Post-weaning Failure to Thrive in Pigs is Associated with Increased Organ Weights and Possible Anemia, but not Changes in Intestinal Function

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Summary and Implications

A total of 96 weanling barrows were utilized in a 27 d experiment to determine the effects of post-weaning failure to thrive (PFTS) on organ weight, blood chemistry, and small intestine physiology and function. Thirty-two pigs from each of the lightest, median, and heaviest weight categories at weaning were placed in individual metabolism cages and allowed *ad libitum* access to water and a common nursery diet. After a 5 d acclimation period, growth rate was evaluated for 27 d. Pigs with ADG that were below two standard deviations from the mean were termed pigs with PFTS (n = 4). All other pigs were considered normal contemporaries. After the 27 d experiment, pigs were fasted overnight and humanely euthanized. Organs were emptied of digesta and weighed, blood was collected for analysis in a complete blood panel and white blood cell differential, and ileal samples taken for morphology and absorptive capacity analyses. Pigs with PFTS had increased ($P < 0.02$) stomach, intestine, kidney, and liver weights relative to body size. Additionally, PFTS pigs had decreased ($P < 0.05$) hemoglobin hematocrit, albumin, sodium, and anion gap concentrations, suggesting either anemia or increased dehydration compared to normal pigs. Finally, PFTS was associated with increased ileal villous crypt depth ($P < 0.0001$), but not with villous height or differences in absorptive capacity of various glucose or amino acids. These data suggest that pigs with PFTS may have a higher maintenance cost due to increased organ weight and a possible anemia or imbalance of blood chemistry. However, differences in post-weaning performance do not appear to affect small intestine function.

Introduction

Post-weaning Failure to Thrive is an economically significant issue that has plagued the swine industry in recent years. By identifying physiological differences between pigs with PFTS and normal pigs, we can improve our ability to predict variation in transition more effectively or earlier in the production process. This, in turn, can allow for the use of different interventional strategies or pig flow schemes to maximize barn efficiency and profitability.

It has been hypothesized that pigs with PFTS fall back from normal performance because they have an increased maintenance cost or are less efficient and absorbing dietary nutrients. However, no experiments have been conducted to evaluate these effects. Therefore, the objective of this experiment was to determine the effects PFTS on organ weight, blood chemistry, and small intestine physiology and function.

Materials and Methods

This study was conducted at the Iowa State University Swine Nutrition Farm under the approval of the university Institutional Animal Care and Use Committee (#9-09-6807-S). Through four replicates, a total of 960 weanling pigs (PIC C22/C29 × 337; ages 18-21 d) were individually tagged and weighed for this experiment. From this general population, 96 barrows, representing the 10% lightest, median, and heaviest pigs at weaning were selected for the experiment (n = 32 per WW category; BW = 4.6, 6.2, and 8.1 kg, respectively). Barrows were housed in individual stainless steel metabolism crates and fed *ad libitum* quantities of a commercial nursery phase feeding program during a 5-d acclimation period and a 27-d growth period. One pig was removed from the experiment, humanely euthanized, and confirmed positive for *Haemophilus parasuis*. No other pigs were removed from the experiment or showed signs of disease.

At the completion of the growth period, pigs with ADG that were below two standard deviations from the mean were termed pigs with PFTS (n = 4). All other pigs (n = 91) were considered normal contemporaries. Pigs were then fasted overnight and humanely euthanized. Organs were emptied of digesta and weighed individually. Blood was collected for analysis in a complete blood panel and white blood cell differential by the Iowa State University Veterinary Diagnostic Laboratory. Ileal samples were taken 1 m proximal to the ileal-cecal junction and evaluated for morphology and absorptive capacity analyses with Ussing Chambers.

Data were analyzed using the GLIMMIX procedure of SAS (SAS Inst. Inc., Cary, NC) with pigs as the experimental unit. The model consisted of the fixed effects of PFTS category (PFTS or normal) and the random effects of replicate and crate. Results were considered significant or trends if their P-values were < 0.05 or < 0.10, respectively.

Table 1. Organ weights, blood chemistry, and ileal absorptive capacity of pigs with post-weaning failure to thrive syndrome (PFTS).

