EVALUATION OF VACCINATION AND DIET FOR THE CONTROL OF *SERPULINA PILOSICOLI* INFECTION (PORCINE INTESTINAL SPIROCHAETOSIS)

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Introduction

Porcine intestinal spirochaetosis (PIS) is a diarrhoeal disease of weaners and growers, associated with a mild colitis. Control of the aetiological agent, *Serpulina pilosicoli*, has relied mainly on the use of antimicrobial agents. In contrast, besides the use of antimicrobials and appropriate management practices, it is our experience that the closely related *Serpulina hyodysenteriae* (the agent of swine dysentery) can also be partially controlled by bacterin vaccines (1), whilst experimentally-infected pigs totally resist challenge if fed a diet based on cooked white rice and animal protein (4, 5). This diet results in reduced microbial fermentation in the large intestine, and it appears that these conditions inhibit colonisation by the spirochaete. The purpose of the present study was to assess whether the use of a bacterin vaccine or a rice-based diet could similarly inhibit colonisation by *S. pilosicoli.*

Materials and methods

Three groups of weaner pigs were housed in adjacent pens. One group of six were vaccinated intramuscularly twice at a three week interval with 2 ml of a bacterin made from 10^{10} formalin-inactivated cells of a Western Australian porcine field isolate of *S. pilosicoli* (strain 95/1000) emulsified in Freund's incomplete adjuvant. The first vaccine was given three days after the pigs were weaned at three weeks of age. These pigs and the second group of eight unvaccinated controls were fed a commercial Western Australian weaner diet based on wheat and lupin. Six other unvaccinated pigs in the third group were weaned onto a cooked rice-animal protein diet, as previously used for the control of *S. hyodysenteriae* (5). All pigs were challenged orally with 10^{10} active mid-log phase cells of *S. pilosicoli* strain 95/1000 over the same three successive days, starting 10 days after the second vaccination. Pigs were monitored daily for signs of ill-health, and faecal swabs were taken every 2 to 3 days, and cultured on selective medium for *S. pilosicoli* (2). Selected spirochaete isolates were identified using multilocus enzyme electrophoresis (3), to confirm they were the same as the inoculated strain 95/1000. One control pig with severe diarrhoea was killed four days after the third oral challenge, and the rest were killed 3 to 4 weeks after this. All were subjected to a full post mortem examination. The mesenteric nodes draining the large intestine were incised with a sterile blade and swabbed, and then the caecum and colon were opened and the walls also swabbed. Histological sections were also prepared from both sites in all pigs.

Results and discussion

All pigs in all groups became colonised with *S. pilosicoli* at some stage, but this occurred later (mean onset at 14 days) and lasted for a significantly shorter period (mean of 13 days) in pigs fed cooked rice than it did in both groups fed the wheat-lupin diet. Mean figures for the unvaccinated pigs fed wheat-lupin were 3.6 and 20 days respectively, and for the vaccinates 5 and 20 days respectively. One unvaccinated pig fed wheat-lupin developed an acute severe watery diarrhoea, and at post mortem four days after the third oral inoculation a severe erosive colitis with *S. pilosicoli* cells attached end-on to the colonic epithelium was present. Pigs in all groups showed signs of a mild transient diarrhoea, and most showed evidence of a patchy mild colitis at post-mortem. Despite isolating *S. pilosicoli* from the caecum and colon of most of these pigs at post-mortem, end-on attachment of the spirochaetes was not observed. *S. pilosicoli* was isolated from the mesenteric nodes of three unvaccinated wheat-lupin fed control pigs (including the acutely affected animal), and from one vaccinated animal, but not from any of the rice-fed pigs. The mesenteric nodes appeared histologically normal in all animals.

In this experiment only one control pig developed severe and acute clinical signs, whilst the rest were only mildly affected. This pattern of disease in infected pigs is similar to that which we have observed in the field. This is the first report of the isolation of *S. pilosicoli* from mesenteric lymph nodes in pigs, and further work is required to investigate the extent and occurrence of extraintestinal spread of the spirochaete in pigs in infected herds.

Vaccination did not have an obvious protective effect against *S. pilosicoli* infection, although no acute disease was observed in this group and the spirochaete was only isolated from the mesenteric nodes of one of the vaccinates at slaughter. In contrast feeding a rice-based diet did significantly delay and reduce the duration of intestinal colonisation. Complete protection, as seen with *S. hyodysenteriae*, was not achieved with this diet, and this points to differences in the physiological and biological properties of the two species of pathogenic spirochaetes.

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References

1 Hampson, D. J., Robertson, I. D. and Mhoma, J. R. L. (1993) Experiences with a vaccine being developed for the control of swine dysentery. *Australian Veterinary Journal*, **70**, 18-20

2 Jenkinson, S. R. and Wingar, C. R. (1981) Selective medium for the isolation of *Treponema hyodysenteriae. Veterinary Record* **109**, 384-385

3 Lee, J. I., Hampson, D. J., Lymbery, A. J. and Harders, S. J. (1993) The porcine intestinal spirochaetes: Identification of new genetic groups. *Veterinary Microbiology*, **34**, 273-285

4 Pluske, J. R., Siba,P. M., Pethick, D. W., Durmic, Z., Mullan, B. P. and Hampson, D. J. (1996) The incidence of swine dysentery in pigs can be reduced by feeding diets that limit fermentation in the large intestine. *Journal of Nutrition*, **126**, 2920-2933

5 Siba, P. M., Pethick, D. W. and Hampson, D. J. (1996) Pigs experimentally infected with *Serpulina hyodysenteriae* can be protected from developing swine dysentery by feeding them a highly digestible diet. *Epidemiology and Infection*, **116**, 207-216

INTERACTION OF DIETARY NON-STARCH POLYSACCHARIDES WITH WEANER PIG GROWTH AND POSTWEANING COLIBACILLOSIS

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Introduction

Postweaning colibacillosis remains an important production-limiting condition in many piggeries. Its occurrence can be influenced by many factors, including the composition of the weaner diet (1). There is some evidence that feeding diets high in non-starch polysaccharides (NSP) may alleviate postweaning colibacillosis (2,3). In this study we examined the effect of dietary NSP in the weaner pig on body growth and the interaction with experimentally reproduced post-weaning colibacillosis.

