EXPERIMENT 6

PROJECT 2B-102-0506

THE RESPONSES OF LIGHT AND HEAVY PIGS AT WEANING TO DIETARY SPRAY-DRIED PORCINE PLASMA

Report prepared for the
Pork Co-operative Research Centre

By

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ABSTRACT

The main objective of this study was to determine whether weaner diets containing SDPP could assist light-for-age pigs to perform better during the post-weaning period, as these are the most disadvantaged group at weaning. A total of 96 pigs weaned at 21 days were used in a 2 x 2 factorially designed experiment with the respective factors being (1) light- (4.9 ± 0.67 kg LW) or heavy- (6.9 ± 0.73 kg LW) for-age pigs and (2) a diet containing SDPP (5% and 2.5%, for phase I and II, respectively) or a control diet not containing SDPP. Concentration of IgG, IgM and IgA in the SDPP included in the diets was 10.8, 3.3 and 0.7%, respectively. Each treatment had 8 replicates (pens) with 3 pigs per pen. Stage I diets were fed for the first week and Stage II for the following 2 weeks until the experiment ceased at 21 days after weaning. Pigs were weighed weekly and feed refusals daily to calculate performance indices. One pig per pen, randomly selected, was bled on days 7 and 14 to measure circulating levels of immunoglobulins, routine haematology indices and plasma urea nitrogen (PUN). Data were subjected to a two-way analysis of variance with the pen as the experimental unit. The inclusion of SDPP in the diet improved performance of both light- and heavy-for-age pigs during the first week post-weaning. Such effects disappeared in the following 2 weeks and over the 3-week study pigs supplemented with SDPP tended to gain (20 g per day) more than the control pigs. Haematology indices as well as immunoglobulin levels in plasma were similar between treatments except for IgG, which was higher in the heavy control pigs than in the rest on day 14 of the experiment. Pigs fed the SDPP diet had lower PUN levels than the pigs on the control diet possibly indicating an increased efficiency of dietary protein utilisation as a result of SDPP supplementation. The inclusion of SDPP in weaner pig diets at 5% during the first week after weaning offers a means of improving performance of weaner pigs.

1. INTRODUCTION

Spray-dried porcine plasma (SDPP) is a feed ingredient used routinely in diets for weaner pigs in other parts of the world, eg, North and South American pig-producing countries. A considerable body of research (eg, 2001; Coffey and Cromwell, 1995; de Rodas et al., 1995; review by van Dijk et al.) exists to demonstrate that adding SDPP to post-weaning diets stimulates feed intake. Low feed intake is well recognised as a major problem for the post-weaning period (Pluske et al., 2006). However SDPP has not been available for use in Australia until recently when a commercial supplier became available.

The precise mechanism(s) whereby SDPP stimulates feed intake after weaning are not fully established, however some data exists showing the inherently high immunoglobulin (Ig) content (particularly IgG) of the SDPP may somehow be responsible (de Rodas et al., 1995), for example, by preventing pathogens from damaging the gut wall and thereby maintaining structural and functional integrity of the small intestine after weaning (Coffey and Cromwell, 1995), and (or) reducing gastrointestinal tract inflammation. There is also some evidence that pigs fed SDPP are less susceptible to post-weaning diarrhoea (PWD) (Nollet et al., 1999). PWD is a condition of weaned pigs characterized by frequent discharge of watery faeces during the first 2 weeks after weaning. PWD is typically associated with faecal shedding of β-haemolytic enterotoxigenic *E. coli* (ETEC) that proliferate in the small intestine of both healthy and unhealthy piglets following weaning. The association between the intensity of faecal shedding of ETEC and (clinically observable) diarrhoea is such that more loose faeces are associated with an increased shedding (higher counts) of ETEC (Hopwood and Hampson, 2003). The ETEC adhere (using fimbria or pili) to receptors on the small-intestinal enterocytes, where they produce one or more enterotoxins such as heat-labile toxins (LT) or heat stable toxins (ST; variants STa and STb). The LT toxins increase secretion of sodium, chloride and hydrogen carbonate ions into the lumen, whilst the ST toxins reduce the absorption of liquid and salts. In both cases, the result is hypersecretion of water and electrolytes to the small intestine that exceeds the ability of the colon to reabsorb them, thus causing diarrhoea and a range of other effects including (but not all encompassing) dehydration, reduced feed intake, reduced nutrient digestibility, reduced growth and even death (Hopwood and Hampson, 2003). Glycan moieties of glycoproteins contained in SDPP possibly compete with the natural receptors in the small-intestinal enterocytes reducing the adhesion of *E. coli* to the gut (Sanchez et al., 1993) and protecting the pig against PWD.

