High-Fibre Diets & Immune Stimulation Increase Threonine Requirements

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With the increased use of high-fibre co-products, such as DDGS, and other feedstuffs resulting in an increase in total dietary fibre content in swine rations, studies into the interaction between high-fibre diets and immune challenge are required. This project aims to address the need to more fully understand the interaction between dietary feedstuffs and immune status on nutrient requirements and utilization for body protein deposition and immune status. Information generated from this project will aid in the development of effective techniques and protocols that reduce the negative effects of disease/stress on pig performance as well as nutrition alternatives to antibiotics.

INTRODUCTION

Sub-clinical disease results in reduced growth and less efficient use of nutrients. With the elimination of in-feed antibiotics for growth promotion it is increasingly important to understand the interaction between nutrition and health and nutrient requirements during disease challenge events. Feeding high-fibre feedstuffs reduces the efficiency of utilization of dietary threonine for growth in pigs due to an increase in endogenous threonine loss as a result of increased mucin production. The mucus layer serves to protect the intestinal mucosal surface against threats, such as enteric pathogens, with mucin production shown to also increase with immune challenge. In addition to mucin production, threonine is an important precursor for the synthesis of many acute phase proteins involved in the immune response. While an increased threonine requirement has been shown with increased fibre (mucin production) and with immune challenge (immunoglobulin production), the interaction of these factors on threonine requirements is unknown. A nitrogen-balance study was performed in growing pigs fed high or low fibre diets and with or without immune system stimulation (ISS) to determine the optimum dietary threonine content for optimal growth and optimal immune status. An enteric pathogen challenge study will then be performed in which pigs are fed high or low fibre diets with or without increased threonine content to determine the impact of dietary threonine on pig robustness.

MATERIALS AND METHODS

A total of 90 growing barrows were used in a nitrogen (N) balance study. Pigs were individually housed in metabolism crates and adapted to the environment and experimental diets for eight days before starting the experimental protocol. The dietary treatments were arranged in a 5×2 factorial randomized complete block with 10 pigs/ block at an initial body weight (BW) of 20.47 ± 0.75 kg. The main two main factors were 1) threonine level (0.49,0.57,0.65,0.73 and 0.81% SID) and 2) fibre level (high fibre, HF; or low fibre, LF) (n=9). Pigs were fed at 2.2 times maintennce ME requirements in meals meals/day. Fecal samples and urine collection was completed daily.

Feed refusals and wastages were collected for each pig daily and weighed to determine actual daily feed intake. Water was provided ad libitum through nipple drinkers. Nitrogen balance was conducted during a pre-ISS and ISS period of 4-days each. At the start of ISS period, pigs were injected intramuscularly (I.M.) with Escherichia coli lipopolysaccharide (LPS; O55: B5) at least one hour before the morning meal to stimulate the immune system. LPS injection was repeated 48 hours after first injection to maintain ISS. The initial dosage was 30µg/kg BW, which was increased by 15% on second injection to counteract the possibility of tolerance.

RESULTS AND DISCUSSIONS

Analyzed nutrient content of experimental diets is presented in Table 1. In general the analyzed total dietary fibre (TDF) content was higher (18.5%) in the HF diets than LF (12.5%) diets. The total indispensable analyzed and calculated amino acid content of the experimental diets were similar.

During pre-ISS, PD increased linearly ($P<0.01$) as Thr concentration in the diet increased with a significant interaction ($P<0.05$) between fiber and Thr. During ISS, PD increased linearly ($P<0.05$) as Thr concentration in the diet increased. Curvilinear plateau model estimated SID Thr required to optimize PD of pigs fed LF and HF diets during pre-ISS period was 0.68% (R2=0.88) and 0.78% (R2=0.99), respectively. During ISS, SID Thr was estimated at 0.76% (R2=0.76) for LF diet and 0.72% (R2=0.95) for HF fed pigs. High fiber and ISS independently increased Thr requirement for optimal PD but these effects were not additive.

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CONCLUSIONS

Overall, both dietary fiber and immune stimulation increased the requirement for threonine for protein deposition in growing pigs, however, the interaction of the two factors did not result in a further increase. Increasing our understanding of the interaction of dietary factors and stressors on nutrient requirements will be critical for developing feeding programs that enhance both animal production and animal health while reducing the use of antibiotics.

