

EFFECTS OF A SEAWEED EXTRACT ON WEANLING PIG GROWTH PERFORMANCE AND IMMUNE FUNCTION DURING AN ACUTE ENTERIC DISEASE CHALLENGE¹

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Summary

A total of 95 pigs (initially 15 lb and 17 d of age) was used in a 28 d growth trial to determine the effects of *Ascophyllum nodosum* seaweed extract (ANOD) on weanling pig growth performance and immune function in response to enteric disease challenge with *Salmonella typhimurium* (ST). Experimental treatments were arranged in a 2 x 4 factorial with main effects of disease challenge (control vs. ST challenge) and dietary addition of ANOD (0, 0.5, 1.0, and 2.0% of diet). Results suggest little beneficial effect of dietary ANOD on growth performance or immune response in the presence or absence of ST challenge.

(Key Words: Weanling Pigs, Disease Challenge, *Salmonella*, Seaweed.)

Introduction

Antibiotics are used extensively in livestock feeding to prevent infection and to improve growth performance and feed efficiency. Today, the use of antibiotics in animal diets has come under increased public scrutiny because of concern about the development of antibiotic-resistant organisms. Management programs (e.g., segregated early weaning, all-in/all-out production) help to minimize exposure to pathogens; however, acute disease challenges still occur. Therefore, research studying natural alternatives to dietary antimicrobials is on the rise.

Preliminary research at another university suggests that the addition of an extract from the seaweed *Ascophyllum nodosum* (ANOD) may enhance growth performance and immune function in porcine respiratory and reproductive syndrome (PRRS) virus-infected nursery pigs. The objective of the current study was to determine the effects of ANOD supplementation (without dietary antibiotics) on growth performance and immune function of nursery pigs with a bacterial challenge of *Salmonella typhimurium* (ST).

Procedures

The experimental protocol used in this study was approved by the KSU Institutional Animal Care and Use Committee. The 95 pigs (initially 15 lb and 17 d of age) were blocked by initial weight, equalized for sex, and allotted randomly to one of eight treatments in a 28 d growth assay. Each treatment had six replicates (pens) with two pigs per pen.

The eight treatments were arranged in a 2 x 4 factorial with main effects of disease challenge (control or ST) and dietary treatment (Table 1; 0, 0.5, 1.0, or 2.0% ANOD). The ANOD extract used in this study was obtained from Acadian Seaplants Limited, Nova Scotia, Canada.

All pigs were housed in two similar environmentally controlled rooms according

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to disease challenge. Pens contained one self-feeder and one nipple waterer to provide ad libitum access to feed and water. Prior to the start of the study, fecal samples were taken to ensure that all pigs were free of *Salmonella*. Pigs were weighed and feed disappearance was measured on d 0, 7, 14, 21, and 28 to determine ADG, ADFI, and F/G. On d 14, each pig housed in the ST room (n=48) were orally gavaged with approximately 6×10^9 CFU of *S. typhimurium* in 10 ml of growth medium. Each pig housed in the control room (n=47) received a similar volume of sterile growth medium. Rectal temperature was measured on one pig per pen through 7 d after challenge. Daily feed intake also was monitored through 7 d after challenge. On d 0, 7, and 14 with respect to challenge, serum samples were obtained from one pig per pen and analyzed for haptoglobin. On d 7 and 14 after challenge, fecal samples were obtained from all pigs and cultured for *Salmonella*.

Data were analyzed as a 2×4 factorial in a randomized complete block design replicated over time using the mixed model procedure of SAS. All means presented are least-square means.

Table 1. Diet Composition (As-Fed Basis)

Ingredient	% of Diet
Corn	49.65
Soybean meal (46.5% CP)	28.03
Spray-dried whey	10.00
Select menhaden fish meal	4.50
Choice white grease	3.00
Cornstarch ^a	2.00
Monocalcium phosphate	1.20
Limestone	0.68
Salt	0.35
Vitamin premix	0.25
Trace mineral premix	0.15
L-Lysine HCl	0.15
DL-Methionine	0.05

^aANOD extract replaced cornstarch to provide the experimental treatments.

Diet was formulated to contain 1.40% lysine, 0.90% Ca, and 0.79% P.

Results and Discussion

No differences ($P > .10$) in ADG, ADFI, or F/G occurred between dietary treatments (Table 2). However, a challenge by time interaction ($P < .0005$) was observed. Prior to challenge, ADG, ADFI, and F/G were similar between control and ST-challenged pigs. The ST challenge resulted in reductions in ADG ($P < .0001$), ADFI ($P < .005$), and F/G ($P < .002$) compared to controls during wk 3 of the study (Table 2). However, by wk 4, ADFI did not differ ($P > .10$) between control and ST-challenged pigs. This increased ADFI for ST-challenged pigs resulted in improved ($P < .05$) ADG and F/G compared to controls in wk 4.

During the 7 d after challenge, a challenge by time interaction ($P < .0001$) affected daily feed intake and rectal temperature. Daily feed intake for ST-challenged pigs began to decline ($P < .05$) between 24 to 48 h after challenge (Table 3), but returned to levels comparable to those of controls by 5 d after challenge. Rectal temperature (Table 3) of control pigs did not differ during the 7 d after challenge. The ST-challenged pigs had a higher ($P < .05$) rectal temperature than controls on 0 d. The ST-challenge produced a marked febrile response. Rectal temperature in ST-challenged pigs was elevated on 1 d ($P < .05$), peaked on 2 d ($P < .05$), and returned to control levels by 4 d after challenge.

