THE RELATIONSHIP BETWEEN DISTILLER'S DRIED GRAINS WITH SOLUBLES (DDGS) AND ILEITIS IN SWINE

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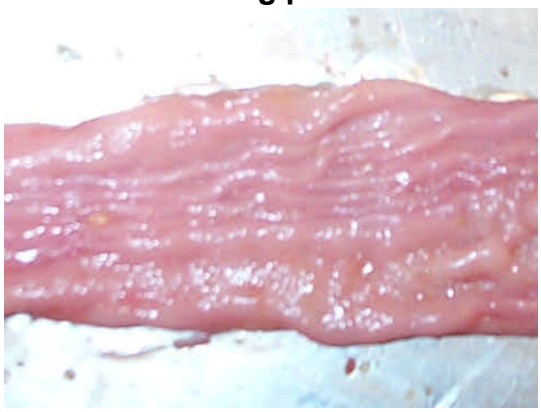
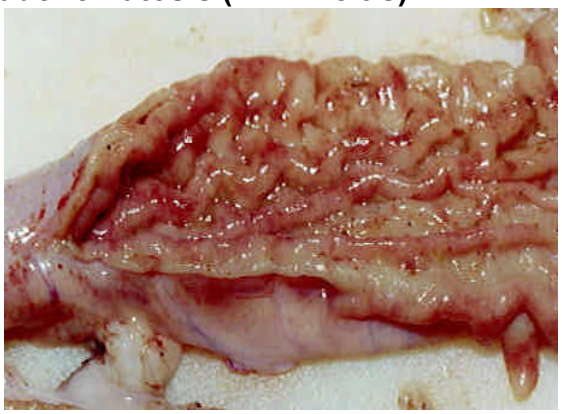
ILEITIS

Ileitis, also known as porcine proliferative enteropathy, is an enteric disease of the lower small intestine and occasionally large intestine that can decrease feed intake, reduce growth performance, and increase mortality in swine. The disease is caused by a gram negative microaerophil bacteria called *Lawsonia intracellularis*, an intracellular parasite of the enterocytes of the intestine (Dufresne, 1999). *Lawsonia intracellularis* infects immature epithelial cells located in the crypts of the intestine, keeping them from maturing and causing them to multiply without leaving the intestine. This results in cellular proliferation and thickening of the infected intestine (primarily ileum and ileocaecal junction), and can result in necrosis, ulceration, and hemorrhaging of the epithelial surface (see Figure 1). Tests using the National Animal Health Monitoring System (NAHMS) serum bank indicate that *Lawsonia intracellularis* is present in 96% of all U.S. swine herds (Bane et al., 1997). This disease has been estimated to cost the U.S. pork industry $20 million annually, based on calculations utilizing NAHMS data, and as much as $8.50 per pig in an infected herd.

Figure 1. Normal ileum and ileum with gross thickening and necrosis indicating porcine intestinal adenomatosis (PIA - ileitis).



Healthy Ileum



PIA lesion in ileum

Ileitis can affect pigs at any time after weaning, but is most commonly found in 40 to 100 lb. growing pigs, bred gilts, sows, and boars and occasionally in finishing pigs (Glock et al., 1994). Generally 1 to 10% of animals are affected in a herd, although this prevalence may rise as high as 50% in young growing pigs. Animals are infected by oral contact with the bacteria shed in feces from other

infected animals. Lesions of the intestinal wall begin to form 7 to 10 days after infection, but reach their maximum approximately 21 days after infection. The disease expresses itself clinically in one of two forms: porcine intestinal adenomatosis (PIA) and porcine hemorrhagic enteropathy (PHE) (Dufresne, 1999). PIA is a chronic condition generally seen in pigs between 6 and 20 weeks of age, and results in decreased feed intake and a lethargic or unthrifty appearance. Growth performance and feed conversion are negatively affected, and often diarrhea is observed. Expression of the disease appears to be triggered when environmental stressors are applied to animals.