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Table 1. Composition of experimental diets with extreme SID threonine levels (as fed basis) 1, 2

	Standardized ileal digestible threonine level, %			
	Low Fiber		High Fiber	
Ingredients, %	0.49	0.81	0.49	0.81
Corn	22.00	21.70	4.30	4.00
Barley	7.00	7.00	7.00	7.00
Wheat	48.00	48.00	48.00	48.00
Soybean meal	18.20	18.20	18.50	18.50
Wheat bran	-	-	5.00	5.00
Sugar beet pulp	-	-	10.00	10.00
Canola oil	1.20	1.20	3.80	3.80
L-Lys HCl	0.58	0.58	0.56	0.56
DL-Met	0.20	0.20	0.20	0.20
L-Trp	0.04	0.04	0.03	0.03
L-Val	0.09	0.09	0.09	0.09
L-Leu	-	-	0.07	0.07
L-Thr	0.00	0.33	0.00	0.33
Limestone	1.25	1.25	1.05	1.05
Monocalcium Phosphate	0.75	0.75	0.71	0.71
Salt	0.20	0.20	0.20	0.20
Vitamin-mineral premix3	0.10	0.10	0.10	0.10
Celite	0.40	0.40	0.40	0.40
Calculated nutrient content				
ME, MJ/kg	13.9	13.9	14.0	14.0
CP, %	17.3	17.5	17.7	17.9
SID Thr, %	0.49	0.81	0.49	0.81

1 The experimental diets with the intermediate SID% Thr 0.57, 0.65 and 0.73 were prepared by blending the 0.49 and 0.81 diets in appropriate proportions.
2 SID Standardized ileal digestible.

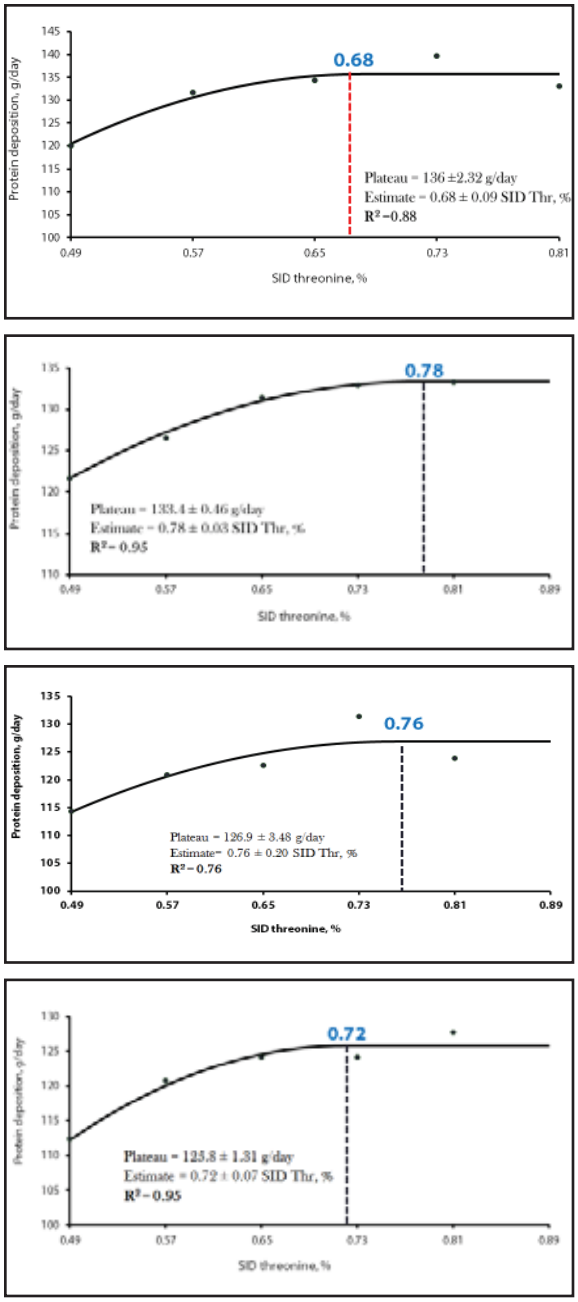

Figure 1. Estimayed threonine requirement (% SID) in pigs fed low-fibre diets (A) or high-fibre diets (B) without ISS or low-fibre diets (C) or high-fibre diets (D) with ISS.