Feeding Ensiled Citrus Pulp to Finishing Pigs[1]

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Introduction

Feed costs have historically been the single largest cost of pork production. For the past six years, feed costs have continually increased, which has driven all facets of animal agriculture in the United States to attempt to reduce feed costs. Florida has greater feed costs than the rest of the country because grain must be shipped here from where it was produced. Taking into account transportation costs, corn in Florida is approximately $1.25 per bushel more expensive on average than in the Midwest. A pig consumes approximately 650 lbs. of complete feed from birth until slaughter, and approximately 70% of the diet is corn. This means it costs over $10 more to raise a pig in Florida than the Midwest because of the cost of corn alone.

Increased feed costs combined with decreased slaughter capacity have dramatically decreased pork production throughout the southeastern U.S., except for North Carolina. Florida currently ranks 36th nationally for pork production (NPB 2012). The state's swine inventory was reduced by half from 2001 to 2005, but since then has been consistently estimated at 20,000 animals (FDACS 2011). The few Florida pork producers active today generally obtain prices above market value for their pigs because of the strong demand for locally-raised foods or by selling pigs to youth for exhibition (Carr, Eubanks, and Dijkhuis 2008a). The number of small USDA-inspected pork processors in Florida has increased over the past five years (Carr, Eubanks, and Dijkhuis 2008b). These Florida pork producers could become more profitable if they could significantly decrease their production costs.

Florida produced approximately three million tons of citrus pulp in 2011, which was primarily used as a byproduct feedstuff in ruminant diets (FDACS 2011). Raising monogastric animals (such as pigs) for food production is often criticized because these animals consume feedstuffs that could be used for human consumption. However, citrus pulp is a byproduct of the citrus juicing industry, and humans do not generally consume it. In Florida, pork producers have an opportunity to use citrus byproducts as a feedstuff to substantially and sustainably decrease their feed costs.

Feeding Citrus Pulp to Livestock

Three primary types of citrus pulp are used as a byproduct feedstuff in livestock diets — whole citrus pulp, pressed pulp, and dried pulp. Whole citrus pulp (pulp residue, rind, and seed) contains approximately 10% dry matter (DM), immediately after the juice is removed. Whole citrus pulp (WP) is then pressed to extract citrus liquor, and 0.05% calcium carbonate is added during grinding to make pressed pulp, which contains approximately 20% DM. Pressed pulp (PP) is heated to make dried pulp (DP), which contains approximately 90% DM. DP is sold as a commodity feedstuff, but WP and PP are available at little to no cost because citrus processors want to avoid further processing costs for those products. However, animal producers

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must pay the transportation cost for WP or PP products. Depending on the length of transportation, these costs can become cost prohibitive, especially since over 80% of the load is water. Because these products are high in fructose and over 80% water, WP and PP products should either be fed within three days of production or preserved by ensiling to extend their storage life.

In a recent University of Florida trial, 30 finishing pigs were fed either a control diet of corn-soybean meal or the same diet, with 15% replaced by either anaerobically ensiled WP or PP on a DM basis (Table 1). Compared to the control diet, diets containing ensiled citrus pulp had additional soybean meal, monocalcium phosphate, and less limestone, which allowed all diets to contain 0.78% lysine and the same calcium/phosphorus ratio. Metabolizable energy values were similar for the diets at 1,660 Kcal/lb (control diet), 1,604 Kcal/lb (WP diet), and 1,590 Kcal/lb (PP diet) (Table 1).

Compared to pigs fed the control diet across the feeding period, pigs fed the PP diet displayed a 20% improvement in feed efficiency (Gain:Feed), while those fed the WP diet had a 13.3% improvement (Table 2). These differences in efficiency primarily occurred during the first two weeks of feeding (Table 2). Although the data are not shown in this report, replacing 15% of the diet DM with ensiled citrus pulp had marginal effect on carcass traits, pork shelf life, and pork sensory characteristics.

Replacing 15% of the diet DM with ensiled citrus pulp can decrease the cost of gain if those feedstuffs are accessible close to the swine operations. But these savings might be negated depending on labor and transportation costs (Table 3). In this study, cost/lb of live gain/pig was calculated using current wholesale prices for all ingredients except the high moisture citrus byproducts. Transportation costs for the high moisture citrus byproducts were calculated as follows:

((300 miles roundtrip ÷ 10 miles/gal) × $3.50/gal) ÷ 20,000 lbs. of high-moisture citrus byproduct or 10,000 lbs. of both WP and PP.

This would be the same as considering a $105 delivery fee. The costs per lb of the diets on a DM basis were calculated to be $0.18 (control diet), $0.12 (WP diet), and $0.13 (PP diet). Additionally, an hour of work /high moisture citrus treatment per day × minimum wage ($7.80) was included as labor cost. Cost of gain per pig was calculated as follows:

((((total DM intake/pen × diet $/lb DM) + labor $/per pen) ÷ live wt. gain/pen) ÷ # of pigs/pen).

Management is important when feeding an ensiled high moisture feedstuff to pigs. These feedstuffs should be used within 2–3 days after removing from the ensilement container to prevent spoilage and mycotoxin development from mold. Additionally, these diets require additional labor as described earlier to ensile the high moisture pulp, to mix and blend feed more frequently to maintain feed quality and palatability, and to prevent feed bridging, clumping, and waste within the feeders. Feeding ensiled citrus pulp probably has even better application for gestating sows because feed is generally offered once daily on the floor, minimizing problems with feeders. Also, sows have improved hindgut fermentation compared to finishing pigs, suggesting that ensiled citrus pulp could be fed at an increased rate (Sotto et al. 2009).