	Normal	PFTS	Pooled SEM	*P* =
Organ weight, g/kg BW[1]				
n =	91	4		
Intestines[2]	57.9	73.3	2.97	0.002
Kidneys	5.9	6.8	0.22	0.02
Liver	23.6	27.8	0.86	0.003
Spleen	2.3	2.2	0.13	0.43
Stomach	7.4	10.5	0.41	< 0.0001
Blood chemistry[3]				
n =	91	4		
Hemoglobin, g/dL	12.2	10.1	0.36	0.001
Hematocrit, %	38.1	31.3	1.09	0.001
Albumin, g/dL	3.3	2.8	0.12	0.005
Sodium, mEq/L	139	137	0.9	0.04
Anion Gap	20	16	1.7	0.04
Ileal absorption, μA/sq. cm[4]				
Glucose	-0.008	0.071	0.0884	0.59
Glutamine	-0.001	-0.001	0.0051	0.96
Lysine	0.003	0.012	0.0094	0.48

[1]Weights were obtained after animals were fasted for 12 hours and remaining digesta was emptied.
[2]Combined weight of the small and large intestine with mesentery.
[3]Values were obtained by large animal complete panel and complete blood count differential after pigs were fasted for 12 h.
[4]Values represent active ion transport when challenged compared to transport when the tissue was at rest (basal).

Results and Discussion

Pigs with PFTS had increased ($P < 0.02$) intestine, kidney, liver, and stomach weights relative to body size (Table1). Literature suggests that these increases in relative organ weight are likely associated with increased maintenance cost of pigs with PFTS. This results in less energy being available for growth, which instigates the animal to fall back from performance. Interestingly, there was no effect ($P = 0.48$) of PFTS on relative spleen weight, which may imply that all pigs had a similar health status.

The combination of decreased hemoglobin and hematocrit levels ($P = 0.001$) in pigs with PFTS may indicate an iron deficiency in the acute (anemia) or chronic (erythropoiesis) manner. However, these measures can be impacted by the hydration status of the animal. Lowered serum albumin, sodium, and anion gap concentrations ($P < 0.05$) in pigs with PFTS suggest that, indeed, these pigs were dehydrated compared to their normal contemporaries. Thus, iron status may be confounded by hydration state. However, these data suggest that further research should evaluate if there is a true anemia or blood chemistry imbalance in pigs with PFTS, which would be detrimental to the physiological status of the pig.

Ussing chamber technology provides a gross measure of nutrients absorbed across the intestinal epithelial. This analysis is conducted using fresh small intestine samples that are oxygenated to maintain the viability of the enterocytes. The resting (basal) current of tissues is calculated and clamped at zero. Tissues are then challenged independently with glucose or amino acids, and the potential difference across tissues is measured by open circuit conditions due to short-circuit current being delivered by a voltage clamp apparatus. Tissue conductance is calculated from the short circuit current and potential difference using Ohm's Law. Thus, the active ion transport, measured in μA per square cm of tissue, is associated with ileal absorptive capacity of that particular nutrient. In this experiment, there was no effect ($P > 0.48$) of PFTS on ileal absorptive capacity of glucose, glutamine, or lysine.

Finally, changes in small intestinal architecture have been shown to affect nutrient absorption. Pigs with PFTS had similar ($P = 0.57$) ileal villous height, which would suggest that no differences exist in nutrient absorption and is in agreement with data from the Ussing chamber analyses. Interestingly, pigs with PFTS had shallower ($P < 0.0001$) crypt depths than their normal contemporaries. This is surprising, because increased crypt depth is typically associated with increased stress. Further research is necessary to replicate and further understand this phenomenon.

In summary, these data indicate that pigs with PFTS may have a higher maintenance cost due to increased organ weight and a possible anemia or imbalance of blood chemistry. However, differences in post-weaning performance do not appear to affect small intestine function.

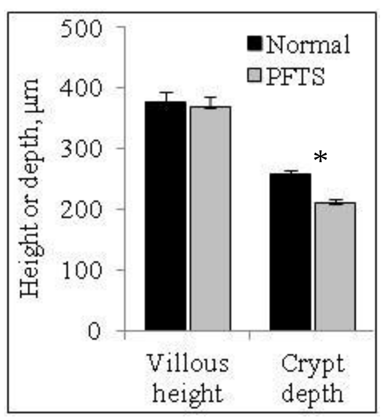

Figure 1. Villous height and crypt depth of the ileum of pigs with PFTS at d 33 post-weaning. Values are mean ± SEM, *n* = 91 and 4 for normal and PFTS, respectively. *Different from one another, $P < 0.0001$.

Acknowledgements

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