A diet by challenge interaction ($P < .056$) also occurred. Control pigs receiving the 0% ANOD diet had higher ($P < .05$) serum haptoglobin concentrations (Table 4) than control pigs receiving 2% ANOD or ST-challenged pigs receiving 0% ANOD. In addition, a challenge by time interaction ($P < .0001$) affected serum haptoglobin (Table 5). Haptoglobin levels for controls declined over time, whereas haptoglobin in ST-challenged pigs was elevated ($P < .05$) on 7 d after challenge, but returned to prechallenge levels by 14 d.

At 7 d after challenge, fecal cultures for control pigs were negative, whereas 21.3% (10/47) ST-challenged pigs were positive for

Salmonella. At 14 d after challenge, one control pig had a positive *Salmonella* culture, and 10.6% (5/47) of ST-challenged pigs were positive. Rectal temperature and serum haptoglobin levels for the one control pig that cultured positive were never elevated. Therefore, we were satisfied that biosecurity was maintained and attribute the positive culture to laboratory error.

The results of this study are consistent with previous studies, indicating that an acute challenge with ST results in increases in rectal temperature and serum haptoglobin with concomitant reductions in ADFI and

ADG. Furthermore, the compensatory gain and improved F/G of ST-challenged pigs during wk 4 of the study suggests that the response to acute enteric disease challenge is transient and appears to have minimal impact on future performance. However, in a commercial setting, chronic exposure to pathogens and other stressors can compromise performance, and further research in this area is needed. In contrast to the previous study using a PRRS-virus challenge, we were unable to detect an effect of ANOD on growth performance and immune function in unchallenged controls or ST-challenged pigs.

Table 2. Effects of *Salmonella* Challenge and Dietary ANOD on Growth Performance of Weanling Pigs

Item	<i>Salmonella</i>			% ANOD in Diet				
	Control	Challenge	SEM	0	0.5	1.0	2.0	SEM
Day 0 to 7								
ADG, lb	.46 ^a	.50 ^a	.057	.43	.44	.49	.55	.071
ADFI, lb	.66 ^a	.77 ^a	.089	.60	.70	.74	.82	.110
F/G	1.52 ^{ac}	1.59 ^c	.084	1.47	1.66	1.56	1.53	.119
Day 8 to 14								
ADG, lb	.94 ^b	1.04 ^b	.057	.90	1.06	1.07	.94	.071
ADFI, lb	1.22 ^b	1.36 ^b	.089	1.15	1.29	1.35	1.37	.110
F/G	1.33 ^a	1.32 ^a	.084	1.34	1.22	1.28	1.47	.119
Day 15 to 21								
ADG, lb	1.39 ^c	.95 ^b	.057	1.12	1.19	1.25	1.14	.071
ADFI, lb	1.91 ^c	1.62 ^d	.089	1.68	1.84	1.83	1.71	.110
F/G	1.39 ^a	1.85 ^{bc}	.084	1.58	1.74	1.59	1.59	.119
Day 22 to 28								
ADG, lb	1.17 ^d	1.40 ^c	.057	1.27	1.28	1.37	1.24	.071
ADFI, lb	2.17 ^e	2.29 ^e	.089	2.14	2.20	2.24	2.34	.110
F/G	1.91 ^b	1.65 ^c	.084	1.74	1.81	1.62	1.94	.119

^{a,b,c,d,e}Means within rows or columns without common superscripts differ (P<.05).

Table 3. Effects of *Salmonella* Challenge on Daily Feed Intake and Rectal Temperature of Weanling Pigs

Day after Challenge	Feed Intake, lb		Rectal Temperature, °F	
	Control	Challenge	Control	Challenge
0	--	--	103.5 ^{ab}	104.0 ^{cg}
1	1.79 ^{ace}	1.70 ^{eg}	103.6 ^{ab}	104.6 ^d
2	1.77 ^{ae}	.90 ^d	103.6 ^{abc}	105.2 ^e
3	1.84 ^{afg}	1.18 ^{dh}	103.6 ^{ab}	104.3 ^g
4	2.11 ^{bf}	1.49 ^{eh}	103.5 ^{ab}	103.8 ^{ac}
5	1.98 ^{afg}	2.05 ^{af}	103.9 ^{ac}	103.6 ^{ab}
6	1.87 ^{acfg}	2.01 ^{bcf}	103.8 ^{abc}	102.8 ^f
7	2.09 ^{bcfg}	2.02 ^{bcf}	103.4 ^b	103.0 ^f

^{a,b,c,d,e,f,g,h}Means within rows or columns without common superscripts differ (P<.05); Feed intake SEM = ± 0.145; Rectal temperature SEM = ± 0.134.

Table 4. Effect of Dietary ANOD on Haptoglobin Concentration (mg/dl) of Weanling Pigs

Diet (% ANOD)	Control	Challenge
0	43.50 ^a	20.17 ^b
0.5	25.94 ^{ab}	35.41 ^{ab}
1	33.00 ^{ab}	36.15 ^{ab}
2	21.28 ^b	27.67 ^{ab}

^{a,b}Means within rows or columns without common superscripts differ (P<.05); SEM = ± 6.50.

Table 5. Effect of *Salmonella* Challenge on Haptoglobin Concentration (mg/dl) of Weanling Pigs

Day after Challenge	Control	Challenge
0	44.13 ^a	27.17 ^c
7	25.88 ^{bc}	35.67 ^{ab}
14	22.79 ^c	26.71 ^c

^{a,b,c}Means within rows or columns without common superscripts differ (P<.05); SEM = ± 4.13.