Another feature of the post-weaning period seen in most, if not all, commercial piggeries is the variation between pigs in performance that is observed. Numerous studies conducted in Australia (Dunshea *et al*. 2000, 2002a, 2002b; 2003; Pluske *et al*., 2003; Morrison *et al*., 2008, *unpublished data*) have consistently demonstrated that light-for-age piglets perform more poorly than heavier piglets of the same age. These piglets are generally born lighter that in turn may affect post-weaning performance, but nevertheless, Pluske *et al*. (2003) demonstrated that light-for-age piglets have a less well-developed gastrointestinal tract (as evidenced by pancreatic and brush-border enzyme activities and small intestinal morphological indices) than heavier pigs of the same age. Given that SDPP stimulates feed intake and might be protective to the gastrointestinal tract of the pig, then we hypothesised that SDPP might be more effective and reduces the growth check after weaning in light-for-age pigs than in their heavier counterparts. The main objective of this study, therefore, was to determine whether weaner diets containing SDPP can assist light-for-age piglets to perform better during the post-weaning period.

2. MATERIALS AND METHODS

This study was approved by the WA Department of Agriculture and Food Animal Ethics Committee (AEC No. 1-09-05) to ensure compliance with the guidelines of the Australian Code of Practice for the Care and Use of Animals for Scientific Purposes.

2.1 Experimental design

The experiment used 96 newly weaned Large White x Landrace male piglets (initial age of approximately 21 days) and was designed as a 2 x 2 factorial with the respective factors being (1) "light" with an average of 4.9 ± 0.67 kg BW (mean ± SD) or "heavy" with an average of 6.9 ± 0.73 kg BW (mean ± SD) piglets; and (2) a diet containing SDPP (5% and 2.5%, for stage I and II, respectively) or a Control diet not containing SDPP. Each treatment combination had 8 replicates with 3 pigs per replicate (per pen). The experiment ran for 21 days after weaning.

2.2 Animals, housing, diets and feeding

The 96 male pigs were obtained from a commercial supplier and transported to the Medina Research Station according to the code of practice for the transportation of pigs in Western Australia (ISBN 7307 6326 9). Upon arrival, pigs were ear-tagged and allocated at random to one of the 2 live weight groups (ie, light or heavy) and each group was allocated to one of the 2 dietary treatments (ie, control or SDPP) after stratification on their live weight. Pigs were housed in 2 environmentally controlled rooms maintained at 29ºC for the first week of the experiment and dropped by 1°C weekly thereafter. Each room had 1 large wire-mesh floored enclosure, divided into 4 pens (replicates), which comprised 4 smaller pens. This configuration permitted 8 replicates (blocks) and 32 pens in total. Pigs were housed in the smaller pens, in groups of 3 so there were 12 pigs per treatment in total. The pigs were fed *ad libitum* in a trough feeder and water was freely accessible through 1 nipple drinker set in each pen.

Two wheat-, barley- and soybean meal-based basal diets were formulated to meet the nutrient and energy requirements of pigs of this age and weight and be isonitrogenous and isoenergetic (Table 1). Diets containing SDPP had 5% inclusion in Stage I and 2.5% in Stage II. Pigs were offered Stage I diet for the first 7 days after weaning followed by Stage II diet until the experiment ceased at 3 weeks after weaning.