Ileitis has been a difficult disease for the swine industry to control. Strict biosecurity measures are necessary to prevent the spread of the disease from one site to the next. In fact, many species of animals have been identified as potential carriers of the disease, including rabbits, hamsters, deer, horses, ostrich (Cooper et al., 1997). Early weaning and use of multiple sites has not been successful in controlling the disease, and this may be due to carrier gilts infecting their piglets very early in life (Dufresne, 1999). Antibiotics and/or antimicrobials, including tetracycline, tylosin, lincosamides, tiamulin, and carbadox, have been used effectively against acute breaks of *Lawsonia intracellularis*, but have been less successful in prevention of disease. Sub-therapeutic levels of these antibiotics often fail to prevent the disease, while therapeutic levels of feed-grade antibiotics are very expensive to maintain in the diet. In addition, public safety concerns over potential residue violations in meat and the risk of antibiotic-resistance in human strains of pathogenic organisms precludes continued use of these drugs if not necessary.

DISTILLER'S DRIED GRAINS WITH SOLUBLES

Reports from informal field studies suggest that including distiller's dried grains with solubles (DDGS) in grow-finish diets in commercial herds with a history of previous ileitis problems may improve the pig's ability to resist or recover from ileitis outbreaks, and thus may reduce dependence on antibiotics to combat this disease. At dietary inclusion levels of 5 – 15% in grow-finish diets, antibiotic supplementation has been decreased or removed completely without apparent appreciable changes in growth performance, mortality, or diagnosis of ileitis in the herd.

DDGS is a co-product of the ethanol production industry that is suitable as a livestock feed, and contains approximately 10% crude fiber. The majority of DDGS has been utilized in ruminant diets, but research conducted by our group has suggested that DDGS originating from "new-generation" ethanol plants located in the upper Midwest is an excellent ingredient for non-ruminant diets as well. Although this DDGS contains a significant amount of crude fiber (8 – 10%), it also contains 10 – 12% fat (Whitney et al., 1999), resulting in considerably higher energy values (approximately 3950 kcal/kg DE or 3800 kcal/kg ME, respectively, on a dry matter basis), compared to values reported in NRC (1998).

The ingredient also is an excellent source of available phosphorus (0.80%) (Whitney et al., 2001), and contributes significant levels of amino acids (0.44, 0.32, 0.62, and 0.15% apparent ileal digestible lysine, methionine, threonine, and tryptophan, respectively), but the amino acid profile is poor (Whitney et al., 2000). Thus, formulating diets with DDGS results in increased in nitrogen and decreased phosphorus excretion (Spiehs et al., 1999), and can play an important role in nutrient management plans.

Laboratory analysis conducted by our group suggests that the fiber composition is primarily insoluble (42.2%) versus soluble (0.7%) in nature (Shurson et al., 2000). According to Hampson (1999), feeding diets that are low in soluble non-starch polysaccharides can reduce the proliferation of pathogenic organisms in the gastrointestinal tract. Providing less soluble and more insoluble fiber in the diet results in less available substrate for organisms in the small, but especially the large, intestine, and thus may reduce pathogen load. Smith and Halls (1968) stated that fiber influences the secretory function of the epithelium, and this alteration may impair bacterial adhesion. Fiber also has a "cleansing" effect in the gut as a result of reducing the viscosity of digesta (Lawrence, 1972). Additionally, a considerable amount of "spent" yeast, remaining from the ethanol fermentation process, is present in DDGS. Yeast cells have been demonstrated to be an excellent source of mannan-oligosaccharides (MOS). MOS have been shown to serve as alternative attachment sites for certain bacteria, thereby blocking attachment to the intestinal wall, and in the case of pathogens, eliciting an immune response (Van der Beke, 1997).

It is quite possible that the fiber or yeast cells remaining in DDGS have the ability to promote gastrointestinal health by any or all of the mechanisms described above. Our group has therefore undertaken a series of studies to develop an ileitis disease challenge model that would be applicable for evaluating nutritional effects, while determining if observations made in the field could be duplicated in a controlled research setting. The two disease challenge studies that have been completed to date involve testing DDGS and/or antibiotic/antimicrobial regimen, while future studies will involve examining other potential ingredients or additives.

RESEARCH EXAMINING DDGS AND ILEITIS

Experiment 1: Effect of DDGS inclusion on ability of the young growing pig to cope with an ileitis challenge

Objectives: (1) Develop a disease challenge model that can be utilized to evaluate nutritional manipulation on ability of the pig to resist or cope with an ileitis challenge, (2) determine if dietary inclusion of DDGS can reduce the incidence or severity of ileitis in growing pigs, and (3) assess the dietary DDGS inclusion level that elicits the greatest response (10 or 20%) in the pig to an ileitis challenge.

