Business Interaction Voucher Awards 2018

Controlling red mites in egg laying farms using biochemical compounds derived from gender screened (male) eggs in hatcheries

Award Holder: Alex Conradie, University of Nottingham
Industrial Partners: Hendrix Genetics & In Ovo B.V.

Project Outcome Public Summary
The poultry red mite, *Dermanyssus gallinae*, has long been recognised as a significant threat to the egg laying industry worldwide. Approximately 83% of European egg farms are infested; reaching 94% in Belgium, Germany and the Netherlands. Mite infestations negatively impact upon feed conversion ratio, egg production, egg quality, disease susceptibility, mortality rate and flock stress. Overall the damage imposed by red mites in Europe has been estimated at approximately €230 million per annum (Flochlay et al., 2017).

The development of resistance to previously effective acaricides has reduced the number of safe and approved treatments available to farmers, a problem highlighted by the 2017 fipronil crisis where inadvertent use of banned insecticides caused contamination and recall of millions of table eggs. A sustainable approach to controlling infestation is required. This project has evaluated fourteen aromatic compounds as acaricides. Four compounds were found to be highly effective acaricides. The techno-economic feasibility of producing the lead compound was assessed and the investment analysis was subject to uncertainty simulation. Reaching towards a circular economy, sustainable production of acaricides will entail the use of gender screened (male) eggs from hatcheries as complex media in fermentation, producing aromatic acaricides in microbial fermentation from this food waste to sustainably control red mite infestation in poultry houses.

Isolation of industrial strains from spent grain used for whisky production

Award Holder: Julie Hawkins, Napier University
Industrial Partner: Celtic Renewables Ltd

Project Outcome Public Summary
The project aims to isolate a proprietary solventogenic clostridia strain from the by-products of the whisky distillery industry, the spent grain (draff) and liquid water effluent from the distillation process (pot ale). Solventogenic clostridia have been isolated from numerous sources, including cereals previously (McCoy. 1926. J. Infect. Dis. 39). Solventogenic clostridia have the ability to convert a number of waste streams and industry by-products to produce chemicals such as Acetone, Butanol, Ethanol (ABE). All of which are net imports into the UK. The success of the ABE industry relies on a sustainable feedstock and strain capable of efficient feedstock utilisation and high product formation. A proprietary strain could potentially add further competitiveness and value to the ABE industry, through improved substrate use, increased product formation and robustness. The industrial partner Celtic Renewables (CRL) employs a circular economy principal, producing ABE and high protein animal feed using draff and pot ale, by-products of the Scottish whisky industry, as substrates. This diverts them from economically and environmentally costly disposal, allowing further value to be derived. CRL are to commission a commercial demonstration plant (end 2019) in Grangemouth, Scotland providing an industrial testing ground for an isolated strain. Such an isolated strain could benefit the UK ABE industry by increasing competitiveness, which in turn encourages further plant builds as well as displacing reliance on fossil fuels and bringing national chemical and energy security.
In this study, 54 presumptive *Clostridium* spp. were isolated and successfully produced solvents in laboratory scale fermentations. Among those with high level of butanol and solvent yield, four isolates were selected for further identification by 16S sequencing. While one of the isolates was confirmed to belong to *Clostridium* spp., the other three isolates were confirmed to species level as *Clostridium beijerincki*, a well-studied species for biobutanol production. The promising results suggest these three isolates have the potential to be developed as propriety strains for the CRL and would benefit from further investigation.

**Pilot scale production of Petroselenic Acid (PSA) from Horse Parsley seed cake**
Award Holder: Juma’a R Al Dulayymi, Bangor University
Industrial Partner: Naturiol Bangor Ltd

**Project Outcome Public Summary**
The project demonstrated that petroselenic acid (PSA) could be extracted and purified from harvested horse parsley (*Smyrnium olusatrum*) seed material, using industry appropriate techniques for solvent extraction and downstream processing.

An oil extraction trial, performed at New Holland Extraction, using an industrial solvent extraction process has generated data to greater understand the extraction properties of the horse parsley seed and establish a base line comparable to operation on NHE’s main full scale-plant. A key technical issue was the relative high moisture content of the seed that has impacted yield results and has potential to impact storage of harvested seed longer term. It was felt that conditioning or drying of the seed may improve oil recovery and seed drying trials were examined by the Biorenewables Development Centre.

