Environment, Natural Resources and Agriculture Strategic Research Programme 2022-2027

RESAS
Rural & Environmental Science and Analytical Services

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 will be published on the SRP 2022-27 project webpages of SEFARI Gateway or on the Scottish Government website.
All sections must be completed

Project Researchfish ID	RI-B7-03		
Project Name	Barley to support food and drink innovation		
Principal Investigator	Wendy Russell		
Start Date	01 April 2022	**Completion Date**	30 June 2023

Purpose of the project

This project addresses the potential of whole grain phytochemical-rich barley accessions developed from ancient grain (for improved climate credentials) to reduce blood sugar levels to complement the health claims associated with lipid lowering and supporting new food and drink market opportunities. It is particularly relevant to the longer-term goal of developing a food system that supports a diet to benefit those at risk of or living with metabolic disorders such as type 2 diabetes mellitus.

Objectives achieved/not achieved

The two main outcomes stated in the submission tender were to: 1) establish whether phytochemical rich barley improves postprandial glycaemia compared to a control barley in a human study and demonstrate any correlation of these observations with systemic dietary metabolites and 2) explore the acceptability of anthocyanin rich barley used in food products for consumers interested in maintaining healthy blood sugar levels.

We sourced and compared four barley lines grown at the James Hutton Institute (JHI) for their nutritional quality and these were shown to be high in beta-glucan (an important fibre for reduction of blood lipids) and a rich source in micronutrients and phytochemicals. These barleys are also considered to require less inputs and be more climate resilient. All the barley lines studied are naked and do not require dehulling (a major problem for the food industry) and are coloured with potential for exciting food innovation. The human study compared one of these barley lines (Black Barley; Tibet Hispanic cross) with a Bere landrace (Berneray) produced by a local farmer and wheat. We engaged with local dehullers, millers and bakers to produce the intervention products. Through *in vitro* digestion we calculated the sugar content (fructose, glucose and sucrose) available early in the gastrointestinal tract so that the intervention products were not significantly different in glucose availability. The amount consumed was based on delivering 3 g of beta glucan, the amount considered to be required to reduce blood cholesterol in the intervention product.

Volunteers (n=10; 3/7 male/female) were recruited with a type II diabetes score risk (by questionnaire) ≥ 7, suggesting a risk > 1/10 of developing diabetes in the next ten years. Both barley breads showed a trend to reduce blood glucose and blood insulin, with the results only significant for black barley, which showed a significant reduction in blood insulin. Stratifying the volunteers by their diabetes score risk gives a clearer picture of glucose and insulin response, but the numbers of volunteers are too low to be conclusive regarding this data. What is clear is that both barleys tested are higher in fibre and can deliver significantly more iron, manganese, copper, zinc, magnesium, phosphorous and potassium than white wheat flour. Both barleys were lower in calcium, but this is due to mandatory fortification of wheat. The barleys were also higher in a several phytochemicals considered to be anti-inflammatory. In particular, Bere Barley was a rich source of catechin, tyrosol, coumaric and vanillic acid and Black Barley being rich in syringaresinol, ferulic acid and its dimers. Results for the human study are being further analysed by Biomathematics and Statistics Scotland and will be published in a scientific journal. To evaluate acceptability of these food products, we invited a group of participants concerned about their elevated blood sugar levels, as well as companies interested in developing food products aimed at reducing type II diabetes risk to a lunch to disseminate the outcomes of the project. Fifteen participants completed feedback forms and the following information was extracted. More than half the participants considered sweets, sweetened drinks, biscuits and alcohol to be the foods contributing to the risk of type II diabetes and 100% said they would make significant changes to their diet if they were concerned about their risk of type II diabetes. Of the top six foods considered as contributing to the risk of type II diabetes, more than 80% would consider removing sweets and sweetened drinks, 73% biscuits, 47% alcohol, 20% pasta/starchy foods and 13% bread. Biscuits were considered by more than half the participants as the most difficult thing to remove from the diet. Only two participants said they would not purchase a range of foods aimed at reducing the risk of type II diabetes, the reason being that one considered that they needed a balanced diet and the other that they would need to be minimally processed to be acceptable. The majority of participants (90%) would pay between 10-50% more for a range of foods aimed at reducing risk of type II diabetes with one participant willing to pay more than 100% more. All participants that responded stated that they would be willing to eat something less tasty if it was good for their health. Biscuits and bread were considered a priority for reformulation.

During the project we engaged with farmers, processors, bakers and NGOs including a bakery chain (Murdoch Allan) that supplies shops in lower-economic areas as well as several major supermarkets. We also engaged with the award-winning bakery (Wild Hearth Bakery) to explore scope for innovation. The work was presented at the Real Bread Festival, the Royal Highland Show and Arable Scotland, where the coloured barley lines stimulated a lot of interest from farmers. An article (Barley vous?) has also been written for Sustain: the alliance for better food and farming. This engagement has resulted in further funding from Innovate UK and Interface

Outcomes

Both barley lines studied were rich sources of fibre and micronutrients, but the Black Barley had a higher beta-glucan content with only 65 g of the flour (one large slice of bread) delivering the recommended amount to reduce blood cholesterol, as well as recommended nutrient intakes for several micronutrients. The Black Barley produced a significant reduction in blood insulin, although both barleys showed a trend to reduce blood glucose and insulin and with a higher number of volunteers this could be significant. An important characteristic of Black Barely is that it can go from field to table with less processing and could support food and drink innovation. These varieties being landrace crosses could potentially be more climate-resilient, as well as

requiring less pesticides and nutrients. Engagement with individuals at risk of type II diabetes suggests that there is a willingness to modify their diet to reduce risk. In addition biscuits were considered the most difficult to remove from the diet and they, along with bread, should be targets for reformulation.

Major outcomes of this project to date has been a clear plan for reformulation of flour-containing products and we have secured funding from Innovate UK (Better Food for All call) for a project; 'Transitioning Sustainable Crop Production into Innovative and Affordable Healthy Food Products for Hard-to-Reach communities in the North-East of Scotland' (£300K) to work with Murdoch Allan to develop these products at scale.

The results of this one-year project also provide valuable preliminary data for longer term funding exploring the health and climate credential of these barley lines. Related to the work on barley, we also received funding from Interface UK (£10K) to explore revalorisation of barley co-products.

Project Insights

This one-year project delivered valuable information, but volunteer recruitment post-covid, as well as new allergy recommendations for human studies was extremally challenging within this timescale. We were allowed a three-month no cost extension, but in retrospect, more time to recruit a higher number of volunteers would be desirable. Also in retrospect, one of the other barley lines looks to have more potential based on its chemical composition, but JHI were not in a position to supply enough material for the human study at this time. This line will be used for further investigations. However, we feel that the results of this project provided novel publishable information. It has led to funding from Innovate UK that could deliver genuine impact on shifting the composition of staple foods to provide more healthy alternatives and preliminary data for further work.

Next Steps/ Future Plans

We will work with our partners Murdoch Allan to reformulate staple baked goods and continue to engage with both farmers and processors to improve the quality of flour containing products. We have started discussions with Deans and Stoats (Scottish biscuit producers). We have also already started to put together an application with several partners to UKRI to fund a longer-term larger intervention with one of these barley lines, as well as to study the climate resilience potential.