Procedures: 80 crossbred pigs (40 gilts, 40 barrows) initially 17 days of age were weaned, transported to the CVM-RAR isolation barns located on the St. Paul campus, and randomly allotted (blocked by sex and weight) to one of four treatments. Pigs were housed in separate rooms (10 pigs/room, 2 rooms/treatment). All pigs were fed a commercial Phase 1 pelleted diet the first 4 days of the trial, then were placed on their respective diets for the remainder of the study. These diets were formulated to be equivalent in energy (3390 kcal/kg ME), calcium (0.80%), total phosphorus (0.70%), and apparent ileal digestible lysine (1.15%).

Treatment:	Diet:	Challenge:
(1) Negative Control (NC)	Corn-soybean meal	No
(2) Positive Control (PC)	Corn-soybean meal	Yes
(3) 10% DDGS (D10)	10% DDGS	Yes
(4) 20% DDGS (D20)	20% DDGS	Yes

Four weeks after experimental diets were initiated, pigs were provided 60 ml via stomach tube of either saline (NC) or an inoculation of *Lawsonia intracellularis* (PC, D10, and D20 treatments). The inoculate was prepared as a mucosal homogenate collected from the small intestines of pigs previously infected with *Lawsonia intracellularis* and exhibiting lesions consistent with ileitis. Care was taken to avoid cross-contaminating pigs from different rooms. Growth and feed intake data were collected for the pre- and post-inoculation periods. Pigs were observed for gantness and lethargy, and fecal scores indicating looseness were taken. Fecal samples were collected on day 14 and 20 post-inoculation, and sent to the University of Minnesota Diagnostic Laboratory for PCR evaluation of *L. intracellularis* shedding. On day 20 or 21 post-inoculation, all pigs were euthanized and necropsies conducted to visually evaluate lesions and collect ileal tissue samples for immunohistochemistry (IHC) testing of *L. intracellularis* presence and proliferation.

Growth performance data were analyzed by room using analysis of variance, providing 2 replications per treatment. All other data were analyzed utilizing the individual pig as the experimental unit, giving 20 replications per treatment. Least squares means were used to compare the negative and positive controls, indicating the effect of infecting the pigs on response criteria. Analysis of variance was conducted on challenged treatment data (PC, D10, and D20) to indicate differences within the challenged group. In addition, least squares means comparisons were conducted between challenged treatments to indicate differences due to dietary composition.

Results: All pigs remained on test for the duration of the experiment. Body weights, growth performance, feed intake, and feed efficiency results are provided in Table 1. Pigs initially weighed 5.7 kg at the beginning of the trial. Feed intake and feed efficiency were similar across all treatments pre-challenge, although pigs fed the 10% DDGS diet grew slightly faster than pigs fed the 20%

DDGS diet. Infecting pigs with *L. intracellularis* greatly reduced feed intake, growth, and feed efficiency by 25, 55, and 40%, respectively, during the 3-week post-challenge period. In addition, looser fecal consistency was observed (data not shown) from day 5 – 20 post-challenge in challenged vs. non-challenged pigs. Dietary treatment (0, 10, or 20% DDGS) did not appreciably affect growth, feed intake, or feed conversion responses post-challenge, however, and resulted in similar end body weights.

Table 1. Effect of dietary distiller's dried grains with solubles inclusion and ileitis challenge on growth performance, feed intake, and feed conversion efficiency.

		Challenged Trts			NC vs PC	Challenged Trts	
	NC	**PC**	**D10**	**D20**	**Pr>F**	**Mean**	**Pr>F**
# of pens	2	2	2	2		6	
Body weight							
Initial, kg	5.7	5.7	5.7	5.7	*0.99*	5.7	*0.99*
Challenge, kg	16.7	17.5	17.8	16.9	*0.26*	17.4	*0.51*
Final, kg	29.9	24.5	23.7	22.6	*0.01*	23.6	*0.36*
Pre-challenge (day 0 - 32)							
ADG, g	354	379[a,b]	389[a]	360[b]	*0.14*	374	*0.15*
ADFI, g	567	595	593	589	*0.16*	592	*0.97*
G/F	0.62	0.64	0.66	0.61	*0.60*	0.64	*0.43*
Post-challenge (day 32 - 53)							
ADG, g	600	311	259	245	*0.01*	272	*0.67*
ADFI, g	1363	990	1012	1067	*0.01*	1023	*0.70*
G/F	0.44	0.31	0.26	0.23	*0.01*	0.27	*0.43*

[a,b] Different superscripts indicate difference between means within challenged treatments ($P < 0.10$).