Preparation of the crude PSA free fatty acid by caustic hydrolysis of the solvent extracted oil was reproducible between batches, with results indicating that up to 90% of the oil was converted to a mixed free fatty acid. Purification of the crude PSA, by cold crystallisation, increased PSA purity content to around 85%, with an associated reduction in oxidatively unstable polyunsaturated fatty acids. A yield recovery of purified PSA product was determined to be around 30%. The fatty acid profile and supporting NMR data confirmed similar product purity to that achieved previously at laboratory scale by Bangor University.

The pilot trial has produced baseline data on equipment representative of commercial seed oil extraction, with recommendation for improvements. Over 250g of purified PSA has been produced to feed into future cosmetic application trials.

**Using waste apples to grow the worm *C. elegans* for biotherapeutic production**
Award Holder: David Weinkove, Durham University
Industrial Partner: TeeGene Biotech Ltd

**Project Outcome Public Summary**
The small nematode worm *Caenorhabditis elegans* can be grown very easily in the laboratory using a strain of *E. coli* on a food source. We have used this worm to make a protein that is normally made by parasitic nematodes and has the potential to treat immune diseases such as rheumatoid arthritis. This protein works by modulating the immune system but currently can only be isolated from parasitic worms grown in lab rodents. The nematode *C. elegans* is found in nature in rotting apples. Thus, we reasoned that waste apples might be used to grow these nematodes. In this project we showed that a strain of bacteria that was isolated from decaying apples can be grown with apple juice as the sole nutrient and can be used to support *C. elegans* growth and that those nematodes can produce a version of the therapeutic protein. Thus, we have established a potential route to convert waste apples into a high-value product. We have enhanced our relationship with TeeGene Ltd and we are looking into acquiring funds for the next step in development towards industrial production.
Functionality enhancement of vegetable fibres by mechanical and enzymatic processing towards novel materials
Award Holder: Francisco M. Goycoolea Valencia, University of Leeds
Industrial Partner: Biopower Technologies Ltd.

Project Outcome Public Summary
The use of fruit and vegetable side streams for the creation of higher value products is critical to moving towards zero waste solutions. In the UK, the production of carrots exceeds the 600 thousand tonnes per year while celery is around 60 thousand tonnes per year placing UK as the third larger producer of this vegetable within Europe. By-products from the cultivation of such vegetable crops have been converted into powder materials by micronisation processing offering a source of copious and cheap dietary fibres for a range of applications that could reduce the amount of food waste going to landfill. Further processing of these materials can enhance their functionality to be used as food additive structures.

In this collaborative project, we have explored the use of green technologies to treat the waste materials in three directions: 1) Mechanical processes involving the use of high shear, high pressure or ultrasound, 2) Enzymatic process and 3) Hybrid process combining the use of both previous technologies. The effect of these treatments has been assessed by measuring changes to their physicochemical properties, mainly: the solubility, hydration properties (water holding and swelling capacities), particle size and bulk volume oil holding capacity and microstructural properties (an insight into their surface and morphology) all of which can contribute to their performance in the final application.

The results have shown that all processes applied can modify to some extent the properties of the materials, where mechanical methods mainly have shown to open up the fibre microstructure previously formed by micronisation, allowing improving the conversion of insoluble into soluble fibre when applying an enzymatic treatment showing a synergistic effect. Subjecting the micronised fibres to mechanical processing has shown to contribute positively to enhance some important technological properties such as their oil holding capacity (OHC) which has seemed to be fibre type dependent. For carrot fibres, a five-fold increase was observed in OHC compared to that exhibited by untreated ones. This opens new functionality alternatives. For instance, its use as natural emulsifiers in food products.

The main outcome of this project shows that applying different treatments and the combination of these can improve the functionality of materials in different ways in food applications. In this specific project, treated fibres have been observed to strengthen pea protein gels. This functionality can be translated to other similar food systems.

Valorisation of avocado skin waste
Award Holder: Gary Black, Northumbria University
Industrial Partner: Greencore UK Centre

Project Outcome Public Summary
This project was a collaboration between Greencore Group PLC and Northumbria University. Greencore Group PLC use large amounts of avocados in their food to go and sushi products. However, only the flesh part of the avocado is used resulting in the skin and stone being wasted. This project has identified using a metabolomics approach that the metabolite content of both the peels and seeds display a higher than expected sample complexity. There is therefore significant potential for further development, most likely via Innovate UK funding in collaboration with Greencore, as both seed and peel do indicate they are a potential source of renewable chemicals.