2.3 Sampling, measurements and analyses

Pigs were weighed upon entry and then on days 7, 14 and 21. Individual pigs were visually checked every day and a faecal consistency score given (1: firm, well formed; 2: soft; 3: loose; 4: watery; 5: watery with blood). Pigs that required therapeutic treatment for diarrhoea were given an intramuscular injection of Trisoprim-480 [(trimethropin 80 mg/mL, sulfadiazine, 400 mg/mL), 1.5 ml/30 kg body weight; Troy Laboratories, Smithfield, NSW, Australia]. Diarrhoea incidence was calculated as the number of days a pig had diarrhoea during the experiment. Feed refusals and/or waste were weighed daily and daily weight gain, feed intake and feed conversion ratio calculated on a weekly basis.

All pigs were swabbed upon arrival to determine the shedding of β-haemolytic *E. coli* by inserting a soft cotton bud into the anus, and then on days 3, 5, 8, 10 and 14. Swabs were cultured on sheep blood agar plates and plates were assessed for β-haemolytic colonies displaying morphology characteristic of *E. coli*, after overnight incubation. The presence of haemolytic *E. coli* was scored (0 = no growth, 1 = haemolytic *E. coli* in 1st section, 2 = haemolytic *E. coli* in 2nd section, 3 = haemolytic *E. coli* in 3rd section, 4 = haemolytic *E. coli* in 4th section, 5 = haemolytic *E. coli* in 5th section).

On days 7 and 14 of the experiment a blood sample (8 mL) was collected via jugular vein puncture into vacutainer tubes coated with EDTA from 8 'focus' pigs per treatment (1 pig per pen selected randomly at the start of the study). An aliquot of blood was taken and analysed for some haematology parameters including white blood cells count (WBC), red blood cells count (RBC), haemoglobin (HGB), haematocrit (HCT), platelets, neutrophils (N) and lymphocytes (L). The remaining blood was immediately centrifuged at 2,000 × g for 10 minutes at 5ºC to recover plasma. Approximately 1 ml of plasma was reserved fresh and analysed for circulating immunoglobulin (Ig) G, M and A and plasma urea nitrogen (PUN) levels. The rest of the plasma was immediately stored at -20ºC.

Table 1. Composition of the experimental diets (on as-fed basis).

Diet	Stage I		Stage II	
	Control	5% SDPP	Control	2.5% SDPP
Ingredients, %				
Wheat	63.03	62.89	60.93	63.16
Barley	10.00	10.71	12.00	12.00
Soybean meal, 48%	2.93	0.5	3.76	2.00
Full fat soya	5.00	5.00	6.72	3.00
Skim milk powder	4.00	4.00	6.00	6.00
Canola oil	1.39	1.39	0.27	0.92
SDPP	0.00	5.00	0.00	2.50
Meat meal	2.46	2.48	0.69	1.00
Fishmeal	9.21	5.57	8.00	7.85
Pea protein isolate	1.00	1.00	0.00	
Limestone	0.35	0.45	0.62	0.58
Dicalcium phosphate	0.09	0.50	0.52	0.50
Salt	0.10	0.10	0.10	0.10
L-Lysine	0.25	0.21	0.21	0.21
DL-Methionine	0.01	0.06	0.00	0.02
L-Threonine	0.09	0.05	0.08	0.07
Mineral/Vitamin supplement[1]	0.10	0.10	0.10	0.10
Calculated composition:				
DE (MJ/kg)	14.7	14.7	14.5	14.5
Crude protein (%)	21.6	21.6	20.8	20.6
Available lysine (%)	1.22	1.22	1.16	1.16
Analyzed composition:				
Gross energy (MJ/kg)	17.2	17.3	17.1	17.1
Crude protein (%)	18.4	18.4	19.0	19.1
Crude fat (%)	4.4	3.9	3.4	3.3

[1]Supplied per kg of diet: 60.0 mg Fe ($FeSO_4$); 10.0 mg Cu ($CuSO_4$); 40.0 mg Mn (MnO); 100.0 mg Zn (ZnO); 0.30 mg Se (Na_2SeO_3); 0.50 mg I (KI); 0.20 Co ($CoSO_4$); vitamin A, 7,000 IU; vitamin D_3, 1,400 IU; vitamin E, 20.0 mg; vitamin K_3, 1.0 mg; thiamin, 1.0 mg; riboflavin, 3.0 mg; pyridoxine, 1.5 mg; vitamin B_{12}, 0.015 mg; pantothenic acid, 10.0 mg; Folic acid, 0.2 mg; niacin, 12.0 mg and biotin 0.03 mg.
[2]Lindox, Lienert Australia P/L, Roseworthy, South Australia.