Necropsy results are presented in Table 2. No lesions were observed for the negative control group. Overall, 63% percent of pigs that were challenged exhibited lesions consistent with ileitis. No dietary effects on prevalence were observed, although pigs fed the 10% DDGS diet had more area (length) of lesions recorded compared to pigs fed the control 0% DDGS diet, with pigs fed the 20% DDGS diet intermediate. These results are consistent with jejunum lesion data, although pigs fed either DDGS level tended to have more severe lesions (higher score), indicating a higher level of infection. No dietary differences were noted in lesion length, severity, or prevalence in the ileum, however.

Table 2. Effect of dietary distiller's dried grains with solubles inclusion and ileitis challenge on lesion location, length, severity, and prevalence.

		Challenged Trts			NC vs PC	Challenged Trts	
	NC	PC	D10	D20	Pr>F	Mean	Pr>F
# of pigs	20	20	20	20		60	
Jejunum							
Length, cm	0.0	15[a]	54.4[b]	31.9[a,b]	*0.02*	33.8	*0.16*
Score (0-4)	0.0	0.4[a]	1.1[b]	1.2[b]	*0.01*	0.9	*0.08*
Prevalence, %	0.0	20.0[a]	50.0[b]	45.0[b]	*0.01*	38.3	*0.12*
Ileum							
Length, cm	0.0	7.5	11.8	11.1	*0.01*	10.1	*0.39*
Score (0-4)	0.0	0.9	1.5	1.5	*0.01*	1.3	*0.22*
Prevalence, %	0.0	50.0	65.0	60.0	*0.01*	58.3	*0.63*
Cecum							
Length, cm	0.0	0.0[a]	1.5[b]	0.15[a]	*0.25*	0.5	*0.05*
Score (0-4)	0.0	0.0[a]	0.5[b]	0.05[a]	*0.21*	0.2	*0.03*
Prevalence, %	0.0	0.0[a]	20.0[b]	5.0[a]	*0.19*	8.3	*0.06*
Colon							
Length, cm	0.0	1.0	6.2	0.6	*0.30*	2.6	*0.20*
Score (0-4)	0.0	0.3[a]	0.7[b]	0.2[a]	*0.06*	0.4	*0.10*
Prevalence, %	0.0	20.0	25.0	10.0	*0.04*	18.3	*0.47*
Total							
Length, cm	0.0	23.4[a]	73.8[b]	43.7[a,b]	*0.01*	47.0	*0.09*
Prevalence, %	0.0	55.0	70.0	65.0	*0.01*	63.3	*0.62*

[a,b] Different superscripts indicate difference between means within challenged treatments ($P < 0.10$).

Laboratory results are presented in Table 3. The PCR technique for determining *L. intracellularis* presence in feces is the most accurate current technique for testing ileitis in the live pig. 4 negative control (NC) pigs on day 14 post-challenge, and 8 NC pigs on day 20 post-challenge tested positive, indicating some cross-contamination between rooms occurred after challenge. By day 20 post-challenge, 80 – 100% of the inoculated pigs tested positive for shedding the causative bacteria. A slightly higher percentage of pigs fed the DDGS diets tested positive compared to positive control pigs. Immunohistochemistry (IHC) results, however, indicated no difference in concentration of or percentage of pigs testing positive for *L. intracellularis,* however. IHC is currently the most sensitive and accurate method of evaluating presence of ileitis, but requires submission of intestinal tissue, and therefore sacrificing of pigs. IHC results indicate that 30% of the NC pigs were exposed to and acquired ileitis, but that the disease was in an early stage of infection at the end of the study.

Table 3. Effect of dietary distiller's dried grains with solubles inclusion and ileitis challenge on fecal PCR and ileum IHC results.

