FEATURE

Next generation biofuels

The Waste2Fuels project aims to convert food waste into high-value product, mainly biofuels, without competing with feed or food production. TEAGASC researchers are going to valorise the agri-food wastes and by-product from fermentation for biofuels by extracting high-value by-product from them using novel green extraction technologies.

One of the major challenges Europe will face in the coming decades is to make its energy systems clean, secure and efficient while ensuring European Union (EU) industrial leadership in low-carbon energy technologies. The production of sustainable biofuels that generate a clear and net greenhouse gas (GHG) saving without negatively impacting on biodiversity and land use is one of the main EU objectives. Low cost, good availability and supply, together with reasonable transportation and upstream processing costs to obtain fermentable sugars, are the most important factors to be taken into account when selecting biomass sources as raw materials for biofuels production.

Agri-food waste

One of the main untapped sources of biomass potential lies in agri-food waste (AFW). Each year in the EU alone, 89 million tonnes of food waste is produced. Recent reports from the Food and Agriculture Organisation of the United Nations (FAO) estimate that as much as 50% of the food produced globally is lost or wasted. Once other higher value valorisation routes have been realised, a huge volume of readily available, renewable, untapped biomass from the lower value fractions can be converted to an enormous amount of energy and high-value co-products. Organic crop residues, for example, including fruit and vegetable residues and processing by-products such as pulp, seeds and peels, pomaces and trimmings, and rejects, comprise an important source of sugar, lipids, carbohydrates, mineral acids, inorganic compounds, dietary fibres or phytochemicals (including phenolics, carotenoids and tocopherols), which can be valorised towards bioproducts and biocompounds. The remaining fractions are very high in cellulosic materials (cellulose and hemicelluloses) but low in lignin, making them potentially good for fermentation processes and, thus, for biofuel production. High sugar content beverage wastes are also good candidates for fermentation. Assuming that about 0.1% of the yearly market flows in industrial wastewater streams (e.g., process wastewaters, seizures of badly-repaired or illegal goods, and stocks after their expiration date), about 70,000m^3/year could be remediated in the EU. In fact, the disposal of waste beverages is a critical issue for the industry because of the cost of the treatment (up to €500/m^3) due to the high COD (chemical oxygen demand) and the suspended solid concentration.

Waste2Fuels project

The Waste2Fuels project aims to develop novel and optimise existing technologies in order to convert unavoidable AFW (food waste and agricultural residues) streams into high-value products, like biochemicals and mainly biofuel – butanol – for use as a direct substitution for virgin fossil fuels (**Figure 1**). Butanol is one of the most promising biofuels due to its superior fuel properties compared to bioethanol and biodiesel, which are the main biofuels at the moment. In addition to its ability to reduce carbon emissions, its higher energy content (almost 30% more than ethanol), ability to blend with both petrol and diesel, lower risk of separation and corrosion, and resistance to water absorption, allowing it to be transported in pipes and carriers used by petrol, butanol offers a very exciting advantage for adoption, as engines require almost no modifications to use it.

Contributing to EU policies

The Waste2Fuels project has the potential to significantly reduce the burden on land use for biofuels not only in Europe but worldwide, along with dramatically improving conversion efficiencies of current biofuel production technologies. Moreover, it would significantly reduce the ever-increasing environmental problem of waste

