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PRAIRIE SWINE CENTRE

Spring 2020 Volume 26, Number 2

Amino Acids can Enhance pig Robustness

Lucas A. Rodrigues, Msc, DVM.
Department of Animal and Poultry Science,
University of Saskatchewan

Dan Columbus, PhD,
Research Scientist,
Prairie Swine Centre

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Highlights

- Average daily gain and feed efficiency in diseased pigs may be improved by a combination of functional amino acids supplemented above requirements for growth
- Functional amino acids improved the immune response associated with Salmonella infection
- Bacterial shedding and intestinal colonization can be reduced by functional amino acid supplementation
- Dietary protein level had limited effect on pig response

Research conducted at the Prairie Swine Centre and the University of Saskatchewan investigated the interaction between functional amino acid (AA) supplementation and dietary protein during disease challenge in growing pigs. To achieve this, growing pigs were either inoculated with an enteric pathogen (Salmonella typhimurium, ST) or received saline (Control, CT) and had ad libitum access to diets differing in crude protein content (low (16%, LP) vs high (20%, HP) containing either basal supplementation of amino acids at requirements according to NRC (2012) (AA-) or supplemented with a functional amino acid profile in which threonine, methionine, and tryptophan were provided at 20% above requirements (AA+). Diets contained no animal products or antibiotics.

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Program funding provided by

Sask Pork · Manitoba Pork · Alberta Pork · Ontario Pork · Saskatchewan Ministry of Agriculture

Publication # 40010021

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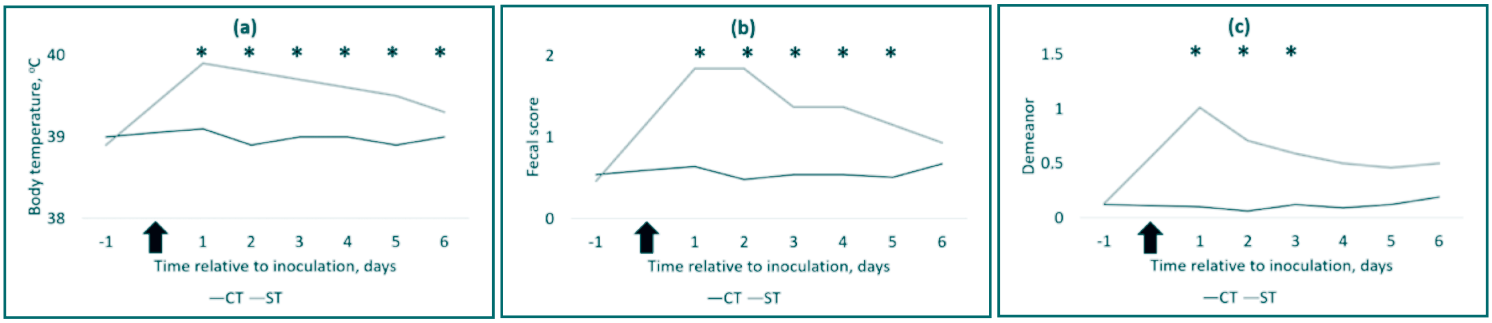

Figure 1. Performance parameters of growing pigs challenged or not with Salmonella typhimurium and fed diets differing in protein content and functional amino acid supplementation.

Clinical signs associated with infection

The post-weaning period is a stressful time for growing pigs, with increased susceptibility to several enteric pathogens, including Salmonella. Pigs infected with Salmonella experience a pronounced inflammatory reaction in the gut, consequently showing compromised performance. The researchers monitored body temperature, fecal score and demeanor daily for each pig over a period of 7 days (day -1, 1, 2, 3, 4, 5 and 6 relative to inoculation). Fecal score and demeanor were then scored from 0 to 3 according to severity (Table 1). Inoculation with Salmonella typhimurium increased body temperature within 24 h which remained elevated for the duration of the study (Figure 1). Demeanor and fecal score were negatively affected by ST inoculation during the first 3 and 5 days after challenge, respectively (Figure 1). There were no diet effects on any clinical signs.