Materials and Methods

Large white X piglets weaned at 21–25 days of age with an average weight of 7.2kg were selected, and then randomly assigned to remain "uninfected" (n=30) or be "experimentally infected" (n=39). Each pig was fed one of the following three diets *ad libitum* for 7 days after weaning: pregelatinised rice fortified with an animal protein supplement (R), the same rice diet with 10% guar gum added (GG), or a typical wheat and barley-based weaner diet which served as a reference diet (W). The R diet was low in total NSP (0.7g/100g dry matter), GG was high in soluble NSP (6.4g/100g dry matter) but not insoluble NSP (0.2g/100g dry matter), and W had soluble (1.2g/100g dry matter) and insoluble NSP (7.6g/100g dry matter).

The "experimentally-infected" group was orally inoculated with a strain of enterotoxigenic *E. coli* (O8;K88;K87) at 48, 72 and 96 hours post-weaning. Infected pigs all exhibited diarrhoea, lethargy and weight loss after inoculation. All pigs were weighed 7 days after weaning,, euthanased and samples taken from the intestinal contents at this time.

Results

Table 1. Growth rate, large intestinal weight and pH in uninfected weaner pigs, and small intestinal haemolytic *E. coli* populations in infected pigs

	R	GG	W	s.e.d.	*P*
Uninfected pigs					
Growth g/day	141[a]	85[b]	57[b]	53	*
Large intestine (g)	95[a]	125[b]	128[b]	17	*
pH upper colon	6.3[a]	5.3[b]	5.9[c]		****
Infected pigs					
Growth g/day	54[a]	-52[b]	-114[c]	69	****
log cfu *E. coli*/g	2.22[a]	4.92[b]	2.93[ab]	2.3	*

R, rice/animal protein; GG, rice+guar gum; W, wheat/barley diet.
Significance: * $P<0.05$, ** $P<0.01$, *** $P<0.001$, **** $P<0.0001$
[abc] Within rows, means not followed by a common superscript differ significantly. cfu, colony-forming units.

All piglets offered the rice/animal protein diet R, the diet low in NSP, grew significantly faster than those fed either the GG diet or the W diet ($P<0.05$). Within the infected group the only group of pigs which gained weight were those fed the R diet. Pigs offered R had lighter large intestines ($P<0.05$) than pigs fed the other diets, and less fermentation was occurring in the large intestine, shown by a more acidic pH ($P<0.0001$).

Measurements of volatile fatty acid production in the colon also reflected the reduced fermentation . The pool of volatile fatty acids was significantly lower in the pigs fed the R diet (7.53 mmol/pig; $P<0.05$) than those fed the GG (16.22 mmol/pig) or W diet (17.59 mmol/pig).

The addition of guar gum to the rice diet was associated with a significant increase in *E. coli* numbers in the small intestine ($P<0.05$). Small intestinal *E. coli* numbers in pigs fed the W diet were not signficantly higher than those from pigs offered the R diet, although additional swabs taken from the intestines showed that the distribution of colonisation covered a greater length of the small intestine in those pigs fed the W diet.

Discussion

The R diet was very low in soluble and insoluble NSP and was highly digestible, leaving little residue of digesta throughout the gut. This is consistent with the low levels of fermentation occurring in the intestines of pigs fed this diet. The adaption of pigs fed the GG and W diets to the inclusion of NSP in their diet was demonstrated by the heavier large intestinal weights, indicating structural development, and by enhanced large intestinal fermentation.

It is possible that physicochemical characteristics within the small intestine of the pigs fed GG, such as increased viscosity of digesta and altered intestinal motility, provided an environment which encouraged proliferation of *E. coli*.

Conclusion

The results from this study indicate that highly digestible diets with low levels of soluble NSP, as in the rice+animal protein diet, can reduce the proliferation of enterotoxigenic *E. coli* in the small intestine of weaner pigs. The rice+animal protein diet also encouraged the greatest increase in growth in the first week postweaning, indicating that gelaninised rice may be a useful cereal component for incorporation in weaner diets.

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References

(1) Hampson D. J. (1995) Postweaning *Escherichia coli* diarrhoea in pigs. In: Escherichia coli *in Domestic Animals and Humans*. Ed CL Gyles. CAB International, Wallingford, England.

(2) Bertschinger, H. U., Eggenberger, E., Jucker, H., Pfirter, H. P. (1978). Evaluation of low nutrient, high fibre diets for the prevention of porcine *Escherichia coli* enterotoxaemia. *Veterinary Microbiology*. **3**:281-290.

(3) Bolduan, G., Jung, H., Schnabel, E. and Schneider, R. (1988). Recent advances in the nutrition of weaner piglets. *Pig News and Information*. **9**:381-385.