Effect of wheat bran fiber components on intestinal mucosal barrier function in the weaned piglet

Hong Chen1,2, Joris Michiels1,3, Stefaan De Smet1, Daiwen Chen2

1Laboratory for Animal Nutrition and Animal Product Quality (LANUPRO), Department of Animal Production, Ghent University, Proethoevestraat 10, 9090 Melle, Belgium
2Institute of Animal Nutrition, Sichuan Agriculture University, Yaan, Sichuan 625014, China
3Department of Applied Biosciences, Ghent University, Valentin Vaerwyckweg 1, 9000 Gent, Belgium
E-mail: Hong.Chen@UGent.be

Introduction and objectives: Wheat bran is believed to improve the intestinal epithelium barrier function in humans and animals, however the effect of different fiber components on intestinal function is not well established. The current objective was to determine the contribution of the major fiber components present in wheat bran; i.e. cellulose and arabinoxylan, to the effects of wheat bran on intestinal mucosal barrier function using the weaned piglet as a model.

Materials and Methods: Thirty weaned piglets (weaned on 26-28 d) were assigned to 5 dietary treatments and each treatment was replicated in 2 pens of 3 pigs each. The piglets were fed synthetic diets, including one basal synthetic diet without fiber components (CON) and four fibrous diets, i.e. wheat bran diet (WB, 10% wheat bran), arabinoxylan diet (AX, amount of arabinoxylan equivalent to that in WB), cellulose diet (CEL, amount of cellulose equivalent to that in WB) and combination of arabinoxylan and cellulose diet (CB, amount of arabinoxylan and cellulose equivalent to that in WB). Feeds and water were available ad libitum for 30 d. At the end of the trial, several intestinal tissue segments and digesta were collected for analysis.

Results and Discussion: No significant effects of diet were found in the mid small intestine and the effects in the ileum were limited. At 90% of the small intestinal length, pigs fed WB had an elevated number of goblet cells per villus and a higher ratio of villus height to crypt depth compared to CON. However, lower active transport (reduced increase in short-circuit current upon glucose stimulation in Ussing chambers) was observed in the WB group. Supplemental AX reduced intestinal permeability (decrease in apparent permeation coefficient for HRP as macromolecular marker) compared to CON. In contrast, major effects were found in the hindgut. In caecum, except for CEL group, the pH in pigs fed fibrous diets as compared to CON was reduced. Higher acetate, propionate and total SCFA and lower BCFA concentrations were observed in pigs fed AX; the latter suggesting a decrease in protein-associated fermentation. Concomitant, pigs fed the CB diet showed higher propionate, butyrate and total SCFA concentrations compared to CON. In the mid-colon, a higher goblet cell number per villus occurred for pigs fed AX diet. A reduction in colonic apparent permeation coefficient and an increase in propionate and total SCFA concentrations was found when pigs were fed the AX and CB diet. Interestingly, only the WB diet showed an increase in butyrate. These results confirmed the positive effects of wheat bran on intestinal integrity and indicate that arabinoxylan, not cellulose, is responsible for this effect, probably by improving intestinal barrier function, increasing the number of goblet cells and SCFA, especially in the hindgut.