Serial Utilisation of Whisky Co-products

Getting Every Last Drop

EXECUTIVE SUMMARY

Rationale

Whisky is Scotland's largest export, totalling £4.51bn in sales in 2021.[1] Scotland is home to around 130 distilleries[2], using both malt and grain. Once whisky has been produced, there are left over whisky co-products from the distillation process, including draff and pot ale. Of 115 Scottish distilleries surveyed, it was found that annually they produce 528kT of draff and 885kT of pot ale[3]. These co-products can be used directly as animal feed or as a feedstock in anaerobic digestion (AD) to produce biogas which can be converted into renewable power i.e. electricity and heat. When considering the hierarchy of value from co-products, there may be an opportunity to extract higher value products from whisky co-products before they're used for AD or supplied to farmers directly as animal feed.

Industrial Biotechnology (IB) companies are exploring a range of innovative uses for whisky co-products to enable additional, and higher value, end products. Currently most companies utilising whisky co-products extract only one component (e.g., protein, carbohydrate) and the rest is managed as a waste stream. This project brought together three small and medium sized enterprises (SMEs), currently extracting different products from whisky co-products. It enabled them to explore whether they could work together, each deploying complementary technologies, to extract the greatest value from whisky co-products to optimise yield and reduce end waste before it is used in AD or as feed.

The project set out to investigate whether it would be viable to extract more than one end-product using whisky co-products as a feedstock. Two of the companies use pot ale as a feedstock, but one extracts the protein fraction whereas the other extracts the carbohydrate, so one aspect of the project explored whether two products could be produced from one pot ale sample, using it in a serial manner to reduce waste. The third company uses draff as a feedstock but some of the draff from the process doesn't pass quality control for use in the final product, it is therefore considered a waste stream. The project explored whether the waste draff had any residual value that could be extracted and whether it could be used to enhance the process of the other two SMEs involved in the project.

[1] https://www.scotch-whisky.org.uk/newsroom/2021-exports-show-industry-on-road-to-recovery/

[2] https://www.scotch-whisky.org.uk/discover/distillery-map/

[3] https://zerowastescotland.org.uk/sites/default/files/ZWS645%20Beer%20Whisky%20Fish%20Report_0.pdf

Project Partners

The project partners of this innovative project were Zero Waste Scotland, the Industrial Biotechnology Innovation Centre (IBioIC) and the Scotch Whisky Research Institute (SWRI), Horizon Proteins, MiAlgae and Biopower Technologies. Zero Waste Scotland is interested in the potential for optimising the use of whisky co-products and co-funded this project. IBioIC is interested in the opportunities afforded by whisky co-products as feedstock for IB companies, and the potential for this project to demonstrate a serial approach to feedstocks to extract greatest value and minimise waste across other industry sectors. Much of the technology development was carried out in the IBioIC bioprocess scale-up labs FlexBio at Heriot-Watt University. SWRI are keen to understand the benefits that the project can potentially bring to Scottish distilleries and provided the pot ale needed for the technology development. The project would not have been possible without the involvement of the three innovative companies who have complementary technologies and a shared interest in deriving the value from whisky co-products.

Overview of Technical Project Partners

Horizon Proteins

Horizon Proteins, an enterprise spin-out from Heriot-Watt University in Edinburgh, uses pot ale to create feed ingredients for Scottish salmon in fish farms. Protein extracted from pot ale can replace soy protein and fishmeal, products normally imported from South America. The proprietary technology relies upon very low-cost separation techniques to isolate the main components of value in pot ale and recycle cleaned water. The yeast and protein components result in high-quality feed ingredients and the residual carbohydrate has value as an AD fuel.

MiAlgae

MiAlgae is an Edinburgh based biotech SME which uses a circular economy approach and a novel technology to connect the Scottish whisky and salmon industries. The company uses nutrients in distillery coproducts to grow microalgae as a sustainable alternative source of omega-3 for sales into the petfood and aquaculture industries. MiAlgae's technology offers the potential to save 80k tonnes of CO_2, recycle 14.4m litres of water and save 51,000 tonnes of wild caught fish annually, using the outputs from a single distillery.

Biopower Technologies

Biopower Technologies' primary focus is on the use and application of draff as a flour product for use in food and bakery. Biopower has developed a unique milling technology that allows the draff side stream to be converted into flour. This technology

has been successfully demonstrated as a fibre and protein containing ingredient. Biopower's unique technology also enables dry biomass to be milled such that it burns as efficiently as a gas.

Key Findings

It was agreed at the start of the project by all partners that the pot ale should be anonymised and SWRI would work with a distillery, 'Distillery X', to obtain fresh pot ale samples for use in the project. The draff used in the project was obtained from Biopower Technologies. The draff used in the Biopower Technologies process must be less than 50 microns after milling, any milled draff that does not meet the particle size requirement is considered a waste stream. Alternative uses for this waste draff were explored as part of the project. Technology transfer work with the partner companies was undertaken ahead of integrating bioprocesses and then the partners technologies were integrated.

The findings from the integration work concluded the following:

1. Proteins were successfully extracted from the effluent generated through MiAlgae's fermentation process and purified using Horizon Proteins' technology.

2. The deproteinated effluent from Horizon Proteins was successfully used as a component in MiAlgae's fermentation process. However, yeast extract had to be added to replace the protein content that was removed. The yeast that is removed during the Horizon Proteins process could be added back to the deproteinated sample in the future, but further research is required.

3. Proteins including hordeins and glutelins were successfully extracted from draff by Biopower Technologies using pH solubilisation and Horizon Proteins' processing. Further investigations are required to determine if this product has a specific market and value or if they could be used to enhance Horizon Proteins' process.

4. From the analytical work undertaken on the anonymised pot ale samples, variations were identified between the samples provided by Distillery X, most notably variances in yeast cell content and carbohydrate. These variances could potentially be due to differences in sample collection, but it would be useful to better understand and 'standardise' the pot ale, e.g., age, collection procedure, raw materials in future studies.

5. From the logistics analysis and consultation undertaken, it was found that the initial high cost of installing the required plant machinery at site to carry out each of the detailed processes could deter distillers. As such, it is considered logical

to develop centralised locations that can handle each aspect of the processes and allow for a single site to process the final products to their respective end points.

6. When exploring suitable locations for a single processing site, it was found that while Grangemouth offers a suitable location for central Scotland, it would be beneficial to investigate suitable land within Speyside. Speyside hosts an abundance of distilleries (over 50) within close proximity to one another, thus offering a prime location to trial a self-contained central facility that could perform every aspect of each process. Haulage costs within Speyside would be a fraction of those seen within central Scotland.

Conclusion

This project demonstrates the viability of using different technologies to produce multiple end products from a single feedstock. This will enable companies to develop synergies and significantly reduce the volumes of feedstock required, reduce waste and maximising product yields. This could be the first in a series of projects where other technical partners and feedstocks could be explored.

Future directions

This project has demonstrated that it is possible to utilise whisky co-products in a serial approach. This was demonstrated at a bench top scale and a follow-on scale-up project will be required to demonstrate the viability of this approach at commercial scale. The companies will continue to work together to progress this and target funding opportunities for follow on research and development.

Other Research Opportunities

Pot ale sampling showed variations between batches, and it would be beneficial to undertake further work to understand the reasons for these variations and develop a method for standardising pot ale sampling.

The logistic analysis identified that a centralised location would be beneficial from a financial point of view and that Speyside is the best region to explore as a potential location due to its proximity to many distilleries. The viability of this approach could be further explored in a follow-on project.


Horizon Proteins
MiAlgae
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