Haematology indices were analysed by an Advia 120 haematology analyser. Circulating levels of active IgG, IgM and IgA were measured by an ELISA kit (Pig IgG, IgM and IgA quantitation kit, catalog Nos. E100-104, E100-100 and E100-102, for IgG, IgM and IgA, respectively, Bethyl Laboratories, Inc.) Plasma urea nitrogen was determined by an enzymatic kinetic method (Randox, Crumlin, Co. Antrim, UK) performed on an automated analyzer (RX Daytona, Randox, Northern Ireland) using alkaline picrate without deproteinisation.

After the experiment finished, pigs were kept in the same environment controlled room for another week and then moved to a grower housed where four replicates were pooled. Pigs were weighed on day 7 and 23 after the experiment finished.

2.4 Statistical analyses

All statistical analyses were performed using the GLM procedures of SPSS (SAS Inst. Inc., Cary, NC), with allotment block (random factor), dietary treatment and weight group as

sources of variation. For all variables the pen was the experimental unit. Significance was accepted at $P < 0.05$. The model used to analyse the data was:

$$Y_{ijk} = \mu + \alpha_i + \beta_j + \gamma_k + (\beta\gamma)_{jk} + \varepsilon_{ijk}$$

where Y_{ijk} is the observed response; μ is the overall mean; α_i is the effect of block; β_j is the effect of diet; γ_k is the effect of live weight (light versus heavy); $(\beta\gamma)$ is the interaction between diet and live weight and ε_{ijk} is the residual error. If an interaction was not significant ($P > 0.05$), it was removed from the model. If an interaction was significant ($P < 0.05$), the data was analysed by diet or by live weight. Data on measurements of *E. coli* shedding and faecal consistency score were analysed as repeated measurements again using the GLM procedure in SPSS. All presented results are expressed as least square means and standard error of the means.

3. RESULTS

3.1 Pig performance

Overall and in the 3-week study period, pigs supplemented with SDPP tended to gain more weight (20 g per day; P = 0.090) than the control pigs, with no significant difference between treatments on ADFI or FCR (Table 2). This overall effect was mainly due to the positive effect of dietary inclusion of SDPP at 5% during the first week of the study where ADG ($P < 0.001$), ADFI ($P < 0.001$) and FCR (P = 0.002) were improved by 72 g/d, 41 g/d and 0.87 kg/kg, respectively. In the following two weeks, when the dietary inclusion of SDPP was lowered to 2.5%, there was no significant improvement in performance. Heavy-for-age pigs gained more weight and ate more feed than the light-for-age pigs in each week during the trial as well as overall ($P < 0.05$). Pigs on the SDPP diets tended to have looser faeces (P = 0.086) and more days with diarrhoea (P = 0.108) and compared with the pigs fed the control diets (Table 6.2). However it is important to note that the pigs in this study were not challenged with *E. coli* and therefore the β-haemolytic *E. coli* shedding observed was naturally occurring; it was also very low (Table 2).

