

Plant Fiber Digestion, an Animal Scientist's Journey from the Cow Rumen to the Human Gut

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Curriculum Vitae

Isaac Cann received his PhD in 1994 from Mie University, Japan. He is currently a Professor of Animal Science and the Institute for Genomic Biology, University of Illinois Urbana-Champaign (UoI), USA. Before joining UoI, he was Senior Research Scientist at Biomolecular Engineering Research Institute (Japan) and Visiting Scientist at New England Biolabs (USA). His research interests include fiber digestion in ruminants and humans, microbial enzymes for bioenergy production, DNA replication in methanogens, and impact of microbiomes on host health. He is a recipient of the prestigious National Science Foundation Career Award and served on the Committee on Metagenomics (National Academies) and as Deputy Director of the Energy Biosciences Institute. He has published in many high impact journals, serves as editor for Applied and Environmental Microbiology and Annual Review of Animal Biosciences and is an elected fellow of both American Academy of Microbiology and American Association for the Advancement of Science.

Fiber Digestion, a Journey from the Cow Rumen to the Human Gut

Plants harvest and store energy from sunlight in the form of structural carbohydrates, significant being cellulose, hemicellulose, and pectin. Due to their critical roles in plants, including providing strength and protection, these structural polysaccharides are recalcitrant to degradation. As an example, cellulose is reported as having a half-life in millions of years at 25°C. Ruminant animals have, however, evolved a complex community of microbes that deploy a vast array of enzymes in their foregut to release fermentable sugars from these polysaccharides. Rumen microbial fermentation of polysaccharides leads to microbial cell proliferation and short chain fatty acids, the major sources of protein and energy, respectively, for the host animal. Genomic and transcriptomic analyses, from our group and others, have yielded the molecular determinants underlying microbial interactions for efficient plant fiber degradation and fermentation in the rumen. In this process, the microbes enlist diverse plant cell wall degradation mechanisms, including the polysaccharide utilization loci (PULs) and cellulosomal paradigms, in accessing the energy trapped in plant fibers. Investigation of the product of a newly discovered hemicellulose-targeting gene, in the rumen bacterium *Prevotella bryantii*, led to the observation that ruminants and humans share xylan degradation strategies. This discovery enhanced our interest to understand the physiological basis of fiber fermentation by human colonic bacteria. Fascinatingly, we discovered that the human colonic *Bacteroides* spp., belonging to the same phylum as the cow rumen *Prevotella* spp., employ not only similar strategies but also similar enzymes to depolymerize arabinoxylan, a common hemicellulose found in human diets. Colonic fiber fermentation contributes to caloric intake of the human host; however, insights from our mechanistic studies also suggest significant health benefits. Our results unravel important attributes of fiber in the diet that with better understanding can be extended to enhance sustainability of both ruminant and monogastric animal production.

