Project number: 6771
Funding source: DAFM/FIRM
Date: Nov 2018
Project dates: Dec 2014 – Nov 2018

Investigating the effect of dietary manipulation on microbiota diversity for controlling immune function

IMMUNOMET

Key external stakeholders:

DAFM, Kerry Foods, Functional food & nutrition companies, Dieticians, Animal feeds companies, General public

Practical implications for stakeholders:

- Methodology was developed that allows researchers to screen multiple food types/components that may modulate immune function through increasing gut bacteria diversity.
- Several fibres tested offer potential as prebiotics to improve gut bacteria diversity and thus promote health and well-being.
- Dietary lipids can have either pro-inflammatory or anti-inflammatory effects and these effects may be, in part, through their effects on our gut bacteria.
- Dietary fibres may promote resistance to infection through increasing diversity of our gut bacteria.

Main results:

- Several dietary fibres obtained from food can promote gut microbiota diversity, with combinations being the most effective.
- Fish oil may illicit its anti-inflammatory effects, in part, through increasing gut microbiota diversity.
- Palmitic acid may promote inflammation through inhibition of gut microbiota derived propionate, a potent anti-inflammatory bacterial metabolite.
- Yeast beta glucan can induce changes in the gut microbiome that reduces survival of the human gut pathogen Shigella.

Opportunity / Benefit:

These results offer potential for functional food companies to enrich foods with dietary fibres to promote health and well-being, in particular combinations of these dietary fibres.

Fish oil may also be a valuable addition to gut modulating functional food formulations/supplements.

Collaborating Institutions:

TMFRC, UUC, UL, UCD

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Teagasc project team: Prof. Catherine Stanton

External collaborators: Prof. Fergus Shanahan (Principal investigator) Department of Medicine, University College Cork & Alimentary Pharmabiotic Centre, University College Cork
Prof. Paul O'Toole (Project coordinator) Department of Microbiology, University College Cork

1. Project background:

ELDERMET established a relational database of macronutrient-microbiota-health associations, including inflammatory biomarkers. Studies of younger adults also support a microbiota-inflammation axis and confirm microbiota diversity modulation by diet. The ELDERMET data identifies exploitable links between food ingredients and microbiota diversity. Additionally, several nutrients such as fatty acids modulate immune function and metabolism, but if this is affected via the gut microbiota is unknown. The synergy between nutrition and nutrient-driven microbiome diversity represents an opportunity for ingredient development for the food industry.

2. Questions addressed by the project:

Can gut microbiota diversity modulate inflammation and susceptibility to enteric infections?
Can interventions with food ingredients modulate inflammation, protect against infection and elicit positive effects on metabolism?

3. The experimental studies:

We ran a number of ex vivo faecal fermentation experiments employing our state of the art fermentation system, the micromatrix. Faecal samples collected from type 2 diabetic, prediabetic, and nondiabetic obese patients were inoculated with prebiotics or potential prebiotics alone or in combination with several dietary lipids. In addition, we inoculated some of the vessels with human pathogens to test whether these ingredients can promote our gut bacteria to protect against disease and infections. We used next generation sequencing techniques to measure the changes in the bacteria and GC-FID technology was employed to assess the effects on the metabolic function of the gut bacteria.

4. Main results:

We subjected several dietary fibres obtained from food sources to our simulated colon model. All tested dietary fibres were found to increase gut microbiota diversity comparable to the prebiotic Synergy 1.