Table 1. Scoring of clinical signs

Clinical sign	Score	Classification
Fecal score	0	Normal consistency
	1	Semisolid, no blood
	2	Watery, no blood
	3	Blood tinged feces
Demeanor	0	Normal behavior
	1	Listless, will stand
	2	Recumbent, will not stand
	3	Moderately depressed

High protein diets: are they harmful?

More susceptible post-weaned pigs also experience an abrupt change from a milk-based to a cereal-based diet. Besides that, highly digestible nutrient sources are not always available, and pigs are commonly fed diets high in protein sources potentially harmful for gut health. As a result, current dietary recommendation in the post-weaning period is to provide lower protein diets that have been supplemented with necessary essential amino acids to meet requirements. This reduces the amount of undigested protein available for fermentation

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Table 2. Performance parameters of growing pigs challenged or not with Salmonella typhimurium and fed diets differing in protein content and functional amino acid supplementation.

	CT[1]				ST[1]				
	LP[2]		HP[2]		LP		HP		SEM[4]
Item	AA-[3]	AA+[3]	AA-	AA+	AA-	AA+	AA-	AA+	
Average daily gain, kg/d									
Pre-inoculation	0.423	0.486	0.450	0.463	0.451	0.456	0.460	0.474	0.051
Post-inoculation	0.571[A]	0.576[A]	0.586[A]	0.580[A]	0.297B[b]	0.458B[a]	0.300B[b]	0.456B[a]	0.06[3]
Average daily feed intake, kg/d									
Pre-inoculation	0.580	0.602	0.563	0.636	0.614	0.646	0.632	0.648	0.054
Post-inoculation	0.880[A]	0.906[A]	0.916[A]	0.936[A]	0.738[B]	0.673[B]	0.744[B]	0.686[B]	0.086
Feed efficiency (gain:feed), kg/kg									
Pre-inoculation	0.73	0.81	0.80	0.73	0.73	0.71	0.73	0.73	0.109
Post-inoculation	0.65	0.64	0.64	0.60	0.40[†]	0.68*	0.40[†]	0.66*	0.104

1 CT = control group; ST = Salmonella-challenged group.
2 LP = low protein diet; HP = high protein diet.
3 AA- = basal dietary amino acid profile; AA+ = supplemented dietary amino acid profile containing 120% of NRC (2012) requirements for Met, Thr, and Trp.
4 SEM = pooled SEM. Means are presented as least squares means.
AB = means lacking the same letter are significantly different (CT vs ST) ($P \le 0.05$)
ab = means lacking the same letter are significantly different (STAA- vs STAA+) ($P \le 0.05$)
*† = means lacking the same sign showed a trend towards significance (STAA- vs STAA+) ($P < 0.10$)

(Pigs consume more water ... continued from page 2)
At the start and middle of the trial, pigs tend to consume more water after the moving activity. On average, pigs consumed about 3,890 and 5,226 mL 24 hours before stress was induced at the start of the trial and middle of the trial respectively, increasing to 4,138 and 5,878 mL after the stress was induced. These results may imply that grower pigs consumed more water when stressed. No apparent trend was observed for water consumption towards the end of the trial.

Water Consumption and Mixing

A comparison of average water consumption of pigs 24 hours before and 24 hours after unfamiliar pigs were introduced into the pen is shown in Figure 3. In contrast to the moving activity, water consumption generally decreased 24 hours after mixing unfamiliar pigs into the pen. Pigs consumed an average of about 5,387 mL/day of water prior to the mixing activity; this decreased to 4,738 mL/day 24 hours after mixing occurred. The decrease in water consumption might be due to aggression that occurred after mixing, which subsequently prevented some of the pigs from drinking. This observation may have also caused the no apparent increase in water consumption from the start to the end of each trial.

