Australian Government
Department of Agriculture and Water Resources

Taking the next step forward in **biofuel technology**

New research is looking at not only the potential to turn bagasse into biofuel, but also adding value to it by transforming it into advanced forms of biofuels such as jet fuel.

The production of ethanol from sugarcane juice and molasses is well understood.

But it is the potential to create advanced biofuels – such as aviation fuel – from bagasse that could be the next step forward for the Australian cane industry.

This is the focus of a major research project that is looking at adding value to the sugar industry by providing a research foundation to create biorefineries alongside the existing sugar industry.

The project is funded by the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit program, along with funding from Sugar Research Australia and the Queensland University of Technology (QUT).

One aspect of this project is looking at the conversion of bagasse into products called microbial oils, which can then be used as a feedstock to create advanced biofuels.

This part of the project is being led by Dr Jan Zhang at QUT, where he and his team have studied different ways of converting bagasse into microbial oils and ensuring maximum yield.

"These oils created from bagasse have very similar properties to algae oil and vegetable oil, and can be used to create biodiesel," Dr Zhang said.

"However, we know that we can generate greater value by targeting the production of advanced fuels."

Why aviation fuel?

Fuel for aviation, whether it be consumed by major commercial airlines or other users such as defence departments, has much higher quality requirements than traditional fuel.

It needs to be able to withstand the risks of icing and explosion and comply with other safety and regulatory requirements. This means it is a higher value product than traditional fuel.

In addition, there is a growing appetite for the production of sustainable aviation biofuels. Australian airlines such as Virgin and Qantas have previously signalled their intent to increasingly use biofuels in their fleets, and successful demonstration flights have already occurred using alternative aviation biofuels.

Defence forces have also expressed their desire to increase their consumption of biofuel. The US Navy has made a commitment to source 50 percent of its fuel from renewable sources by 2020. Last year, they also signed an agreement with the Queensland Government that outlined a commitment to explore research, development, supply and sale of advanced drop-in alternative fuels.

A CSIRO road map on biofuels for aviation indicated that the percentage of bio jet fuel in Australia could be up to 40 percent by 2050.

What is needed

End-users are looking for biofuels to be drop-in products to replace fossil fuels, so they can avoid any changes or redesign to aircraft and systems. They also need to continue to meet the high safety standards already in place, while reducing carbon emissions.

The cane industry

Biofuel – and high value biofuel – can be produced from a wide range of sources and feedstocks. But this research is helping the Australian sugarcane industry into a position to assess the viability of this fuel production, prove the concept, and then capitalise on opportunities when they occur.

The research

The first part of the process is converting the molasses and bagasse into microbial oils, with the research teams using micro-organisms for this process. They have worked on two different approaches: one using filamentous fungi and another using yeast.

To be successful, a process would need to deliver a high oil content (50 percent to 70 percent), as well as a high biomass. This means ensuring a high yield of oil from the bagasse. Dr Zhang said that there were challenges with both, as well as opportunities.

Using the filamentous fungi creates a risk of quality control because it can grow in various morphological forms, as well as posing cultivation problems that mean not enough biomass is created.

However, he said that they had developed a morphological control method and used one strain of the fungi that could accumulate up to 70 percent of its dry biomass as oil, which is very high.

"Currently we can achieve more than 20 grams (gm) per litre of microbial oils from fermentation of molasses. That is a very significant achievement. When we started the project in 2016, the concentration was less than 5 gm per litre, and we are still working on improving the concentration further, and replacing molasses with lower-cost substrate–bagasse, " Dr Zhang said.

The second process, using yeast, does not present the same control problems as the fungi, meaning it may produce more biomass. However, the oil content may be lower. One current strain of yeast accumulated up to 45 percent of its biomass as oil, based on preliminary screenings.

A PhD student is working on this part of the project and will develop it further to improve oil production by the yeast.

The next step

A process called hydrothermal liquefaction (HTL) is used to convert the oleaginous microbial biomass into bio-oils, from which advanced fuel is produced through catalytic cracking processes.
QUT researchers are working on the HTL process and will collaborate with Southern Oil Refining to test and demonstrate the oil-upgrading process for advanced biofuels.

There remain a number of policy and infrastructure hurdles for the development of this technology, but the research is providing a valuable foundation for the future.

As the project also involves other industries, other aspects of the project are looking at research avenues such as using animal waste products to create the advanced biofuels, and also if the bagasse-based oils can be turned into nutraceuticals, which are in turn much higher value than the advanced fuels.

The Biorefineries for Profit project is funded by SRA and QUT and the Australian Government Department of Agriculture and Water Resources as part of its Rural R&D for Profit program.