Utilizing *in vitro* protein digestion kinetics and resistant fiber to steer ingredient composition of nursery pig diets for reduced risk of post-weaning diarrhea

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Background and objectives: It was hypothesized that not only the extent of protein digestibility at the end of the ileum influences pig performance and risk for post-weaning diarrhea (**PWD**), but rate of protein digestion also influences performance and gut-health post-wean. Therefore, a 2-step *in vitro* assay that simulated nursery pig gastric and small intestinal protein digestion over-time was developed in collaboration with Wageningen University and ForFarmers (Chen et al., 2018). This assay determined protein degradation in feed ingredients at 30 min intervals over a 6 h incubation and enabled the differentiation of ingredients based on protein digestion rate. Furthermore, it was hypothesized that dietary fiber resistant to fermentation in the hindgut of nursery pigs would reduce the risk for PWD. The objective of this experiment was to validate the use of *in vitro* protein digestion kinetics and resistant fiber to formulate a nursery pig diet to reduce PWD compared with a negative control (150 ppm ZnO; **NC**) and a positive control containing a pharmacological concentration of ZnO (3,200 ppm in phase 1 and 1,800 ppm in phase 2; **PC**).

Materials and methods: 864 pigs (20 d of age, 6.26 ± 0.15 kg BW) were assigned randomly to 54 pens across 3 rooms at a commercial facility with a persistent *E. coli* challenge. There were 18 replicate pens / treatment and 16 pigs / pen. Treatments were fed according to a feed budget (phase 1 = 2 kg / pig; phase 2 = 5 kg / pig) and the third phase was a common diet fed until d 42 post-wean. Experimental diets were formulated to be isocaloric (phase 1 = 2,600 kcal NE / kg; phase 2 = 2,400 kcal NE / kg), isonitrogenous (phase 1 = 16.2%; phase 2 = 17.5% CP), and equal in SID Lys (phase 1 = 1.18%; phase 2 = 1.21%). The ingredient composition was based on corn, oats, whey ingredients, canola meal, soy protein concentrate, and plasma and was the same for both NC and PC. The NC and PC contained 10.6% fast protein based on *in vitro* protein digestion kinetics and 7.0 and 4.0% resistant fiber in phase 1 and 2, respectively. The test diet (**TEST**) was formulated next to contain greater fast protein (12.5 and 11.4% in phase 1 and 2 respectively) and greater resistant fiber (9.0 and 6.1% in phase 1 and 2 respectively). Ingredient composition of TEST changed to a diet based on wheat, oats, whey ingredients, and 2% more plasma. The addition of 7 and 5% oat hulls to phase 1 and 2 TEST, respectively, was used to increase resistant fiber. Pigs were provided ad libitum access to feed and water. Pens and feeders were weighed weekly to calculate ADG, ADFI, and FCR. Diarrhea scores were determined weekly and any score above 0 (no evidence of diarrhea) was considered a positive incidence to determine the percent of pens with diarrhea.

Results and conclusion: A severe gut-health challenge occurred because over 76% of pens experienced diarrhea in week 1 and this was not different among pigs fed the NC, PC, or TEST diets. However, pigs fed the TEST containing more fast digestible protein and resistant fiber had improved ($P < 0.05$) ADFI by 9%, ADG by 27%, and FCR by 12% compared with NC and PC fed pigs. In week 2, pigs were switched from phase 1 to phase 2 and pigs fed PC and TEST had 55.6 and 38.9%, respectively, of pens with scours and this was less ($P < 0.05$) than 88.9% of pens with scours when pigs were fed NC. Overall (d 0-42), pigs fed TEST had improved ($P < 0.05$) performance and similar cost per kg gain compared with NC and PC fed pigs as well as diarrhea reduction similar to pharmacological concentrations of ZnO. These results support our hypothesis that steering ingredient composition towards greater concentrations of *in vitro* fast digestible protein and resistant fiber can reduce the risk of PWD and improve performance similar to using pharmacological concentrations of ZnO and this could result in a return of $0.30-0.40 per market pig.

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