Cluster 2 – Progress Report for the Cluster 2 Science Advisory Body

1. CLUSTER PROJECT DETAILS

Project number: T4.H25.V1
Name of Project: Determining the Link Between Pulse Foods, Gut Health, and Chronic Disease
Project research period: 2015-2016
Period covered by this report: 2015-2016
Principal investigator and research collaborators: Krista Power (PI); collaborators: Susan Tosh, Lindsay Robinson, Rong Cao, Emma Allen-Vercoe

NON-CONFIDENTIAL ABSTRACT/SUMMARY

Sub-Activity 1: Determining the effects of pulse foods on human gut microbiota structure and activity from healthy, obese, and inflammatory bowel disease (IBD) subjects

We are using a novel combined *in vitro* human upper gut (i.e. small intestine) digestion and lower gut (i.e. colonic) microbial fermentation "Robogut" model (seeded with defined microbial communities isolated from lean, obese, or IBD human subjects) to determine the potential for different pulses to modulate human microbial community composition (16S rRNA sequencing) and activity (e.g. SCFAs and phenolic metabolites). One variety each of red lentils (CDC Maxim), Kabuli chickpeas (CDC Frontier), yellow peas (Meadow), and navy beans (Nautica) were processed (crackers, porridges, home cooked, and canned) and analysed for starch, resistant starch, protein, and phenolics. *In vitro* upper gut digestion of pulse foods are completed and the non-digestible fractions submitted to Dr. Emma Allen-Vercoe for testing in the Robogut colonic microbial fermentation model. Microbial communities for testing non-digestible pulse fractions in the Robogut have now been developed from healthy, obese, and IBD subjects and the first pulse substrate (canned lentils) has been tested using a healthy microbial community. Preliminary results demonstrate that the lentil fraction significantly alters the microbial community composition, which remains stable post removal of the lentil digest. Further analyses of the microbial-derived products (SCFAs and branched-chain (BCFAs)) within the lentil fermenta are currently being analyzed. Other pulse non-digestible fractions using Robogut seeded with healthy, obese, and IBD microbial communities are in progress.

Sub-Activity 2: *In vivo* assessment of the gut health promoting effects of pulses and the impact on human chronic disease

Our *in vivo* studies assess the effects of dietary pulses in healthy mice (determines colon priming effects of pulses) and following 2% (w/v) dextran sodium sulfate (DSS), which induces colitis and mimics IBD. Dietary interventions with 20% dietary pulse-supplemented diets (bean (B) and chickpea (CP)) are finished and the lentil study will commence in January 2016. Our results demonstrate that both B and CP exert similar beneficial effects within the colon microenvironment (microbiota and colonic tissues). B and CP prime the colon by altering the fecal microbiota community structure assessed by fecal 16S rRNA sequencing (e.g. increased Prevotellaceae, Porphyromonadaceae, S24-7 and reduced Rikenellaceae, Lachnospiraceae, Streptococcaceae, and Erysipelotrichaceae abundance). Similarly, B and CP enhanced microbial activity resulting in increased beneficial gut-health modulating cecal SCFAs. Colonic tissue responsiveness to SCFA was also enhanced, based on mRNA expression of GPR41, GPR43, and GPR109a in pulse-fed mice indicative of increased SCFA signal transduction. Colonic tissue function, barrier integrity, and mucosal defense mechanisms were all enhanced by B and CP in healthy unchallenged mice. During colitis, clinical symptoms of the disease were attenuated by B and CP, and the degree of histological structural damage to the colon tissue architecture was attenuated by B (CP analysis in progress). B fed mice had increased colonic expression of microbial-responsive and epithelial barrier integrity promoting genes and reduced local and systemic pro-inflammatory mediators. Similar analyses of colitic CP tissue samples are in progress. Collectively, these data demonstrate that colonic function is enhanced in pulse-fed mice prior to the DSS inflammatory challenge, which results in an attenuation of the severity of the ensuing colitis-associated inflammatory response and disease symptom.