Brown rice increases faecal and large bowel short-chain fatty acid levels in pigs

AR Bird[1], RJ Illman[1], T Hayakawa[2] and DL Topping[1]

[1]CSIRO Division of Human Nutrition, Kintore Ave, Adelaide, SA, 5000
[2]Faculty of Agriculture, Gifu University, Gifu 501-11, Japan

Starch escaping small intestinal digestion is a fermentable substrate for the large bowel microflora leading to production of short chain fatty acids (SCFA) (1). These acids (especially butyrate) are thought to play an important role in maintenance of large bowel health. An intact bran layer in whole grains would restrict access to the starchy endosperm by small intestinal amylases, increasing starch flow into the large bowel and shifting SCFA towards the distal colon. This would explain the greater SCFA levels in the distal colon of pigs fed brown rice (2).

We tested this hypothesis in two groups of eight pigs (Large White strain) fed either boiled white (WR) or brown rice (BR) diets for 3 weeks. The diets provided 21% of energy as fat, 62% as carbohydrate (of which 54% was starch), and 17% as protein. Dietary fibre content of the BR diet was 3% (as non-starch polysaccharides, NSP) and sufficient heat-stabilised rice bran was added to WR to ensure comparable NSP intakes. Faeces were collected at the end of the first 2 weeks of study and digesta samples from three sites in the large bowel taken at slaughter. These were weighed and analysed for starch, SCFA, and pH.

In the first week, faecal output was significantly higher in pigs fed BR (364 vs 210 g/d for BR and WR treatments, respectively; $P<0.001$) but by the end of the second week faecal excretion values for the BR group had declined and were similar in both groups. On both sampling occasions, faecal pH was lower and total short chain fatty acid (SCFA) concentrations were higher in pigs fed BR (see Table).

Variable	White Rice (WR)	Brown Rice (BR)	SED	Significance
Faecal				
pH	7.08	6.28	0.14	***
Total SCFA (mmol/d)	10.8	28.1	2.0	***
Colonic butyrate pool (mmol)				
Proximal	0.63	1.55	0.21	***
Mid	0.36	1.18	0.77	***
Distal	0.20	0.64	0.14	**

Digesta mass and SCFA were greater at each of the three colonic sites in pigs fed BR. For butyrate, the increase in the distal colon was 320% (Table) which would lead to greater availability of this acid for the colonocytes. However, there was no difference between the two groups in distal colonic starch content. These data suggest that consumption of brown rice (BR) stimulated large bowel fermentation through passage of starch into the colon. It appears that the microflora adapt to the increased substrate supply by increasing starch degradation, and that the NSP present in brown rice were responsible for the passage of SCFA to the distal colon.

1. Annison G, Topping DL. Nutritional role of resistant starch: chemical structure vs physiological function. Annu Rev Nutr 1994;14:297-320.
2. Marsono Y, Illman RJ, Clarke JM, Trimble RP, Topping DL. Plasma lipids and large bowel volatile fatty acids in pigs fed white rice, brown rice and rice bran. Br J Nutr 1993;70: 503-513.