Fermentation kinetics of resistant starch and its interaction with protein in large intestine of growing pigs

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Background

Animal feeding has been recognized as an essential tool for controlling gas emissions from manure in the livestock sector. That is because the undigested protein in the small intestine will go to the large intestine and be fermented by the bacteria in the large intestine. This process will produce some metabolites which will cause detrimental effects to gut health and gas emissions. Various nutritional strategies, as the inclusion of fiber sources in feeds, have been proposed to mitigate ammonia emission derived from manure in pig farms. Some studies have proved that combine protein diet with fermentable carbohydrates could improve gut health of pigs and reduce the nitrogen excretion and harmful gas emissions.

Objectives

Exploring the fermentation kinetics of different types of resistant starches by *in vitro* and *in vivo* methods, selecting appropriate resistant starch structure and dosage as the source of carbohydrate fermentation in the hindgut of growing pigs and fermenting with protein, changing the nutrient fermentation mode of pig hindgut and reducing the injury of pig intestines and environmental pollution problems caused by protein fermentation.

Methods

Ileum-cannulated growing pigs were used as animal model, by feeding four types of resistant starch to investigate their digestion, fermentation and structure changes in the whole intestine. All pigs were slaughtered to collect digesta samples in different intestine segments. Meanwhile, the *in vitro* digestion were conducted to compare the digestion characteristics with the small intestine digestion in pigs. The second animal experiment were conducted to investigate the pure fermentation of resistant starch substrates in the hindgut of growing pigs by infusing resistant starch to the ileum. The feces from normal and experimental pigs were collected to use as microbiota inoculum of the *in vitro* fermentation. After these experiments, the pivotal microorganisms that degraded the resistant starch substrates were found. Then the bacteria cultivation was conducted to research the resistant starch degradation mechanism. The optimal resistant starch substrates will be selected to ferment with protein and observe their fermentation interactions.

Figure 1. Ileum-caecum-cannulated pig model and gas production system

Results

By analyzing the changes of crystal and molecular structure of different types of resistant starch before and after in vitro digestion, insignificant results were observed, that means pure enzymatic hydrolysis cannot significantly influence the structure of different types of resistant starch. But resistant starch apparent structure endured more destruct during in vivo fermentation, suggesting small intestine bacteria involved in the resistant starch degradation. By comparing the resistant starch feeding and infusing experiments, we found *Lactobacillus* were the main bacteria which fermented original resistant starch and their fermentation could happen in both small or large intestine, according to the segments where resistant starch emerged.

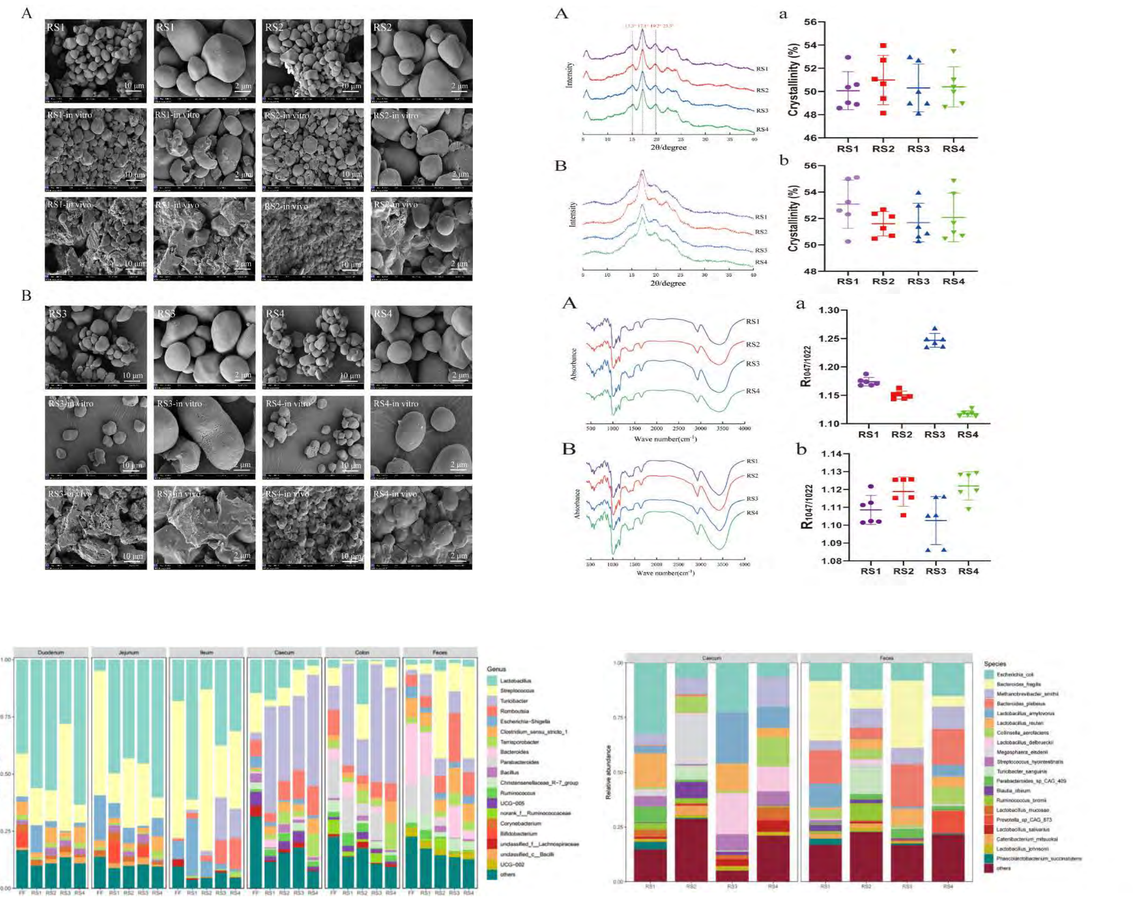

Figure 2. Resistant starch structural changes and their effects on microbiota composition of growing pigs

Conclusions

For now, we can conclude that:

- Different types of resistant starch have similar effects during digestion and fermentation
- Resistant starch structure is the main factor determined fermentation performance
- The fermentation ability of small intestine bacteria was underestimate
- The utilization of bacteria on resistant starch substrates are not intestine segments specific

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