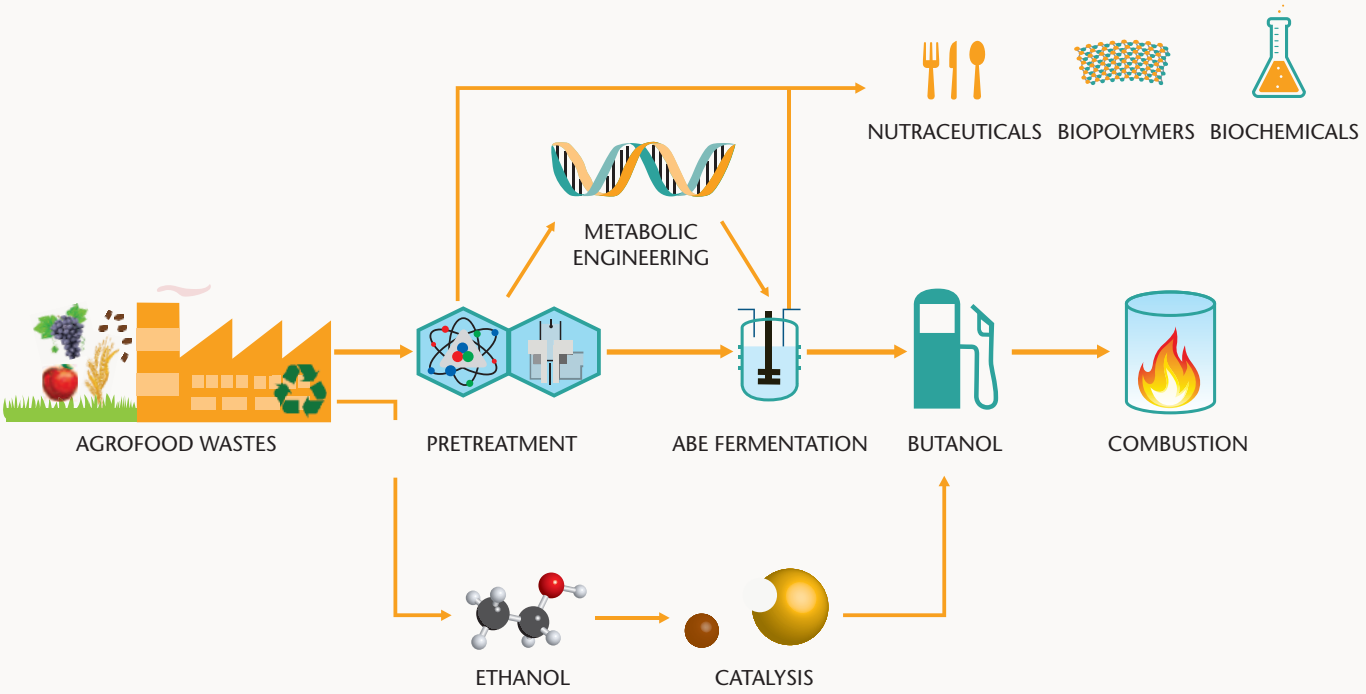

Figure 1: Waste2Fuels – a project for next-generation biofuels.

management and the landfill use for waste deposition. This is a very significant and timely development that can contribute to EU legislation specifying a reduction of GHG intensity of the fuels used in vehicles by up to 10% by 2020 – a low-carbon fuel standard. It will also contribute to the European policy target of reducing food waste by 50% and the 27% renewable energy target by 2030. Developing and optimising the AFW-to-fuel pathway would provide an immediate solution to the growing volumes of waste and create a sustainable, secure, stable and indigenous source of fuel for Europe with a positive energy balance. The waste-to-fuel (Waste2Fuels) technologies would also create opportunities for environmental and social gain by reducing the negative GHG implications of using fossil fuels. It would also contribute to the creation of significant employment opportunities – both directly in the conversion of waste streams into fuel and indirectly through feedstock preparation in the value chain, including increased sorting, capturing and recovering of biowaste.

Waste2Fuels aims to produce biobutanol as a sustainable alternative fuel contributing to decentralised energy production and towards EU energy security, and will enlarge the current biomass feedstock basis by the development of next-generation biofuel technologies capable of converting unavoidable AFWs into high-quality biobutanol. It is envisaged that by valorising 50% of the unavoidable and undervalorised AFWs as biomass feedstock for butanol production, we could potentially prevent up to 45 million tonnes of food waste ending up in EU landfills, preventing 18 million tonnes of GHG and saving almost 0.5 billion litres of fossil fuel. In doing so, Waste2Fuels would make a major contribution to leading the EU into the next generation of sustainable butanol, domestic bioenergy production and advanced AFW management.

Teagasc's contribution to the project

Another pathway to valorise the AFWs in the project is to extract high-value bioproducts, like nutraceutical components or biopolymer, from the AFWs. Designed as a sustainable technology, the by-product after butanol fermentation is also used to extract valuable components. Teagasc uses green novel extraction technologies, like power ultrasound-assisted extraction, microwave extraction, enzymatic extraction and their combinations to complete the extractions. These novel extraction technologies considerably increase yield, shorten extraction time, and reduce energy consumption.

Acknowledgements

The Waste2Fuels project is supported by Horizon 2020 (EU R&D programme) grant agreement no. 654623. For more on the project, see http://www.waste2fuels.eu/.

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