Infrared Thermography - Handling

During the start and middle of the trial, no considerable change in body temperatures was observed. Towards the end of the trial when pigs were close to market weight, a slight increase in body temperature was observed after the moving activity. Pig average body temperature was 36.5°C before the moving exercise; this increased to 36.8°C after the mixing activity. This minimal change in body temperature could indicate that the moving activity was not strenuous enough to cause a marked change in body temperature of pigs.

CONCLUSION

1. Using the individual water consumption system, it was observed that grower pigs tend to consume more water when stressed. The system also confirmed that water consumption increased as the pig grew regardless of stress induction.
2. As captured by the infrared thermography system, aggression as a result of mixing unfamiliar pigs to the pen caused an increase in the recorded body temperature of pigs. The system also showed that the pigs' body temperature was affected by changes in room temperatures.
3. In this study, installation of the individual water consumption system and infrared thermography system and inducing stress due to moving and mixing had no considerable negative impact on pig production performance.

ACKNOWLEDGEMENTS
We would like to acknowledge the financial support for this research project provided by Swine Innovation Porc. The authors would also like to acknowledge the collaboration of researchers from CCSI, CDPQ, and Lacombe Research Centre in carrying out this study. Strategic program funding provided by Saskatchewan Pork Development Board, Alberta Pork, Ontario Pork, the Manitoba Pork Council and the Saskatchewan Agriculture Development Fund is also acknowledged. In addition, we also wish to acknowledge the support of the production and research technicians at Prairie Swine Centre that make it possible to conduct this research.

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in the gut, reducing the inflammatory response. Therefore, it was hypothesized that the severity and incidence of diarrhea in Salmonella-challenged pigs would be aggravated by high protein diets. However, there was no effect of dietary protein content on fecal score. On the other hand, Salmonella counts in cecal digesta were increased in HP pigs compared to LP pigs. Thus, lowering dietary protein levels may be useful to suppress proliferation of microbial metabolites and consequently minimize intestinal disturbances in commercial settings with enteric problems.

During an immune response amino acids which are utilized for growth in healthy animals, are redirected towards immune support in diseased animals, decreasing their availability for protein deposition. Thus, supplementing functional AA may be necessary to support both the immune response and growth performance, reducing the negative effects of disease on performance.

As expected, inoculation with ST resulted in reduced average daily gain and average daily feed intake in the post-inoculation period compared to CT pigs regardless of dietary treatment (Table 2). However, ST pigs fed the AA+ diet had increased ADG and a tendency for improved feed efficiency (gain:feed) in the post-inoculation period, regardless of dietary protein level. While this performance was still reduced compared to healthy pigs, this shows that functional AA supplementation may provide an additional strategy for reducing the negative impact of disease challenge on animal performance.

In addition to the impact on performance, the supplemental AA profile attenuated the immune response through modulation of acute-phase protein levels in Salmonella-challenged animals. Disease-challenged animals showed increased serum concentration of haptoglobin and decreased concentration of albumin, respectively. However, when fed the AA+ profile, challenged pigs showed reduced overall levels of haptoglobin and increased levels of albumin compared to those fed the AA- profile. These findings corroborate the role of functional AA as regulators of metabolic pathways during inflammation, particularly through regulation of immune response.

Functional AA supplementation also decreased overall shedding of Salmonella compared to pigs fed AA- diets and Salmonella counts in colon were reduced in AA+ pigs compared to AA- pigs. Pathogen shedding is important as infected feces are a major source for cross infection between individual pigs and in a commercial setting reduced shedding could reflect in decreased incidence of natural exposure.

Overall, supplementation of key functional amino acids (methionine, threonine, tryptophan) above requirements appears to be a potential strategy for improving growth performance and health status of pigs exposed to an enteric pathogen.

Acknowledgments: Funding for this project was provided by Swine Innovation Porc. Evonik Nutrition & Care GmbH, and MITACS. Prairie Swine Centre receives program funding from the Government of Saskatchewan, Sask Pork, Alberta Pork, Manitoba Pork, and Ontario Pork.