Test	NC	Challenged Trts			NC vs PC	Challenged Trts	
		PC	D10	D20	Pr>F	Mean	Pr>F
Fecal PCR							
Day 0	0.0	0.0	0.0	0.0	*	0.0	*
Day 14	20.0	70.0[a]	90.0[b]	90.0[b]	*0.01*	83.3	*0.15*
Day 20	40.0	80.0[a]	95.0[b]	100.0[b]	*0.01*	91.7	*0.06*
IHC							
Score (0-4)	0.55	2.00	2.15	2.25	*0.01*	2.13	*0.71*
Prevalence, %	30.0	100.0	90.0	95.0	*0.01*	95.0	*0.36*

[a,b] Different superscripts indicate difference between means within challenged treatments ($P < 0.10$).

The target dose of *L. intracellularis* for this study was 1 x 10^8. The difficulty in achieving this dose, however, is that the inoculate is a mucosal homogenate that is harvested from infected tissues the day of challenge, and therefore laboratory quantification of the actual concentration of *L. intracellularis* is not possible prior to challenge. The actual laboratory quantification of the inoculate determined a *L. intracellularis* concentration of 2.6 x 10^7 per ml, or a dosage rate of 1.56 x 10^9. Since this was considerably higher than our goal, and visual observations during post-challenge and necropsy indicated that animals were perhaps sicker than they needed to be or what would normally be observed in the field, we felt that any possible nutritional effects on ileitis may have been masked by the extremely high dosage rate. Therefore, we chose to modify our next disease challenge study by lowering the dosage rate.

Conclusion: Results from this experiment suggest minimal or no effect of dietary DDGS inclusion on ability of the pig to resist or cope with an ileitis challenge. The inoculation dosage used in this study, however, was much higher than originally targeted for, and may have masked any potential dietary effects that would otherwise have been observed.

Experiment 2: Effect of DDGS and/or antibiotic regimen on ability of the young growing pig to cope with an ileitis challenge

Objectives: (1) Modify the disease challenge model such that it can be utilized to evaluate nutritional manipulation on ability of the pig to resist or cope with an ileitis challenge, (2) determine if dietary inclusion of DDGS can reduce the incidence or severity of ileitis in growing pigs, and (3) compare dietary DDGS inclusion to an antibiotic/antimicrobial regimen currently used to treat ileitis.

Procedures: 100 crossbred pigs (50 gilts, 50 barrows) initially 17 days of age were weaned, transported to the CVM-RAR isolation barns located on the St. Paul campus, and randomly allotted (blocked by sex and weight) to one of five

treatments. Pigs were housed in separate rooms (10 pigs/room, 2 rooms/treatment). All pigs were fed a commercial Phase 1 pelleted diet the first 4 days of the trial, then were placed on their respective diets for the remainder of the study. These diets were formulated to be equivalent in energy (3390 kcal/kg ME), calcium (0.80%), total phosphorus (0.70%), and apparent ileal digestible lysine (1.15%). Pigs were fed either a corn-soybean meal or 10% DDGS diet, with or without antibiotic regimen. Antibiotic regimen consisted of continuous BMD® inclusion (30 g/ton of mixed feed) along with pulsing of Aureomycin® (500 g/ton of mixed feed) from day 3 pre- to day 11 post-challenge.

Treatment:	Diet:	Antibiotic:
(1) Negative Control (NC)	Corn-soybean meal	No
(2) Positive Control (PC)*	Corn-soybean meal	No
(3) DDGS (D)*	10% DDGS	No
(4) Control & Antibiotic (PC + A)*	Corn-soybean meal	Yes
(5) DDGS & Antibiotic (D + A)*	10% DDGS	Yes

* indicates pigs were inoculated with a mucosal homogenate 4 weeks after initiation of dietary treatments

Challenged treatment data were analyzed as a 2 x 2 factorial (DDGS and antibiotic regimen as the factors). All other animal management and data collection procedures were conducted similar to Experiment 1, except that dosage rate was reduced when infecting pigs.

Results: Two pigs were removed from the experiment prior to completion due to health reasons unrelated to the ileitis challenge. Body weights, growth performance, feed intake, and feed efficiency results are provided in Table 4. Pigs initially weighed 6.7 kg at the beginning of the trial. Growth, feed intake and feed efficiency were similar across all treatments pre-challenge.