References

Carr, C. C., L. E. Eubanks, and R. D. Dijkhuis. 2008a. *Adding Value to Livestock with Niche Meat Marketing Programs*. AN197. Gainesville, FL: University of Florida Institute of Food and Agricultural Sciences. http://edis.ifas.ufl.edu/an197.

Carr, C. C., L. E. Eubanks, and R. D. Dijkhuis. 2008b. *USDA-Inspected Livestock Slaughter Facilities in Florida*. Gainesville, FL: University of Florida Institute of Food and Agricultural Sciences. http://edis.ifas.ufl.edu/an203.

FDACS (Florida Department of Agriculture and Consumer Services). 2011. *2011 Florida Agriculture by the Numbers*. Tallahassee, FL: FDACS. http://www.florida-agriculture.com/brochures/P-01304.pdf.

NPB (National Pork Board). 2012. *Quick Facts: The Pork Industry at a Glance*. Des Moines, IA: National Pork Board. http://viewer.zmags.com/publication/5bb6aa6d#/5bb6aa6d/1.

Sotto, V. R., M. Brito, B. Lopez, E. Perez, and F. Velazquez. 2009. "Use of Citrus Meal for Feeding Sows during the Gestation and Lactation Stage." *Revista Computadorizada de Produccion Porcina* 16 (1): 45-49.

Table 1. Ingredients and chemical composition of the experimental diets on a dry matter basis.

	Diet[1]		
	CON	WP	PP
Diet Ingredients, %			
Citrus pulp	0.00	15.00	15.00
Corn	79.45	65.00	64.55
Soybean meal	16.00	16.25	16.25
Vegetable oil	1.75	1.75	1.75
Limestone	1.30	0.45	0.90
Monocalcium phosphate	1.00	1.05	1.05
Salt	0.30	0.30	0.30
Vitamin-trace mineral premix[2]	0.20	0.20	0.20
Chemical composition			
Dry matter, %	88.8	57.7	66.9
Metabolizable energy, Kcal/lb	1,660	1,604	1,590
Crude protein, %	16.9	16.69	16.69
Neutral detergent fiber, %	8.43	10.51	10.95
Lysine, %	0.78	0.78	0.78
Calcium, %	0.73	0.72	0.73
Phosphorus, %	0.57	0.56	0.56

[1]CON = corn-soybean meal control diet; WP = diet containing 15% ensiled, whole citrus pulp; PP = diet containing 15% ensiled, pressed citrus pulp, on a DM basis.

[2]Supplied per lb: 2,497 IU vitamin A; 309 IU vitamin D_3; 2.5 mg vitamin K activity; 3.2 mg riboflavin; 10.4 mg d-pantothenic acid; 15.4 mg niacin; 63.6 mg choline chloride; 12.3 mg vitamin B_{12}; 45.4 mg zinc (ZnO); 22.7 mg iron ($FeSO_4$); 12.3 mg manganese (MnO); 2.3 mg copper ($CuSo_4$); 0.4 mg iodine (CaI_2) and 0.1 mg selenium ($NaSeO_3$).

Table 2. Effect of dietary citrus pulp inclusion on growth and feed efficiency of pigs.

	Diet[1]		
Item	**CON**	**WP**	**PP**
No. of pigs	10	10	10
No. of pens	5	5	5
Initial pig wt, lb	197.8	186.1	193.6
1st 13 d			
Average daily dry matter intake, lb/d	8.6	5.3	5.4
Average daily gain, lb/d	2.3	2.2	2.3
Gain:Feed	0.25	0.41	0.41
2nd 13 d			
Average daily dry matter intake, lb/d	6.2	6.0	6.3
Average daily gain, lb/d	2.0	1.8	2.2
Gain:Feed	0.36	0.33	0.37
3rd 13 d			
Average daily dry matter intake, lb/d	6.4	5.3	5.4
Average daily gain, lb/d	1.9	1.5	1.6
Gain:Feed	0.3	0.28	0.29
Overall			
Average daily dry matter intake, lb/d	7.1	5.6	5.7
Average daily gain, lb/d	2.2	1.9	2.1
Gain:Feed	0.3	0.34	0.36

[1]CON = corn-soybean meal control diet; WP = diet containing 15% ensiled, whole citrus pulp; PP = diet containing 15% ensiled, pressed citrus pulp, on a DM basis.

Table 3. Effect of dietary citrus pulp inclusion on cost of gain per pig ($/lb gained).

Feeding period	Diet[1]			Diet + Labor[2]		
	CON	WP	PP	CON	WP	PP
1st 13 d	0.91	0.56	0.54	0.91	0.95	0.96
2nd 13 d	0.62	0.71	0.58	0.62	1.17	0.96
3rd 13 d	0.82	0.77	0.74	0.82	1.31	1.29
Overall	0.76	0.66	0.61	0.76	1.11	1.05

[1]CON = corn-soybean meal control diet; WP = diet containing 15% ensiled, whole citrus pulp; PP = diet containing 15% ensiled, pressed citrus pulp, on a DM basis.

[2]Labor calculated using 1 hour per day × minimum wage for both WP and PP treatments.