Replacing Animal Protein with Soy-Pea Protein in an "American Diet" Controls Murine Crohn Disease-Like Ileitis Regardless of Firmicutes: Bacteroidetes Ratio

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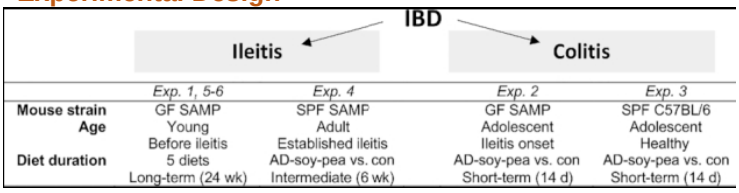
Abstract

Statement of the Problem: The current nutritional composition of the "American diet" (AD; also known as Western diet) has been linked to the increasing incidence of chronic diseases, including inflammatory bowel disease (IBD), namely Crohn disease (CD). This study investigated which of the 3 major macronutrients (protein, fat, carbohydrates) in the AD has the greatest impact on preventing chronic inflammation in experimental IBD mouse models. Methodology: We compared 5 rodent diets designed to mirror the 2011-2012 "What We Eat in America" NHANES. Each diet had 1 macronutrient dietary source replaced. The diets were AD, AD-soy-pea (animal protein replaced by soy + pea protein), AD-CHO ("refined carbohydrate" by polysaccharides), AD-fat [redistribution of n-6:n-3 PUFA ratio; ~10:1 to 1:1], and AD-mix (all 3 "healthier" macronutrients combined). In 3 separate experiments, 8-wk-old germ-free SAMP1/YitFC mice (SAMP) colonized with human gut microbiota ("hGF-SAMP") from CD or healthy donors were fed an AD, an AD-"modified," or chow diet for 24 wk. Two subsequent dextran sodium sulfate-colitis experiments in hGF-SAMP (12-wk-old) and specific-pathogen-free (SPF) C57BL/6 (20-wk-old) mice, and a 6-wk feeding trial in 24-wk-old SPF SAMP were performed. Findings: The AD-soy-pea diet resulted in lower histology scores [mean ± SD (56.1% ± 20.7% reduction)] in all feeding trials and IBD mouse models than did other diets ($P < 0.05$). Compared with the AD, the AD-soy-pea correlated with increased abundance in *Lactobacillaceae* and *Leuconostraceae* (1.5-4.7 log2 and 3.0-5.1 log2 difference, respectively), glutamine (6.5 ± 0.8 compared with 3.9 ± 0.3 ng/μg stool, $P = 0.0005$) and butyric acid (4:0; 3.3 ± 0.5 compared with 2.54 ± 0.4 ng/μg stool, $P = 0.006$) concentrations, and decreased linoleic acid (18:2n-6; 5.4 ± 0.4 compared with 8.6 ± 0.3 ng/μL plasma, $P = 0.01$). Conclusion & Significance: Replacement of animal protein in an AD by plant-based sources reduced the severity of experimental IBD in all mouse models studied, suggesting that similar, feasible adjustments to human diets could help control/prevent IBD in humans.

Experimental Design



Recent Publications

1. Basson A, Rodriguez-Palacios A, Cominelli F, et al (2021) Human Gut Microbiome Transplantation in Ileitis Prone Mice: A Tool for the Functional Characterization of the Microbiota in Inflammatory Bowel Disease Patients. Inflamm Bowel Dis, 11;26(3):347-359.
2. Kolodziejczyk AA, Zheng D, Elinav E. (2019) Diet–microbiota interactions and personalized nutrition. Nat Rev Microbiol. 2019;17:742–53.
3. Statovci D, Aguilera M, MacSharry J, Melgar S. (2017)The impact of Western diet and nutrients on the microbiota and immune response at mucosal interfaces. Front Immunol. 8:838.
4. Rizzello F, Spisni E, Giovanardi E, Imbesi V, Salice M, Alvisi P, Valerii MC, Gionchetti P. (2019) Implications of the westernized diet in the onset and progression of IBD. Nutrients. 11:1033.
5. Basson A, Trotter A, Rodriguz-Palacios A, Cominelli F. (2016). Mucosal Interactions between Genetics, Diet, and Microbiome in Inflammatory Bowel Disease. Front Immunol. 2:7:290.
6. Basson A, Cominelli F, Rodriguez-Palacios A. Sweets and Inflammatory Bowel Disease: Patients Favor 'Artificial Sweeteners', and 'Diet Foods/Drinks' over 'Table Sugar' and consume less 'Fruits/Vegetables'. (2023). Inflamm Bowel Dis.

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Abigail R Basson is a registered dietitian and NIH-funded instructor in the Department of Nutrition and Division of Gastroenterology at Case Western Reserve University and a clinical dietitian for the Preventive Medicine Center at Cleveland Clinic, Cleveland USA. Her expertise is in basic mechanisms of inflammatory bowel disease and dietary manipulation of disease severity in mouse models and in human clinical trials. The overarching goal of her work is to translate scientific knowledge and discoveries into applied knowledge that can be disseminated at the community level. Her work challenges the traditional paradigm of a 'one size fits all' diet approach and underscores the importance of quantifying person-specific host and microbiota dietary responses into personalized diets that are of benefit to the individual.

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Session name/ number: Role of Nutrition in Disease Prevention
Category: Oral presentation