New Developments in Corn for Swine and Poultry

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Introduction

The recent developments in corn production, breeding, and market emphasis have led to a greater variety of corn hybrids for growers and livestock producers to choose from that focus on the major user, livestock production. Animal use of US corn production consumes 55 to 80% of all production. The ability to incorporate specific traits and genes into corn hybrids is going to further enhance corn's position as the number one US feed grain. Through these corn hybrid trait modifications, livestock producers are beginning to realize the economic benefits of high oil, high protein, low lignin/high digestible, low phytate, and other corn hybrid traits.

The latest trends for nutrient-enhanced corn for livestock have created a value added product that livestock producers are willing to pay for. High oil corn is valued at 15 to 25 cents per bushel more to swine and poultry livestock producers because of the increased energy concentration. A nutrient dense product that contains elevated oil and amino acids has even greater value for livestock producers. High available phosphorus corn will greatly decrease the need for supplemental inorganic phosphorus in livestock diets (reducing cost) and reduce the potential environmental impact livestock operations have in a given area. The use of edible vaccines and antibodies will play a major role in the future to limit the impact of gastrointestinal tract (GIT) diseases on livestock production. The development of vaccine delivery through corn is probably the most exciting and yet controversial development to date for livestock users of corn.

High Oil Corn

High oil corn (HOC) research started back in 1896 at the University of Illinois and has been ongoing for over a century. Yield reductions with HOC inhibited the commercialization of HOC until the "Top Cross®" technology was employed in 1990 by Pfister and DuPont. Today, the Top Cross® technology has created corn products that yield similarly to the standard hybrids but with increased oil contents of 6 to 8% compared to the usual 3.4 to 3.5% oil in normal corn varieties. High oil corn has its greatest impact in feeding animals during times of high energy demand/stress and low feed consumption. In the livestock sectors these periods coincide with the times of peak lactation, when energy intake is limiting growth, and times of heat stress.

In a sow lactation trial conducted Purdue University (Bowers et al., 1999b), sows fed the increased energy diets, HOC and normal corn plus fat (NC+Fat), had greater litter weight gain ($P<.05$) over the whole lactation period than sows fed the normal corn (NC) diet (Table 1). Average daily feed intake also increased for sows fed HOC and NC+Fat diets for the first week of lactation ($P<.07$). Splitting the data to evaluate high producing sows (weaning 10+ pigs) demonstrated that sows fed HOC and NC+Fat had even greater litter weight gains during the first week and overall lactation period ($P<.05$ and $P<.01$, respectively) than sows fed the NC diet.

Feeding HOC to grow-finish pigs has great potential to increase feed efficiency, reduce dust levels, and supply a more nutrient dense diet during times of heat stress. In a trial conducted at Purdue University last summer (Bowers et al., 1999a), there were no dietary treatment differences in ADG (Table 2). However, pigs fed HOC had a greater G:F ratio than pigs fed NC during the grower ($P<.042$) and finisher ($P<.05$) periods and over the entire 16-week period (HOC/HOC; $P<.09$).

Barrows and gilts fed the HOC/HOC treatment were leaner ($P<.01$), and HOC-fed gilts also had greater loin depths than pigs fed the NC/NC diets. The increase in loin depth of the gilts and decrease in fat depth in both sexes of pigs fed HOC may be due to the increased nutrient density of the HOC diet better meeting the nutrient needs of the pigs during the summer heat.

As with most supplemental energy sources, pigs fed the HOC treatments had better feed efficiency. However, the level of improvement in gain:feed (G:F) was not as high as the standard rule of thumb of 2% improvement for each 1% added fat. The HOC diets would project to a 6 to 7% improvement in feed efficiency, but only a 3% improvement was observed for the gilts and 4% for the barrows. This less than expected response in feed efficiency to the added fat from HOC appears to be related to the lower fat digestibility of 55% in HOC compared to supplemental liquid fat which is 85% digestible (Adeola and Bajjalieh, 1997). High oil corn offers livestock producers the opportunity to add energy to diets without the expense of installing and maintaining supplemental fat equipment for feed processing.

High Available Phosphorous Corn

High available phosphorus (HAP) corn has reduced phytate content, which increases the phosphorus availability from 15% to 65%. This change in phytate phosphorus is due to a nonlethal mutant gene in corn lines that have 33% (*Lpa2*) and 66% (*Lpa1*) less phytic acid phosphorus (Raboy and Gerbasi, 1996). This reduces the dependence of the livestock producer on inorganic phosphorus and significantly reduces the potential for environmental runoff and pollution from livestock manure.

Research reported by Spencer et al. (1998) indicated that the entire grow-finish period could be conducted without supplemental phosphorus when the diets contain HAP corn (Table 3). Pig growth performance is identical in HAP corn diets with or without supplemental phosphorus, while the normal corn diets required supplemental phosphorus, at least through the grower phase.