3.2 Circulating plasma immunoglobulin levels, plasma urea nitrogen, and haematology

Plasma levels of IgG tended to be higher in the Heavy control pigs on day 7 (Diet x LW interaction; P = 0.051) whereas on day 14 this effect was significant (P = 0.026) (Table 3). Plasma levels of IgM and IgA were not affected by treatment in this study. Plasma urea nitrogen was reduced in pigs fed SDPP compared to pigs fed the control diet on day 7 ($P < 0.001$) and day 14 (P = 0.031) after weaning. Haematology parameters were within normal levels for pigs of this age and WBC, RBC and platelets on day 7 and WBC, HGB, platelets, N and L on day 14, did not differ between treatments. On day 7, pigs fed the SDPP diet had higher levels of neutrophils (N; P = 0.015) and lower levels of lymphocytes (L; P = 0.007) and therefore a higher N/L ratio (P = 0.008) than the control pigs. Heavier pigs had a lower concentration of haemoglobin (HGB; P = 0.030) and a lower haematocrit (HCT; P = 0.024) than the light pigs. On day 14, pigs on the SDPP supplemented diet had fewer red blood cells (RBC; P = 0.045) and a lower HCT (P = 0.048) compared to the control pigs (Table 3).

Table 2. Least-squares means for performance traits of light- and heavy-for-age piglets fed diets supplemented or not with SDPP (n[1]=8).

Weight group	Light		Heavy			P-value[2]	
Diet	Control	SDPP	Control	SDPP	SEM	DIET	LW
Live weight							
Initial	4.99	4.97	6.91	6.90	0.042	0.828	<0.001
Final	9.29	9.70	12.24	12.65	0.240	0.146	<0.001
Overall							
ADFI, g/d	324	351	394	421	14.4	0.121	<0.001
ADG, g/d	205	225	253	274	9.9	0.090	<0.001
FCR, kg/kg	1.59	1.56	1.57	1.54	0.028	0.315	0.652
Week 1							
ADFI, g/d	129	183	161	215	11.4	<0.001	0.023
ADG, g/d	63	134	92	164	1.04	<0.001	0.023
FCR, kg/kg	2.38	1.51	2.06	1.19	0.209	0.002	0.214
Week 2							
ADFI, g/d	315	343	397	425	14.7	0.111	<0.001
ADG, g/d	228	231	285	289	12.3	0.818	0.001
FCR, kg/kg	1.39	1.48	1.40	1.50	0.043	0.081	0.758
Week 3							
ADFI, g/d	529	527	625	623	24.4	0.953	0.002
ADG, g/d	324	311	383	370	18.64	0.546	0.012
FCR, kg/kg	1.64	1.70	1.66	1.72	0.054	0.330	0.804
E. coli score	0.43	0.32	0.31	0.20	0.071	0.195	0.144
Faecal consistency	1.019	1.057	1.023	1.061	0.019	0.086	0.855
Days with diarrhoea	0.083	0.208	0.042	0.167	0.067	0.108	0.590

[1] n = number of replicates: Eight pens of three pigs each.

[2] Interactions between diet and live weight were not significant and therefore removed from the model.

Table 3. Least-squares means for plasma concentrations of IgG, IgM and IgA, PUN and haematology indices of light- and heavy-for age pigs fed diets supplemented or not with SDPP ($n^1 = 8$).

