

END OF PROJECT REPORT

Purpose of End of Project Report

SRP 2022-27 projects provide quarterly progress reports and annual narrative summaries as well as research outcomes throughout the term of the project via the Researchfish platform. This end of project report provides additional information when a project finishes that can be used to summarise what the project has delivered, lessons learned and next steps.

This report may be published or uploaded to the SRP 2022-27 webpages of SEFARI Gateway.

Project Researchfish ID	RI-B7-8		
Project Name	Understanding how fibre reduces food intake and adiposity.		
Principal Investigator	Alexander W. Ross		
Start Date	01/04/2022	Completion Date	31/03/2023

Purpose of the project

Overconsumption and obesity have become serious human problems. These excesses contribute to the climate and biodiversity crises which we must endeavour to halt or reverse. Our previous work has shown that high fibre diets can act as a natural brake on our food intake, but we need a better understanding of how this works within the gut. This project was needed to help work towards more informed and accurate dietary policy advice for healthier weight management, help the food industry produce healthier foods, and importantly, help advocate the benefits of more sustainable plant-based diets to the public.

We investigated the effects on intake of high-fat diets when supplemented with a single fibre type, either pectin, fructo-oligosaccharide (FOS), or a mixed fibre diet (pectin, FOS, beta-glucan and inulin) when fed to mice. This project was expected to deliver new knowledge on how these soluble, indigestible but fermentable fibres act on the gut in the context of a high fat dietary challenge. It was predicted to show whether the ability of fibre to act as a brake on food intake and body weight gain depended on the type of fibre and whether single fibres are more, or less, effective than mixed fibre types. It should also reveal how important high relative to low fibre levels are to the response.

The primary result was that mixed fibre intake, which is more typical of human consumption than diets with single fibre types only, were not effective at reducing body weight gain. Clear statistically significant reductions in weight gain were observed with single fibres only, whilst indicating that pectin was more effective than FOS, but no effects were observed with equal amounts in total, of mixed fibres.

It appeared that the individual fibre levels within the mixed fibre diet were at a sub-threshold inclusion rate to cause reduced body weight gain. In rodents this threshold has been determined to be around 5%^{w/w} for pectin as fibre. Differences that may account for the variable responses to these fibre supplements were explored by 16S sequencing of the gut microbiota, but no individual species was found to correlate with the body weight changes observed. Further new knowledge on differences between the gut to brain signalling satiety hormones, short chain fatty acid levels and epithelial cell gene expression were investigated between the fibre supplements used.

Objectives achieved/not achieved

This project addressed Theme B, Topic 7, RQ 1 '*Please set out your plans for researching the components of healthy diets and their effects. How can we develop our understanding of the physiological effects of interventions on dietary health?*'

To address this question the project had three primary objectives:

Objective 1. To identify how distinct the effects of the different fibres (pectin, oligofructose and mixed fibre) are on the profile of the gut microbiome, when compared side by side.

Objective 2. To elucidate how any changes in microbiota in Obj. 1) translate into short chain fatty acid (SCFA) profiles.

Objective 3. To determine the host response to the three different dietary fibres at the level of gene expression in the gut epithelial cell layer.

These objectives were achieved by successfully conducting a trial as proposed, feeding the different fibre-containing diets to mice on a high fat background. Samples of the microbiota were processed for 16S sequencing and bioinformatic analysis was performed. Although different bacterial profiles were observed for the different fibre types and the mixed diet, there was no correlation between any individual bacterial species and reduced weight gain. Of primary interest, we observed that with individual fibre diets, threshold levels of both PYY and GLP-1 needed to be reached to slow weight gain on a high fat diet, whilst with mixed fibre feeding, these hormones were not induced to high enough levels to drive reduced weight gain. The related SCFA profiles were analysed and the concentrations of acetate and propionate were not significantly different between the colonic samples from mice fed individual or mixed fibres whilst the butyrate concentration in the mixed fibre sample was the highest. This indicates that the SCFA levels were not correlated with the changes in gut satiety hormones or body weight.

The colonic epithelial cell gene expression profiles were analysed by RNAseq but due to some unforeseen RNA extraction issues, repeated extractions were required, which delayed the analysis, and this meant that follow up real-time PCR could not be considered before the end of the project. The results are being collated now for publication.

Lessons Learned

This study was very carefully planned by highly experienced researchers who were realistic about the extent of work that could be achieved in such a short, one year study. The project was executed according to the plan and produced some very interesting and relevant results that are sufficiently important as to be followed up, for confirmation of similar responses in human trials. Metagenomics, which should be more revealing, would be recommended instead of only 16S analysis in any future microbiome study. This would require higher levels of funding which was not an option for this study.

Next Steps/ Future Plans

The outcomes of the work were discussed at the planned annual meeting with FSS in March 2023. Further, these outcomes have informed the human study being conducted in RI-B7-01. In the part of this project where weight loss is a goal, the highest possible level of inclusion of the selected inulin-type fibres will be adopted. The combined results of these mouse and human studies should provide information to advise FSS about the health benefits of fibre consumption and potentially help them promote increased fibre consumption for healthy weight management with more sustainable plant-based diets.

Once published, the results should help inform future human trials to determine whether similar outcomes, in terms of body weight responses, with respect to mixed versus single fibre types, are observed. It is important to determine if threshold levels of fibres are required for similar effectiveness in humans as observed in this mouse study. Furthermore, future human studies should investigate whether mixed fibre feeding, at an achievable intake level, is effective at all for weight loss. This would help in forming appropriate health advice to provide to consumers concerning dietary fibre consumption, especially in relation to body weight and obesity.