Future Products

Vaccines and antibodies play a key role in maintenance of good health. The expression of antigens as vaccines and antibodies against specific antigens in plants (corn) is a potentially cheap and convenient delivery method to improving animal and human health (Sharma et al., 1999).

The GIT diseases have the greatest potential to be developed and implemented in the near future. By inducing immune responses at the gut mucosal level, edible vaccines have the potential to stimulate both local and systemic responses. To date, hepatitis B, *E. coli*, a rotavirus, and now transmissible gastroenteritis (TGE) have all been shown to have efficacy. The recent trial by Prodigene, Inc. in Texas with the edible TGE vaccine in corn was a huge step forward in an agronomic livestock species (swine) to demonstrating its effectiveness to stimulate immunity.

A new round of questions and potential effectiveness centers around respiratory and reproductive disease vaccines and can they be delivered in this way with good efficacy? Will we see a selective population that is more virulent become the resident disease population we will be facing and trying to control? The challenges in the future will be much like the specialty grains use: identity preservation, timing for utilization, cost of use, and the effectiveness of the product.

The products in corn in the future are going to continue to focus on human and animal health. The best products are yet to come and they will be made to have a direct or indirect benefit to human health. Products that make corn chips or the pork chop the consumer eats better for them are the future of the corn industry, with products that contain high conjugated linoleic acid (CLA), antioxidants, or anticarcinogenic products that improve the health of the US consumer.

References

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Table 1. Effect of replacing normal corn with high oil corn or normal corn with added fat and protein on sow and litter performance (Bowers et al., 1999b).

	NC Diet	HOC Diet	NC+Fat Diet	CV	Significance[b]
Number of sows/treatment	40	41	37	-	
Litter weight gain[a], lb/day					
Days 2-7	20.43	22.87	23.44	33.71	1†
Days 2-wean	104.98	116.27	117.94	21.74	1*
ADFI, lb/day					
Days 0-7	7.16	8.29	8.45	31.92	1*
Days 0-wean	9.28	9.80	10.31	20.56	1†
Sows Weaning 10+ Pigs					
Number of sows/treatment	22	22	21	-	
Litter weight gain[a], lb/day					
Days 2-7	22.19	25.37	26.38	28.2	1*
Days 2-wean	110.4	131.1	127.5	19.7	1**
ADFI, lb/day					
Days 0-wean	9.54	10.57	10.95	16.9	1*

[a] Adjusted day 2 litter size used as a covariate.
[b] Contrast 1: NC vs. HOC and NC+Fat; Significance: † P<.10, * P<.05, ** P <.01.

Table 2. Effect of feeding high oil corn or normal corn during the grow-finish period (Bowers et al., 1999a).

	Barrows				Gilts					
Grower/ Finisher	NC/ NC	NC/ HOC	HOC/ NC	HOC/ HOC	NC/ NC	NC/ HOC	HOC/ NC	HOC/ HOC	CV	Significance[c]
Days 0-112										
ADG, lb	1.86	1.81	1.82	1.84	1.74	1.76	1.70	1.70	4.05	Sex***
Gain:Feed[a]	.314	.323	.315	.327	.321	.328	.329	.330	3.84	
Carcass[b]										
Fat depth, in	1.01	1.00	.992	.952	.843	.843	.779	.684	16.31	Trt**, Sex***
Loin depth, in	2.31	2.15	2.14	2.21	2.35	2.25	2.30	2.46	9.30	Trt**, Sex***
% Lean	51.7	51.0	51.0	51.6	52.9	52.5	53.1	54.4	4.67	Sex***

[a] Treatment contrast HOC/HOC vs. NC/NC (P<.09).
[b] Fat-o-meter probe data, determined at a local Indiana slaughter facility.
[c] Significance: ** P<.01, *** P<.001.

Table 3. Effect of phosphorous addition to low phytate and normal corn diets on overall grow-finish pig performance and carcass characteristics (Spencer et al., 1998).

Corn	Low Phytate			Normal			
Added P[a]	Entire Grow Finish	Grower Only	No Added P	Entire Grow Finish	Grower Only	No Added P	SEM
Final Weight[d], lb	246	247	245	243	243	213	1.32
ADG[d], lb/day	1.95	1.97	1.98	1.91	1.94	1.61	13.6
Gain:Feed[d]	.37	.36	.36	.36	.36	.33	.004
BF, in	1.04	1.02	1.03	1.00	1.03	.93	1.27
LEA[c], in^2	6.73	6.79	6.59	6.54	6.24	6.28	1.19
Bone Strength[bd], lb	340	326	291	306	282	174	3.7

[a] Phosphorous regimens: .20% added avail. P during the grower and .15% added avail. P during the finisher.
[b] 4th metacarpal.
[c] Corn main effect, P<.05.
[d] Corn x Phosphorous effect, P<.01.