Weight group	Light		Heavy			P-value		
Diet	Control	SDPP	Control	SDPP	SEM	Diet	LW	D × LW
Day 7								
Ig G (mg/ml)	5.68	6.32	8.49	6.18	0.713	0.254	0.076	0.051
Ig M (mg/ml)	1.08	1.01	1.11	1.04	0.161	0.712	0.876	0.146
Ig A (mg/ml)	0.21	0.20	0.22	0.21	0.024	0.769	0.781	0.091
PUN (mmol/l)	5.25	3.83	5.27	3.85	0.219	<0.001	0.941	0.134
HGB (g/l)	124.3	113.6	111.8	111.5	3.01	0.097	0.030	0.099
HCT (l/l)	0.363	0.335	0.327	0.328	0.0087	0.159	0.024	0.113
Platelets ($x10^9$/l)	642.0	568.4	637.9	564.3	49.25	0.209	0.623	0.359
RBC ($x10^{12}$/l)	6.57 [b]	5.78 [a]	5.84 [a]	5.91 [a]	0.178	0.059	0.106	0.026
WBC ($x10^9$/l)	12.95	14.69	14.84	16.58	0.984	0.140	0.111	0.090
Neutrophils (%)	41.65	49.17	47.13	50.48	2.046	0.015	0.111	0.318
Lymphocytes (%)	51.30	42.78	46.09	42.40	2.037	0.007	0.188	0.248
N/L ratio	0.87	1.12	1.01	1.26	0.075	0.008	0.116	0.410
Day 14								
Ig G (mg/ml)	6.07 [a]	6.22 [a]	10.41 [b]	6.44 [a]	0.836	0.033	0.013	0.023
Ig M (mg/ml)	1.75	1.66	1.90	1.81	0.304	0.818	0.675	0.775
Ig A (mg/ml)	0.78	0.66	0.73	0.61	0.119	0.394	0.708	0.223
PUN (mmol/l)	5.64	4.70	5.35	4.41	0.345	0.031	0.493	0.377
HGB (g/l)	97.2	90.0	101.8	96.4	3.181	0.063	0.111	0.778
HCT (l/l)	0.301	0.276	0.315	0.299	0.009	0.048	0.108	0.665
Platelets ($x10^9$/l)	675.3	581.2	630.8	536.6	45.14	0.089	0.417	0.770
RBC ($x10^{12}$/l)	5.29	4.77	5.61	5.25	0.202	0.045	0.072	0.692
WBC ($x10^9$/l)	20.82	19.71	20.83	19.72	1.425	0.517	0.992	0.276
Neutrophils (%)	45.56	47.68	46.01	41.97	2.554	0.715	0.373	0.237
Lymphocytes (%)	45.50	43.86	46.48	49.00	2.544	0.863	0.278	0.419
N/L ratio	1.12	1.12	0.99	0.98	0.111	0.977	0.323	0.288

[1] n = number of replicates: One pig sample per pen.

[a,b,c] Values not having the same superscript are significantly different ($P < 0.05$).

4. DISCUSSION

Many studies have demonstrated that SDPP enhances growth and feed intake in young pigs (Coffey and Cromwell, 1995; Van Dijk et al., 2001). Although the magnitude of this improvement varies with weaning age, the composition of the control diet and performance of the control pigs, baseline growth, feed processing (Van Dijk et al., 2001) and health and hygiene status (Coffey and Cromwell, 1995), it seems that the beneficial effect of SDPP on performance is much more pronounced in the first week than in the following weeks post-weaning (Van Dijk et al., 2001). Results from the present study conform to previous observations and show that SDPP supplementation improved ADG, ADFI and FCR in both light- and heavy-for-age pigs during the first week after weaning. On average, pigs on the SDPP supplemented diet grew 9% faster, ate 37% more feed and were 64% more efficient in converting feed into gain than the control pigs. The positive effects associated with the inclusion of SDPP in the diet disappeared in the following two weeks and over the 3-week study SDPP-supplemented pigs tended (20 g per day) to gain more than the control pigs

Immunoglobulin G levels in plasma in the current study were a little lower than those reported in the literature for pigs of this age (9 mg/mL) (Martin et al., 2005). One of the proposed mechanisms by which SDPP enhances pig performance is by an improvement in the immunocompetence of the pig by its high content of immunoglobulins, especially IgG (Pierce et al., 2005). In an experiment reported by Pierce et al., (2005), pigs were fed diets with various levels of the IgG fraction of SDPP: 40, 80 and 120% of the level provided by the SDPP (9, 18 and 27% IgG for 40, 80 and 120%, respectively), and compared them to pigs on an 8% SDPP diet and control pigs on a diet devoid of SDPP. Average daily gain was maximised in pigs on the SDPP and the 80% IgG diets, compared with the controls, with no further improvement at the 120% IgG level. Considering that SDPP was included in the diet at 8% and the concentration of IgG in the product was 22.5%, then the SDPP diet provided 1.8 g IgG/100 g of diet and the 80% IgG diet provided 1.44 g IgG/100 g of diet. In our study the SDPP dietary inclusion was 5% and the concentration of IgG was considerably lower (10.8%) than the levels in the study of Pierce et al., (2005) (22.5%), thus the SDPP diet in this experiment provided only 0.54 g IgG/100 g of diet. If we take into account that ADG is maximized when the concentration of IgG is approximately 1.44 g/100 g of diet (Pierce et al., 2005), then the inclusion level of the SDPP used in the present study would need to be around 13%, which would most likely not be feasible under commercial conditions. However, it would be worth considering a follow-up experiment where higher levels of SDPP are included, and also looking at the manufacturing process of the product to help improve the levels of immunoglobulins.

