Almond hulls produce unexpected results in hog trials

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Supplementation with up to 15 percent almond hulls provided ample energy for growing pigs

Almond hulls, which correspond to the fleshy fruit of the closely related peach, are obtained by drying the portion of the almond fruit that surrounds the hard shell. The California Almond Board reported receipts of 170,868 metric tons of almonds, as of October 1984, and forecast total production for the 1984 season at 235,868 metric tons. That level of production would yield approximately 470,000 metric tons of almond hulls. Although the hulls are used in both feedlot and dairy rations, little information is available concerning their composition and nutritional value, especially for nonruminant species such as growing-finishing pigs.

Chemical composition

Previous research at the University of California, Davis, Animal Science Department indicated that the chemical composition of almond hulls was variable within variety as well as by variety (table 1). Although the hulls contain slightly more than 5 percent crude protein, earlier work suggests that little if any of the protein is available for maintenance or production.

Crude fiber in the hulls ranged from 12.1 to 24.9 percent of the total hull, and Neplus contained considerably more than the Merced and Nonpareil varieties. Crude fiber is the current criterion used to evaluate almond hull quality. California regulations require that shipments of almond hulls containing more than 15 percent crude fiber be labeled "almond hulls and shells." Earlier research at UC Davis (see *California Agriculture* March 1965, p. 12) demonstrated that crude fiber in almond hull-shell mixtures was highly correlated with digestible energy content. However, recent research at Davis demonstrated that, at least with ruminants, crude fiber was not a useful index of almond hull quality. Rather, acid detergent fiber was found to have the highest correlation with digestible energy.

Acid detergent fiber varied from 19.9 to 35.2 percent of the hull, but, as an average, Nonpareil and Neplus contained similar amounts. Likewise, the digestible energy of these two varieties was similar (Nonpareil, 2.52 Mcal/kg, and Neplus, 2.45 Mcal/kg), even though Neplus contained 48 percent more total crude fiber than Nonpareil. The sixth revised edition of *Nutrient Requirements of Beef Cattle* indicated that the average almond hull contained 33.2 percent crude fiber and 38 percent acid detergent fiber, and provided 2.43 Mcal of digestible energy per kilogram of almond hull. W. N. Garrett of the Davis Animal Science Department determined that almond hulls fed to feedlot cattle provided 1.36 Mcal/kg of net energy for maintenance and 0.85 Mcal/kg of net energy for production, whereas the above publication indicated that net energy for maintenance and production was 1.14 and 0.58 Mcal/kg, respectively. Similar information is also available for dairy cattle.

The commercial almond hulls used in our study with growing-finishing pigs were similar in composition to the Nonpareil and Neplus, although the commercial mix contained more ash than either of the specific varieties. Current California regulations require that shipments of almond hulls containing more than 9 percent ash be labeled as "almond hulls and dirt." Still, the commercial mix of hulls contained only slightly more than 9 percent ash and, on an as-fed basis, contained less than 9 percent.

Feeding trials

We supplemented barley-soybean meal rations with 0, 5, 10, and 15 percent almond hulls (table 2). The rations were formulated to contain 16 percent protein, 0.70 percent phosphorus, and 0.80 percent calcium on an as-fed basis and did not include the crude protein contribution made by the almond hulls. Chemical analysis of the mixed diets indicated that they contained 16.59 percent protein on an as-fed basis. The experiment was designed specifically to evaluate almond hulls as a source of energy and not to examine the availability or quality of almond hull protein.

The feeding trial was conducted at the UC Davis Hog Barn using 48 commercial three-way cross-bred pigs and 24 purebred Durocs from the Animal Science swine herd. The pigs had an average initial weight of 38.1 kg and were divided by breed into 12 groups (eight groups of crossbreds and four groups of Durocs) of six pigs each with three barrows and three gilts in each group. The pigs were housed, by group, in modified open-front concrete slab pens measuring 7.5 by 20 feet with nipple waterers and self-feeders adjusted to minimize waste. Each ration was fed to three groups of pigs with body weight and feed consumption measured every other week.

Pigs were individually removed for slaughter when their weight approximated 100 kg. Hot carcass weight was determined at slaughter. After a 24-hour chill, carcasses were measured for length and backfat. The Pork Value Task Force (PVTF) score, computed USDA grade, National Swine Improvement Federation score, dressing percentage, and percent lean were determined and used as indices of comparable carcass value.

Results

Pigs had similar initial and final weights across all treatments (table 3). Likewise, treatment did not affect daily gain, feed efficiency, and age to slaughter. Pigs fed diets containing up to 15 percent almond hulls thus were not adversely affected with regard to feed efficiency or weight gain. Some nutritive value does exist for almond hulls fed to growing-finishing pigs. The results must be interpreted with caution, however, since the weight gain of pigs fed almond hulls may not represent normal growth of lean body mass. Carcass comparisons are necessary to determine the quality of the weight gain.

