High-fibre diets and immune stimulation increase threonine requirements in growing pigs

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Understanding the interaction between nutrition and pig health

With new legislation eliminating the use of in-feed antibiotics for growth promotion in Canada and increasing consumer pressure to reduce antibiotic use in animal agriculture, it is critical that we develop alternatives to antibiotic use in order to maintain animal performance and health during immune challenge. An increased understanding of the interaction of nutrition and animal robustness (i.e., the ability to cope with an immune challenge), therefore, will be a key component in efforts to replace and/or reduce antibiotic use. Specifically, nutrition-based alternatives to antibiotic use need to be identified.

Pigs are continuously exposed to microbial pathogens and immune-stimulatory antigens that negatively impact animal productivity. Pigs exposed to immune challenge, without exhibiting any clinical signs of disease, show reduced appetite and growth and less efficient use of nutrients compared to healthy animals. Previous studies have estimated a reduction in lean growth of 20-35% and feed efficiency of 10-20% in growing pigs at sub-clinical levels of disease (Williams et al., 1997; Le Floc'h et al., 2009). This decrease in performance can have a substantial impact on profitability of producers. Stimulation of the immune system alters protein and amino acid metabolism and utilization, with amino acids redirected from growth towards supporting the immune response. Of the amino acids, glutamine, arginine, threonine, and aromatic and sulfur amino acids are of particular importance as precursors for synthesis of many critical components of the immune response (Reeds and Jahoor, 2001). It is thought that provision of these amino acids may be important for improving pig response and growth performance during times of stress and disease challenge.

Pork producers have been incorporating increased amounts of co-products from the milling and biofuel industries and other feedstuffs in swine rations. These feedstuffs have higher fibre content and variable protein content and digestibility which may have a detrimental effect on overall pig immune status and robustness. It has already been established that an increased level of threonine is required in high-fibre diets. However, the impact and interaction of factors such as dietary fibre and health status on requirements for specific amino acids that are used for the immune response are not well characterized.

What We Did

A nitrogen-balance study was conducted to determine threonine requirement for maximum protein deposition when dietary fibre and immune system stimulation (**ISS**) were present alone and in combination. Ninety barrows (20.5 ± 0.75 kg initial body weight) were randomly assigned to 1 of 10 wheat and barley-based dietary treatments (n = 9). Diets consisted of a low fibre (12.5% total dietary fibre) or high fibre (18.5%

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total dietary fibre from sugar beet pulp and wheat bran added at 15% of the diet in a 2:1 w/w ratio) with graded levels of threonine (0.49, 0.57, 0.65, 0.73 and 0.81% standardized ileal digestible) fed at 2.2 × maintenance metabolizable energy requirements. After an 8 day adaptation period, two 4 day nitrogen-balance collection periods (pre-ISS and ISS) were conducted. Immune stimulation was induced by repeated injections of increasing doses of *E. coli* lipopolysaccharide. The threonine requirement was determined in each period based on the response in nitrogen retention to dietary threonine content using a quadratic regression statistical model.

What We Found

Feeding pigs high-fibre diets and stimulating the immune system both independently increased the threonine requirement for nitrogen retention when compared to low-fibre and non-stimulated pigs, resulting in an estimate of 0.78 and 0.76% SID threonine, respectively, compared to 0.68% SID threonine. The threonine requirement was also increased when pigs received both high-fibre diets and the immune stimulation (0.72% SID threonine), however, this was not further increased above what was determined for fibre and immune stimulation alone. The exact mechanism behind the interaction of fibre and immune challenge is unknown but may be indicative of a protective effect of fibre. Interestingly, stimulation of the immune system resulted in an increase in the variability of pig response to dietary threonine content, highlighting the difficulty in determining nutrient requirements and development of feeding programs during disease challenge.

Conclusions

This study was the first to confirm an increased threonine requirement during immune challenge in pigs and also the first to determine the interactive effects of both fibre and immune stimulation. This information will be important for the development of feeding programs that decrease feed costs and maintain animal performance while reducing reliance on antibiotics.

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