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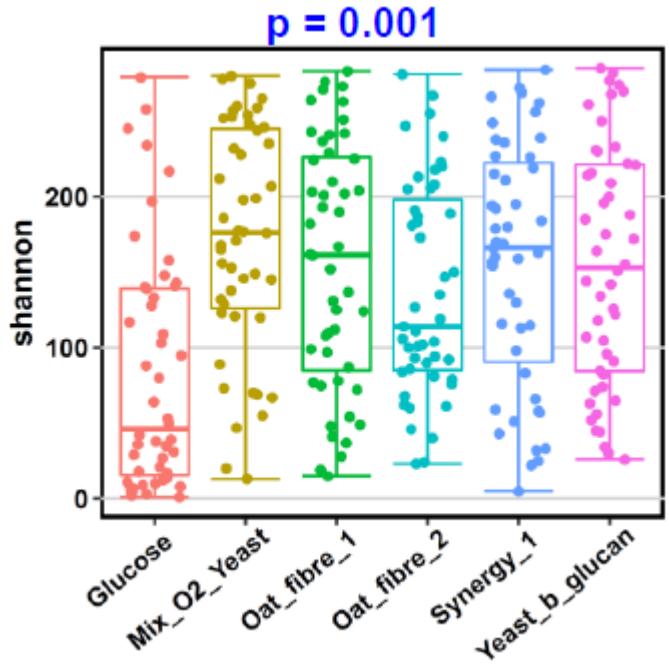
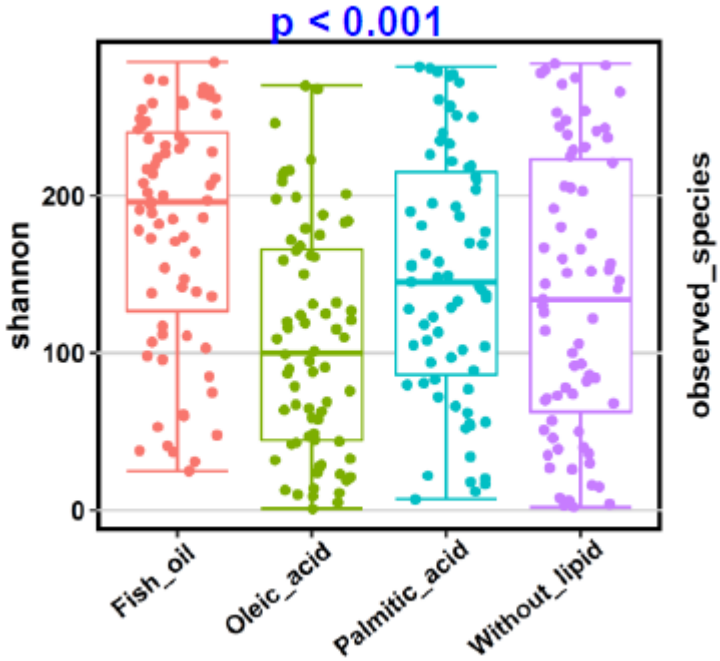


Out of the dietary lipids we assessed we found that fish oil was able to promote gut microbiota diversity.



Palmitic acid was found to significantly reduce the anti-inflammatory short chain fatty acid, propionate.

Yeast beta glucan was found to significantly inhibit the human gut pathogen, Shigella,

5. Opportunity/Benefit:

The establishment of our colonic model coupled with a simulated in vitro digestion has been shown to be a valuable tool for companies to assess potential gut modulating.

We have already formed several collaborations with commercial companies to assess functional foods on

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the human gut microbiome using our model that was developed with this project.

6. Dissemination:

Poster presentation by Conall Strain at the 17th Annual International Scientific Association of Prebiotics and Probiotics (ISAPP) meeting, Singapore, 2018.

Main publications:

1. Mills S, Lane JA, Smith GJ, Grimaldi KA, Ross RP, Stanton C. (2019). Precision nutrition and the microbiome, Part II: Potential opportunities and pathways to commercialisation. Nutrients 11, 1468.
2. Mills S, Stanton C, Lane JA, Smith GJ, Ross RP. (2019). Precision nutrition and the microbiome, Part I: Current state of the science. Nutrients 11, 923.
3. Shanahan F, van Sinderen D, O'Toole PW, Stanton C. (2017). Feeding the microbiota: transducer of nutrient signals for the host. Gut, 66(9):1709-1717.
4. Reid G, Abrahamsson T, Bailey M, Bindels LB, Bubnov R, Ganguli K, Martoni C, O' Neill C, Savignac HM, Stanton C, Ship N, Surette M, Tuohy K, van Hemert S. (2017). How do probiotics and prebiotics function at distant sites? Benef Microbes, 8(4): 521-533.
5. Power SE, O'Toole PW, Stanton C, Ross RP, Fitzgerald GF. (2014). Intestinal microbiota, diet and health. Brit J Nutr, 111: 387-402.

Popular publications:

Pathogen data featured during a knowledge exchange session at the 18th Annual International Scientific Association of Prebiotics and Probiotics (ISAPP) meeting, Antwerp, Belgium, 2019.

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