Comparison of pigs fed the control and almond hull diets demonstrate that the hulls had little, if any, adverse effect on carcass quality. Hot carcass weight and carcass length were not affected by dietary level of almond hulls, whereas backfat and dressing percentage were significantly affected (table 4). No plausible explanation can be given for the treatment effect on backfat. Since pigs fed diets containing 0 and 10 percent almond hulls had more backfat than those fed the 5 and 15 percent diets, it is doubtful that consumption of almond hulls is responsible for the observed difference. Adding almond hulls to the diet significantly decreased dressing percentage; the poorest dressing percentage occurred in car-

TABLE 1. Almond hull analysis

Item	Variety			Commercial mix
	Merced	Nonpareil	Neplus	
Crude protein	5.4 (4.9-5.8)	6.7 (4.7-8.8)	6.1 (5.4-6.7)	6.4
Crude fiber	14.4 (14.0-14.8)	14.3 (12.1-16.6)	21.1 (17.4-24.9)	-
Acid detergent fiber	21.5 (20.6-22.5)	27.3 (19.9-34.8)	29.9 (24.6-35.2)	28.3
Cellulose	13.3 (12.8-13.8)	15.5 (12.9-18.1)	18.3 (15.9-20.7)	14.78
Crude lignin*	7.9 (7.5-8.4)	12.1 (7.7-16.6)	11.7 (7.9-15.6)	9.99
Ash	7.3 (7.0-7.7)	6.1 (5.2-7.0)	7.6 6.8-8.3)	9.65
Soluble sugars	26.4 (19.6-33.2)	37.7 (20.8-33.7)	23.9 (18.5-29.4)	-

NOTE: Mean percentage of dry matter with range in parentheses to indicate variance for 6, 16, and 10 samples, respectively, of Merced, Nonpareil, and Neplus almond hulls. Data generously supplied by Dr. R.L. Baldwin, Dept. of Animal Science, University of California, Davis. The commercial mix was used in the swine feeding trial.
* Lignin plus cutin.

TABLE 2. Experimental diets

Ingredient	Almond hull treatment			
	0%	5%	10%	15%
	%	%	%	%
Barley	81.71	74.46	68.99	62.61
Almond hull	0.0	5.00	10.00	15.00
Soy bean meal	11.22	12.47	13.89	15.24
Meat and bone meal	5.00	5.00	5.00	5.00
Salt	.25	.25	.25	.25
Swine PX482*	.35	.35	.35	.35
Dicalcium phosphate	.81	.92	.97	1.08
Limestone	.66	.55	.55	.47

NOTE: All diets were formulated to contain 16 percent protein, 0.70 percent phosphorus, and 0.80 percent 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 mg; manganese 6,000. mg; iron, 10,000 mg; iodine, 4,000 mg; copper, 1,600 mg; zinc, 15,000.

TABLE 3. Effect of almond hulls on pig growth

Item	Almond hull treatment				Pooled SEM*
	0%	5%	10%	15%	
Number of pigs	18	18	18	18	
Initial weight (kg)	38.0	38.3	38.2	37.9	0.628
Final weight (kg)	97.3	96.1	97.8	96.1	0.858
Daily gain (g)	808.7	817.2	830.3	839.9	11.61
Feed per gain	3.57	3.67	3.62	3.68	.021
Age to slaughter (days)	172.3	171.8	172.3	168.1	1.243

* SEM: standard error of the mean (confidence range).

TABLE 4. Carcass evaluation of pigs fed almond hull supplement diets

Item	Almond hull treatment				Pooled SEM
	0%	5%	10%	15%	
Number of pigs	14*	17*	17*	14*	
Hot carcass weight (kg)	74.4	71.2	73.3	72.1	0.580
Carcass length (cm)	81.4	81.3	82.3	81.2	0.564
Average backfat (cm)	3.59 a†	3.21 b	3.62 a	3.30 b	0.076
Dressing percentage	74.8 a	73.9 bc	74.6 ab	72.5 c	0.264
PVTF score (%) ‡	97.9	100.1	97.9	99.7	0.033
Computed USDA grade	1.81	1.32	1.81	1.44	0.083
NSIF score §	162.8	165.4	165.9	164.1	1.315
Percent lean	47.56	46.02	47.04	46.43	0.289

* Not all pigs were slaughtered; some were retained as replacement gilts.
† Means in the same row followed by a different letter differ significantly (P = <0.05).
‡ Percent comparison to the standard U.S. hog.
§ Days required to produce 80 pounds of lean.

casses of pigs fed the highest level of almond hulls. Still, the real difference in dressing percentage between groups was minimal, and actual percent lean was not significantly affected by dietary treatment.

The computed USDA grade was not influenced by dietary treatment. The Pork Value Task Force score, which is a comparison with the average U.S. hog, did not differ between groups and indicated that the pigs used in the study were average, on a national scale. Dietary treatment did not influence the National Swine Improvement Federation (NSIF) score, which indicates days required to produce 80 pounds of lean pork.

It is of some interest that replacement gilts were selected from all treatments, four each from the 0 and 15 percent, and one each from the 5 and 10 percent almond hull rations. Although it is difficult to quantify all the factors considered when replacement gilts are selected for the herd, even the 15 percent almond hull diet did not preclude selection of gilts from that treatment.

Conclusions and recommendations

The results of this research were somewhat unexpected. Although we were certain that almond hulls would provide some usable energy for the growing pig, the similar weight gains and feed efficiences across treatment groups strongly suggest that, at supplementation levels of up to 15 percent, sufficient energy was available from the almond hulls to maintain maximum growth. The trial was conducted during an unusually hot period (spring-summer 1984), but the growth rate and feed efficiency of all groups were considered normal for the existing climatic conditions.

Although specific recommendations concerning the use of almond hulls in swine rations may be premature, it certainly appears that 10 to 15 percent of the grain in a grain-soybean meal ration for growing-finishing pigs may be replaced with almond hulls. Rations should be formulated with the consideration that the almond hulls are not a source of dietary protein. Additional research is required to define more accurately the nutritional value of almond hulls for all classes of swine and determine the upper limits at which the hulls can be incorporated into swine diets.

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