, while other research demonstrated that 20 percent rice bran diets decreased feed efficiency. More recently, researchers in Florida reported that up to 30 percent raw rice bran in a maize-soybean oil meal diet did not affect weight gain in swine, but higher levels decreased weight gain and feed efficiency. In research conducted at the University of Hawaii, 40 percent raw bran in corn-soy diets did not adversely affect growth or feed efficiency of growing-finishing pigs, but higher levels of bran reduced growth. They also reported that the apparent digestibility of both dietary protein and energy components decreased as dietary levels of raw rice bran increased.

These results were all obtained with diets supplemented with raw rice bran produced at some previous unreported time. Furthermore, there was no indication of the type of storage or any estimation of the amount of bran oil that might have undergone hydrolysis, although in some cases it was stated that the bran had been produced outside the state. Rice bran thus treated would be likely to have higher levels of free fatty acids than stabilized bran.

Some limited information exists on the feed value of stabilized rice bran for growing swine. Feeding trials in Spain with growing-finishing pigs compared a control ration composed mainly of sorghum, corn, and soybean meal and an experimental ration that substituted 20 percent stabilized rice bran for part of the corn and sorghum. Stabilized rice bran at that level did not significantly affect growth or feed efficiency. It should be noted that the stabilized bran fed had been in storage two to three months.

At the University of California, Davis, a pilot study compared raw and stabilized bran at 20 and 40 percent levels in corn-soy rations for effects on growth and feed efficiency of swine. Five purebred Duroc barrows were assigned to each of five dietary treatments for a 92-day growth study. The control diet was a corn-soy ration supplemented with 20 percent fat-free stabilized rice bran (table 1). Although statistical analysis indicated no differences in the measured parameters (as a consequence of the small number of animals), pigs fed the 40 percent stabilized bran diet had the lowest weight gain among treatment groups but better feed efficiency than pigs fed a similar level of raw rice bran. The modern crossbred pig would probably grow faster and utilize feed more efficiently than did pigs in any of the aforementioned research.

Feeding trial

To evaluate raw and stabilized rice bran as grain substitutes, we conducted a growing-finishing trial at the UC Davis Animal Science Swine Research Facility. Fresh processed raw and stabilized rice bran was obtained from a single source and analyzed for nitrogen, fat, energy, and phytic acid. The stabilizing process had no effect on these nutrient levels, although the phytic acid content of the raw and stabilized bran was 9.1 and 9.9 percent, respectively. The two rice brans were added at levels of 40 percent to corn-soy diets formulated to contain 15 percent crude protein. A standard corn-soy mixture was used as the control ration. To evaluate the effect of the high levels of phytic acid, we formulated each diet at two levels of vitamin-mineral premix — a standard level and a low level (table 2).

The six diets were fed to a total of 72 three-way crossbred pigs having an average initial weight of 24.2 kg (53 pounds). The pigs were divided into groups of four, each with two barrows and two gilts. The pigs were housed by groups in 18 modified open-front concrete slab pens measuring 7.5 by 20 feet with nipple waterers and self-feeders. The feeders were routinely adjusted to minimize waste of the ground feed.

All pigs were weighed every other week and feed consumption was calculated for each weigh period. Pigs were individually removed for slaughter when their weight approximated 100 kg (220 pounds). Hot carcass weight was obtained at slaughter and, after a 24-hour chill, carcasses were measured for length, rib eye area, and average back fat. Percent lean carcass was calculated as well as the USDA muscling score, carcass score, and

TABLE 1. Pilot study: performance in swine growth trial*

Item	Dietary rice bran				
	Fat-extracted stabilized (20%)	Raw		Stabilized	
		20%	40%	20%	40%
Initial weight (kg)	23.0	23.6	23.4	22.0	21.8
Final weight (kg)	65.2	68.4	66.2	69.2	60.4
Daily weight gain (kg)†	0.71	0.74	0.72	0.75	0.66
Daily feed intake (kg)	2.77	2.72	2.91	2.75	2.44
Feed:gain ratio	3.90	3.68	4.04	3.67	3.70

* 92-day growth period with five pigs per treatment group.
† All values in this row ± 0.03.