Infecting pigs with *L. intracellularis* appeared to reduce feed intake, growth, and feed efficiency during the 3-week post-challenge period, but these effects were not significant. DDGS or antibiotic regimen did not affect performance, but the combination appeared numerically to improve feed intake and growth rate to levels near those of unchallenged pigs. Looser fecal consistency was observed (data not shown) from day 3 – 20 post-challenge in challenged vs. non-challenged pigs, and pigs fed the combination of DDGS and antibiotic regimen tended to have improved stool scores the final week of the study ($P < 0.15$).

Table 4. Effect of dietary distiller's dried grains with solubles and or BMD/CTC inclusion under an ileitis challenge on growth performance, feed intake, and feed conversion efficiency.

		Challenged Trts				NC vs PC	Challenge		*P*-value		
	NC	PC	D	PC+A	D+A	Pr>F	Mean	Pr>F	D	A	D x A
# of pens	2	2	2	2	2		8		4	4	2
Body weight											
Initial, kg	6.6	6.9	6.8	6.6	6.7	*0.11*	6.7	*0.45*	*0.92*	*0.18*	*0.46*
Challenge, kg	19.5	20.8	19.2	19.9	20.0	*0.26*	20.0	*0.61*	*0.40*	*0.98*	*0.35*
Final, kg	36.3	34.9	30.6	33.4	35.1	*0.65*	33.5	*0.47*	*0.57*	*0.50*	*0.22*
Pre-challenge (day 0 - 32)											
ADG, g	404	432	386	417	416	*0.41*	412.8	*0.65*	*0.40*	*0.79*	*0.41*
ADFI, g	695	645	726	731	692	*0.35*	698.6	*0.23*	*0.47*	*0.39*	*0.09*
G/F	0.584	0.670	0.533	0.573	0.603	*0.27*	0.595	*0.38*	*0.34*	*0.80*	*0.17*
Post-challenge (day 32 - 53)											
ADG, g	799	672	542	642	720	*0.29*	644.2	*0.49*	*0.75*	*0.39*	*0.25*
ADFI, g	1262	1148	1046	1167	1276	*0.52*	1159.3	*0.67*	*0.98*	*0.38*	*0.45*
G/F	0.632	0.589	0.517	0.550	0.578	*0.65*	0.559	*0.89*	*0.77*	*0.88*	*0.52*

Necropsy results for Experiment 2 are presented in Table 5. Two pigs in the negative control (NC) group had lesions had lesions that were suspect for ileitis. Overall, 59% percent of pigs that were challenged exhibited lesions consistent with ileitis, which was similar to Experiment 1. Including 10% DDGS in the diet appeared to reduce lesion length, severity, and percentage of pigs exhibiting lesions in the ileum, and to a lesser degree in the colon, resulting in an overall decrease in percentage of pigs with lesions and numerical trend towards reduced lesion length. Continuous BMD® inclusion with pulsing of Aureomycin® reduced severity of lesions and percentage of pigs exhibiting lesions in the jejunum, and resulted in a numerical trend towards reduced lesion length overall.

Fecal PCR and ileum tissue IHC results are presented in Table 6. Challenging pigs resulted in a 97.5% detection rate of *L. intracellularis* in ileal tissue, indicating nearly all pigs were successfully infected with ileitis. Although the combination of DDGS and antibiotic regimen appeared to affect fecal shedding 14 days post-challenge, there were no dietary effects on shedding by 20 days post-challenge, and ileum IHC indicated no dietary effect on percent of pigs testing positive for ileitis. IHC scores (indicating proportion of cells infected with *L. intracellularis*) did, however, indicated a positive effect of DDGS and antibiotic regimen on reducing concentration, or potentially severity, of the infection. The combination of DDGS and antibiotic regimen also may have had an additive effect, with differences approaching significance.

Table 5. Effect of dietary distiller's dried grains with solubles and or BMD/Aureomycin inclusion under an ileitis challenge on lesion location, length, severity, and prevalence.

