Effectiveness of functional amino acids in Salmonella-challenged low and normal birth weight pigs

Lucas A. Rodrigues[1, 2] Daniel A. Columbus[1, 2]

[1]Prairie Swine Centre, Inc., Saskatoon, SK
[2]Department of Animal and Poultry Science, University of Saskatchewan, Saskatoon, SK

We have shown previously that providing pigs with a blend of functional amino acids (FAA; methionine, threonine, and tryptophan) at 120% of NRC (2012) requirements improves growth performance and immune status of pigs during an enteric disease challenge (i.e., Salmonella). In order to develop feeding programs that maximize pig robustness and performance, it is important to understand how the effectiveness of strategies, such as FAA supplementation, are affected by different factors. The increase in sow prolificacy over the past decade has resulted in an increase in the incidence of low birth weight (LBW) pigs. These pigs have reduced growth performance and impaired gut and immune development. We wanted to determine the influence of birth weight on pig response to a subsequent disease challenge and on the effectiveness of FAA supplementation in ameliorating this response.

Pigs were identified as low or normal birth weight category (BWC) with piglets of 0.9 kg to 1.3 kg initial body weight considered LBW and piglets of 1.4 kg to 1.8 kg initial body weight considered normal birth weight (NBW). At weaning (28 d), a total of 32 mixed-sex piglets (16 LBW, 16 NBW) were individual housed and placed on 1 of 2 dietary treatments (n=8 pigs/BWC-dietary treatment combination). Dietary treatments consisted of corn-wheat-barley-soybean meal-based diets with a basal (FAA-) or functional (FAA+) amino acid profile. The FAA- diets met NRC (2012) requirements and FAA+ diets contained methionine, threonine, and tryptophan supplemented at 120% of requirements. Diets were fed in 2-phases, with phase 1 and 2 fed for 10 d and 21 d, respectively. Dietary treatments were fed for 31 d post-weaning at which point all pigs were placed on a common grower diet with no functional amino acid supplementation. One week after switching to the grower diet, all pigs were inoculated with Salmonella Typhimurium, and euthanized 1 week post-inoculation.

Pre-inoculation growth performance was not affected by dietary treatment. Low birth weight pigs had reduced body weight and growth performance compared to NBW pigs throughout the study, regardless of dietary treatment.

We found that LBW pigs are more susceptible to Salmonella inoculation than NBW pigs. This was demonstrated by a greater rise in body temperature, lower glutathione, and decreased intestinal alkaline phosphatase activity in LBW compared to NBW pigs post-inoculation. This suggests that LBW pigs have reduced antioxidant capacity, increased intestinal dysbiosis, and a greater overall inflammatory state than NBW pigs.

Functional amino acid supplementation improved average daily gain in NBW pigs, but not LBW pigs, post-inoculation. Also, while FAA supplementation reduced cecal myeloperoxidase in NBW pigs, the same effect was not observed in LBW pigs. Supplementation with FAA also reduced fecal shedding of Salmonella and translocation of Salmonella to the spleen only in NBW pigs. Overall, our findings show that LBW pigs are more susceptible to the negative effects of disease challenge than NBW pigs. We also found that supplementation of nursery diets with FAA improve growth performance, reduce pathogen shedding and translocation, and improve antioxidant capacity and acute phase response. However, the beneficial effects of FAA were dependent on birth weight, with NBW pigs having a more beneficial response to FAA than LBW pigs.

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Table 1 Pre- and post-inoculation growth performance of low and normal birth weight pigs inoculated with Salmonella[1]

Low birth weight			Normal birth weight				P-value	
Item	**FAA-**	**FAA+**	**FAA-**	**FAA+**	**SEM**	**BWC**	**FAA**	**BWC×FAA**
Phase I (day 0 to 10)								
Phase I (d 25 to 35 of the experiment)								
Initial body weight, kg	6.79	6.98	8.24	8.72	0.347	<0.01	0.64	0.27
Average daily gain, kg	0.246	0.249	0.287	0.313	0.044	0.45	0.22	0.16
Average daily feed intake, kg	0.386ab	0.405ab	0.361b	0.446a	0.025	0.73	0.21	0.05
Gain:Feed, kg/kg	0.64	0.62	0.79	0.70	0.093	0.28	0.86	0.89
Phase II (d 35 to 56 of the experiment)								
Initial body weight, kg	9.25	9.47	11.11	11.85	0.605	<0.01	0.44	0.68
Average daily gain, kg	0.382	0.400	0.360	0.403	0.036	0.80	0.41	0.72
Average daily feed intake, kg	0.699	0.721	0.780	0.773	0.050	0.20	0.88	0.79
Gain:Feed, kg/kg	0.55	0.55	0.46	0.52	0.043	0.17	0.36	0.63
Pre-inoculation (d 56 to 63 of the experiment)								
Initial body weight, kg	17.27	17.87	18.67	20.31	0.460	0.05	0.70	0.15
Average daily gain, kg	0.416	0.529	0.718	0.784	0.157	0.07	0.56	0.88
Average daily feed intake, kg	0.854	0.914	0.926	1.099	0.106	0.21	0.26	0.58
Gain:Feed, kg/kg	0.49	0.58	0.78	0.71	0.153	0.55	0.71	0.35
Post-inoculation (d 63 to 70 of the experiment)								
Initial body weight, kg	20.18	21.57	23.70	25.80	0.967	0.01	0.63	0.16
Average daily gain, kg	0.436b	0.446b	0.477b	0.565a	0.034	0.33	0.08	0.03
Average daily feed intake, kg	0.831	0.913	0.938	1.065	0.146	0.55	0.31	0.34
Gain:Feed, kg/kg	0.52	0.49	0.51	0.53	0.038	0.43	0.76	0.82
Final body weight, kg	23.23	24.69	27.04	29.76	0.841	0.03	0.07	0.48

[1]Values are least squares means; n=8 pigs/treatment. Phase I, d 0-10 post-weaning. Phase I, d 10-31 post-weaning. Pre-inoculation, d 31-38 post-weaning. Post-inoculation, d 38-45 post-weaning.
a–bMeans within a row with different superscripts differ (P ≤ 0.05).