TABLE 2. Experimental diets, growing-finishing trial

Ingredient	Diet*		
	Control	Raw bran	Stabilized bran
Corn-cracked	80.85	50.50	50.50
Raw rice bran	—	40.00	—
Stabilized rice bran	—	—	40.00
Soybean oil meal	13.00	2.70	2.70
Meat and bone meal	5.00	5.00	5.00
Salt	.25	.25	.25
Swine PX 482†‡	.35	.35	.35
Dicalcium phosphate	.30	—	—
Limestone	.25	1.20	1.20

* All diets were formulated to contain 15.0% protein, .60% phosphorus and .70% calcium.
† Provided the following minimum per pound of premix; vitamin A, 1,000,000 USP units; vitamin D_3, 400,000 I.U.; vitamin E, 1,000 I.U.; riboflavin, 700 mg; d-pantothenic acid, 2,500 mg; choline, 67,000 mg; niacin, 5,000 mg; vitamin B_{12}, 3.0 mg; manganese, 6,000 mg; iron, 10,000 mg; iodine, 4,000 mg; copper, 1,600 mg; zinc, 15,000 mg and selenium, 12.26 mg.
‡ Each diet was also formulated with only .15% premix and designated as "low mineral" diets

TABLE 3. Performance of pigs fed experimental diets

Item	Control	Raw bran	Stabilized bran
No. of pigs	24	24	24
Initial weight (kg)	25.0	24.5	23.2
Final weight (kg)	99.8	96.7	97.1
Average daily gain (kg)	.93 a*	.85 b	.78 c
Feed per gain	3.09	3.17	3.22
Age at slaughter (d)	160.2 a	169.1 b	180.0 c
Hot carcass weight (kg)	76.7	73.3	73.8
Carcass length (cm)	78.2	78.7	78.5
Back fat (cm)	3.45	3.45	3.51
Rib eye (cm^2)	33.3 a	29.81 b	29.94 b
Lean carcass, %	48.7	47.0	47.2
USDA color of lean	1.28	1.33	1.37
USDA grade	1.79	1.77	1.80
NSIF score (d)†	155.1	169.7	179.2

* Figures in the same row followed by different letters are significantly different.
† Age units to produce 85 lbs of lean.

the National Swine Improvement Federation (NSIF) score used to evaluate comparable worth of the carcasses.

Results

Statistical analysis indicated that pigs fed the low-mineral diets performed at levels equal to those fed rations containing standard levels of trace minerals. Thus, level of dietary trace minerals was ignored as a treatment, and the pigs were pooled by dietary treatment (control, 40 percent raw bran, or 40 percent stabilized bran) for all further analysis. Previous research with pigs fed rice-bran-supplemented wheat-soy diets did result in poorer performance that could be overcome by addition of trace minerals to the diet. However, the phytic acid in wheat is less digestible than that in corn and barley, so that more of the trace elements are rendered unavailable in wheat diets. Adding rice bran to wheat-soy diets further limited trace element absorption. This did not appear to be a problem with corn-soy diets supplemented with raw or stabilized rice bran.

Performance of the pigs fed the corn-soy control ration and the rice-bran-supplemented diets is detailed in table 3. The pigs used in our research gained weight at a more rapid rate than those reported in any other published research, to our knowledge, on the feeding value of rice bran. The more rapidly growing animal provides a more stringent test of nutrient quality and palatability of the feedstuff.

Daily gain was significantly depressed in pigs fed the raw rice bran compared with those consuming the control ration. Although this result agrees with some previously published research, it differs from the results of the Florida and Hawaii studies and the Davis pilot study. Weight gain of pigs fed stabilized bran was further reduced when compared with those on raw bran diets. Feed utilization efficiency tended to decrease when pigs were fed raw bran and stabilized bran diets; these differences were not statistically significant, however, indicating that most of the decrease in weight gain was the result of lower feed intake. It is not clear why the stabilized bran diet was less palatable than either the raw bran or control rations. If the raw rice bran had been older, thus possibly having a higher concentration of free fatty acids, the raw and stabilized bran might have been equal in palatability. Since the two brans were handled and produced similarly, with the exception of extrusion, equivalent levels of stabilized bran in the diet must have been slightly more detrimental to feed intake and growth than raw bran. Consequently, age to slaughter was significantly higher for pigs fed the stabilized bran than for pigs fed raw bran, and those, in turn, were slower to reach market weight than pigs fed the ration without bran.

Rib eye area was significantly smaller in pigs fed either of the bran diets than in those fed the control ration, although there were no differences between the two bran-fed groups. Hot carcass weight, carcass length, back fat, and percent lean carcass were not affected by dietary treatment. Similarly, USDA color of lean and grade were not affected by dietary treatment. While the differences in NSIF scores between treatments were not statistically significant, they indicated that more days on feed were required to produce 85 pounds of muscle when pigs were fed rice-bran-supplemented diets. This is in agreement with the age at slaughter.

Conclusions

Addition of rice bran to a standard corn-soy diet at the level of 40 percent decreased feed consumption and had a negative effect on growth. This problem was more severe with stabilized rice bran than with raw bran of equal age. In neither case did rice bran have a negative influence on feed efficiency.

General recommendations based on this research and the work of others is to limit the bran in the growing-finishing ration to 25 percent or less. No specific recommendation can be made at this time for the use of stabilized bran, although a level of 20 percent seems acceptable. The producer should, however, be aware of the oil degradation that takes place in raw bran.

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