		Challenged Trts				NC vs PC	Challenge		*P*-value		
	NC	PC	D	PC+A	D+A	Pr>F	Mean	Pr>F	D	A	D x A
# of pigs	19	19	20	20	20	38	79		40	40	20
Jejunum											
Length, cm	1.26	22.16	14.65	8.60	10.20	*0.02*	13.80	*0.49*	*0.68*	*0.18*	*0.50*
Score (0-4)	0.05	0.90	0.38	0.28	0.25	*0.01*	0.45	*0.03*	*0.11*	*0.03*	*0.16*
Prevalence, %	5.3	47.4	30.0	20.0	15.0	*0.01*	27.8	*0.12*	*0.28*	*0.04*	*0.54*
Ileum											
Length, cm	0.37	10.58	5.50	9.75	6.40	*0.01*	8.03	*0.11*	*0.02*	*0.98*	*0.62*
Score (0-4)	0.05	1.54	0.75	1.43	1.05	*0.01*	1.19	*0.10*	*0.02*	*0.70*	*0.40*
Prevalence, %	5.3	68.4	40.0	80.0	55.0	*0.01*	60.8	*0.06*	*0.02*	*0.22*	*0.87*
Cecum											
Length, cm	0.00	0.16	0.25	0.30	0.00	*0.57*	0.18	*0.76*	*0.62*	*0.79*	*0.36*
Score (0-4)	0.00	0.05	0.05	0.05	0.00	*0.36*	0.04	*0.80*	*0.55*	*0.55*	*0.59*
Prevalence, %	0.0	5.3	5.0	5.0	0.0	*0.36*	3.8	*0.80*	*0.55*	*0.55*	*0.59*
Colon											
Length, cm	0.00	2.11	0.30	1.20	0.50	*0.01*	1.01	*0.08*	*0.02*	*0.51*	*0.30*
Score (0-4)	0.00	0.47	0.10	0.20	0.15	*0.01*	0.23	*0.15*	*0.09*	*0.37*	*0.19*
Prevalence, %	0.00	31.6	5.0	20.0	10.0	*0.01*	16.5	*0.12*	*0.03*	*0.70*	*0.32*
Total											
Length, cm	1.63	35.05	20.40	19.45	11.35	*0.01*	21.39	*0.19*	*0.14*	*0.11*	*0.67*
Prevalence, %	10.5	68.4	40.0	80.0	50.0	*0.01*	59.0	*0.04*	*0.01*	*0.32*	*0.94*

Table 6. Effect of dietary distiller's dried grains with solubles and or BMD/Aureomycin inclusion under an ileitis challenge on fecal PCR and ileal tissue IHC scores.

		Challenged Trts				NC vs PC	Challenge		*P*-value		
	NC	PC	D	PC+A	D+A	Pr>F	Mean	Pr>F	D	A	D x A
IHC											
Score (0-4)	0.00	2.58	1.95	2.00	1.90	*0.01*	2.10	*0.05*	*0.05*	*0.10*	*0.16*
Prevalence, %	0.0	100.0	95.0	100.0	95.0	*0.01*	97.5	*0.59*	*0.17*	*1.00*	*1.00*
Fecal PCR											
Day 14	0	63.2	25	25	40	*0.01*	40	*0.04*	*0.28*	*0.28*	*0.02*
Day 20	0	68.4	60	65	45	*0.01*	59.5	*0.47*	*0.21*	*0.41*	*0.61*

Conclusion: Results from this study suggest that including DDGS in growing pig diets may provide some protection and aid the pig in coping with ileitis under a challenge situation. These results are consistent with field reports suggesting that DDGS inclusion results in reduced severity of clinical signs during an ileitis outbreak. The beneficial effects observed during this study were similar to the results observed for an approved antibiotic regimen (BMD® with 14-day Aureomycin® pulse). An additive effect of the two factors, however, was not observed. The lower inoculation dosage rate used for this study (compared to Experiment 1) was quite successful in infecting most pigs, and appeared to be a

more appropriate level of infection, allowing for examination of dietary treatment differences.

FUTURE RESEARCH

Two studies are currently funded and scheduled for completion during the next year. One study is a collaborative effort with South Dakota State University, in which animals will be raised in a more typical commercial grow-finish environment. Animals will be either a corn-soybean meal control diet or diets containing either DDGS or soy hulls. Similar responses to DDGS and ileitis have been reported from using soy hulls. Animals will be inoculated similar to the previous two experiments described, but animals will be maintained and growth and mortality data recorded over the entire grow-finish period. This study is scheduled to begin in August or September of 2002. The other study is another disease challenge study that will be conducted similar to Experiment 2. Dietary alternatives planned for testing include DDGS, soy hulls, and a polyclonal antibody feed additive product due to be marketed beginning of next year. This study is scheduled to begin in October of 2002.

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