




Cite this: *Food Funct.*, 2017, **8**, 1810

In vivo fermentation of a *Pleurotus eryngii* polysaccharide and its effects on fecal microbiota composition and immune response†

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A novel, homogeneous *Pleurotus eryngii* polysaccharide (PEP) (molecular weight 426 kDa, purity 91.25 ± 3.14%) which mainly consisted of glucose with β-type glycosidic linkages was used to investigate *in vivo* fermentation behavior and effects on immune response in mice. Different doses (0.2, 0.4, 0.8 g per kg body weight) were orally administered to the mice for a period of six weeks. The results showed that the SCFA concentration, pH value, and moisture contents of cecum and colon contents were significantly altered with high-dose PEP treatment compared to the control group ($P < 0.05$). Moreover, the fecal microbiota in the PEP treated group was found to be structurally different compared to the control group; especially, the *Porphyromonadaceae*, *Rikenellaceae*, *Bacteroidaceae* and *Lactobacillaceae* abundances were all increased at the family level. In addition, the exerted immune response was significantly altered after the high-dose PEP oral administration. This exploratory study indicated that intake of PEP could have a positive role in gastrointestinal tract health.

Received 1st March 2017,
Accepted 26th April 2017
DOI: 10.1039/c7fo00341b
rsc.li/food-function

1. Introduction

As the main substance with multiple biological functions, including antioxidant,¹ immune-enhancing,² hypoglycemic,³ renal protection,⁴ and gastrointestinal regulating activities,⁵ polysaccharides isolated from natural sources have become one of the most significant active components in numerous life processes. It has been proved in various studies that due to the deficiency of carbohydrate-active enzymes, most polysaccharides, which are also called non-digestible polysaccharides, cannot be digested or absorbed by the body directly.^{6,7} In recent years, with the deepening of the understanding of the relationships between food components and gastrointestinal function, scientists have found that the gastrointestinal tract could be one of the most important loci for the functional performance of natural polysaccharides.⁸ So far, considerable experimental research has shown that natural polysaccharides exert activities mainly through fermentation reaction by the

colonial microbiota in the gastrointestinal tract.⁹ The polysaccharides will be decomposed and used by the gut microbiota in the gastrointestinal tract to serve as an energy source for diverse beneficial bacterial groups, including the promotion of their propagation and production of beneficial compounds. These compounds are mostly short-chain fatty acids (SCFAs), including acetate, propionate, butyrate and valerate acid. As the essential nutritional sources for the colonic epithelium, SCFAs not only can modulate gastrointestinal inflammatory conditions, but also can increase the blood flow, maintain colonic homeostasis and affect the composition of the mucus layer.¹⁰ Besides their biological functions, existence of more SCFAs has been shown to lower the pH value of the gut luminal environment and this has a deep relationship with the health of gastrointestinal tracts. Above all, SCFAs can particularly reduce the risk of some diseases including the irritable bowel syndrome,¹¹ inflammatory bowel disease (IBD)¹² and cardiovascular diseases.¹³ On the other hand, non-digestible polysaccharides could also increase the gut content moisture to generate softer fecal matter, which is beneficial for the host health.

Edible mushrooms seem to be potential candidates for non-digestible polysaccharides as they contain different functional carbohydrates which are all resistant to acid hydrolysis in the stomach and remain unbroken by human digestive enzymes. *Pleurotus eryngii*, as a new kind of important species of edible mushrooms, displays multiple biological functions due to its unique variety of bioactive compounds. *P. eryngii*

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†Electronic supplementary information (ESI) available. See DOI: 10.1039/c7fo00341b