Although it is unlikely that the IgG fraction is absorbed intact from the small intestine in weanling pigs, there is evidence that IgG prevents the proliferation of bacteria (Nollet et al., 1999; Owusu-Asiedu et al., 2003) and ameliorates inflammation after weaning. Glycan moieties of glycoproteins contained in SDPP possibly compete with the natural receptors in the small-intestinal enterocytes reducing the adhesion of *E. coli* to the gut (Sanchez et al., 1993) and protecting the pig against post-weaning diarrhoea. Bosi et al. (2004) observed a reduction in IgA production in pigs challenged with *E. coli* and fed a SDPP diet and explained this as a consequence of an inhibition of *E. coli* colonisation or binding to intestinal receptors by glycoproteins contained in the SDPP.

In our study there were no differences in *E. coli* between the different treatments, as the current study was not designed to detect differences in PWD. The primary parameters were the production indices of the pigs. In the current study it is important to note that the pigs were not challenged with *E. coli* and therefore the β-haemolytic *E. coli* shedding observed was naturally occurring, and also very low. The tendencies for more diarrhoea and looser faeces in pigs fed the diets containing SDPP can probably be neglected, as they are without any practical implication. Therefore an immune response would not be expected to be as clear as for example in the study of Bosi et al. (2004). Plasma IgG levels decreased in the heavy-for-age pigs fed the SDPP supplemented diet, compared to the controls, but not in the light pigs, and even though it has been shown that the presence of receptors specific for *E. coli* on enterocytes is a prerequisite for the induction of an immune response in pigs (Van den Broeck et al., 1999), it seems to be unlikely that only the heavy-for-age pigs had receptors for *E. coli*. If the present study had included an *E. coli* challenge it would have had provided information about the degree of protection against colibacillosis offered by this specific SDPP product.

The ratio of N/L is between 0.4:1 and 0.7:1 in an adult pig, however young pigs normally have a greater percentage of neutrophils than lymphocytes (McGlone and Pond, 2002), which is in accordance with the findings in the current study. A higher N:L ratio is generally indicative of stimulation of the immune response, albeit a systemic indicator.

Another mechanism by which SDPP improves performance in weaner pigs is by improving the morphology of the small intestine (Owusu-Asiedu et al., 2003; Yi et al., 2005). A more functional intestinal wall and a greater degree of small intestinal absorption of nutrients in SDPP-supplemented pigs could have contributed to the better performance of the SDPP fed pigs during this study. Indirectly, the observed lower PUN levels in the SDPP-fed pigs in the present study support this. Improved utilisation of nutrients for tissue protein synthesis, consequently decreasing amino acid catabolism, will result in lower PUN levels. These findings correspond well with previous studies conducted in North America (Jiang et al., 2000; Owusu-Asiedu et al., 2003).

5. CONCLUSIONS AND RECOMMENDATIONS

This study showed that including SDPP at 5% in weaner diets improved pig performance during the first week after weaning in both light- and heavy-for-age pigs. Whether feeding SDPP at the levels used in this experiment protects the pig against colibacillosis could not be determined from the results and further research where pigs are *E. coli*-challenged are recommended. Further studies should also investigate whole-of-life performance as well as estimating the relative bioavailability of immunoglobulins. Moreover, further studies are required under more commercial conditions to ascertain whether SDPP might have other benefits, e.g., reduction in mortality, pen withdrawals, reduced within-pen variation in weight at transfer.

6. LIMITATIONS AND RISKS

The major impediment to using SDPP in diets at present is likely to be the price. It is envisaged that the commercial cost of the product is between $5,000 and $6,000 per tonne, meaning that at a 5% inclusion level, this would add $250-300 to the cost of a tonne of feed.

7. REFERENCES

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